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20 technologies to improve your EV development program
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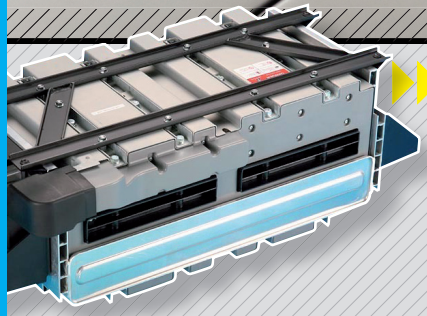
January 2011



Two **micro gas turbines**, four electric motors and a Li-ion battery pack

Jaguar showcases its electric future. Exclusive details inside

January 2011



BATTERY RECYCLING:
With EVs gaining in popularity, the industry now faces a new dilemma

TIRE TECHNOLOGY:
It's one thing to create advanced EVs, but what about the tires that these green saviors will ride on?

LOTUS INTERVIEW:
Former AMG man, Wolf Zimmermann, reveals his powertrain vision for the British marque

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JANUARY 2011



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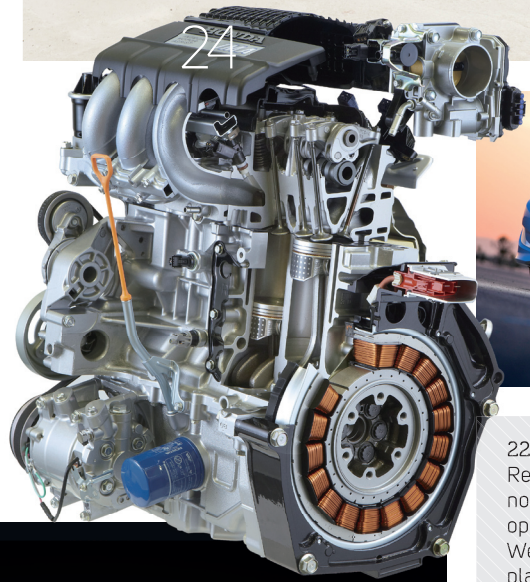
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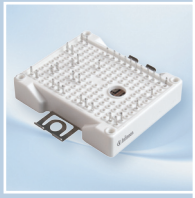


Cost-effective and compact solution for auxiliary applications in xEV

Automotive Easy 1B/2B power modules



Easy 1B

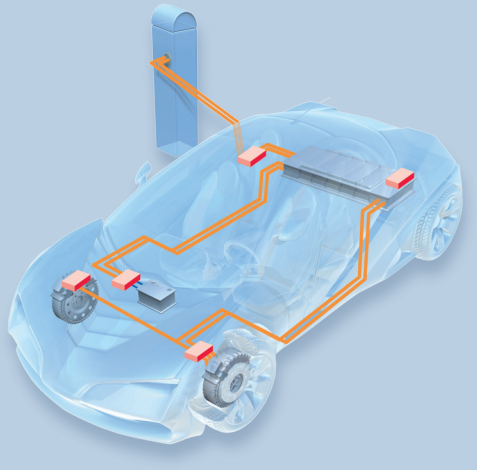


Easy 2B

The new fully automotive-qualified Easy 1B and Easy 2B power modules provide a cost-effective, compact and flexible platform for applications with a power range of up to 6kW. The Automotive Easy modules are based on the popular industrial Easy power module family which has established quite a reputation for itself since its launch several years ago.

The availability of a high-voltage battery system in both Hybrid Electric Vehicles and Electric Vehicles provides the opportunity to increase the efficiency and reduce the cost of applications that are currently supplied by the low-voltage board net (14V) in IC engine vehicles. These systems include: air conditioning compressor, oil pump, cooling pump, power steering, heaters, auxiliary (HV to LV) DC/DC converter and charger.

All these different topologies can be addressed with customizable Easy-based modules. And it's flexible! You can choose your own layout, power components and package pin-out.



The Automotive Easy modules come with press-fit connections for quick and easy mounting and are fully automotive-qualified. Additional key benefits include reliable isolation, low stray inductance and NTC for temperature sensing.

Products based on the Automotive Easy modules are already in development for auxiliary drives, PTC heater and auxiliary DC/DC. Engineering samples are available on request.

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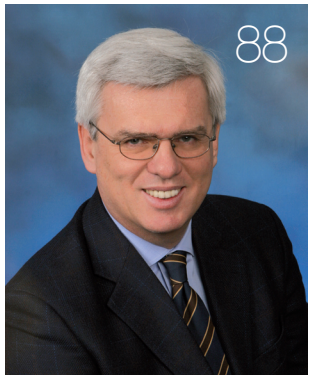
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Editor's Note

It's the Paris Motor Show. My mobile phone rings. Having spent the morning rushing from one stand to another, interviewing engineers and getting exclusive technical stories on the new breed of electric powertrains, I decide to afford myself a five-minute break and tuck into some free sushi courtesy of Mazda. I look down at the phone, hit the green button and accept the call. Mouth full of raw fish and rice, I mumble, "Hello". On the other end is a Lotus PR, asking if I have 20 minutes to speak to their new chief technical officer, Wolf Zimmermann.

"Zimmermann?" I splutter. "Zimmermann as in Mr Mercedes-AMG Wolf Zimmermann?" Phone off, sushi down and notepad in hand, I scramble from my Mazda lunch spot to Hall One – home of Lotus at the Paris Motor Show.

Now, I'd heard quite a lot prior to Paris about the so-called 'Lotus revolution' – grandiose plans to regalvanize the company and its sports car range. Like many, I was skeptical to say the least. A whole load of hot air, I thought, from a company with a renowned engineering division, but not much to shout about on the product front.

I arrive at the Lotus setup to be greeted by the PR. I know Zimmermann from days of old, having spoken to him many times in his previous incarnation. But while he has always been a little leftfield, flamboyant, and even quirky, one should not forget that he's had a huge hand to play in the growth of AMG and its award-winning powertrains, from the 6.3-liter V8, to the new 5.5-liter bi-turbo and the electric SLS AMG.

Some 22 minutes and two espressos later, the Lotus PR calls time on my interview with Zimmermann, and I can honestly say I'm only a little wiser about Lotus and its revolution. Granted, there are at least five new sports cars on the horizon, massive investment planned for the car maker's production facility and an electric powertrain future that Zimmermann insists will become reality. These are ambitious, lofty plans for a niche sports car maker that has struggled in recent times. But I'm wondering if this is just clever spin?

Back on the Mazda stand, I indulge in some more sushi, and my precious few minutes allow me time to digest Zimmermann's words. Okay, there are lots of changes going on at Lotus and a great deal of PR and marketing activity is taking place too. But the biggest indicator of impending change comes not from the press releases and all the marketing hype, but from the simple fact that Zimmermann would not have swapped Offenbach for Hethel lightly. His appointment alone makes me reassess the potential for evolution at Lotus. With an engineering division that most car makers can only dream of, I can only hope that Zimmermann and co can realize their Lotus dreams. As the man succinctly put it himself: "I saw the future product range and the investment they're planning to bring in. This is one cool project and I had to be part of it."

Dean Slavnich

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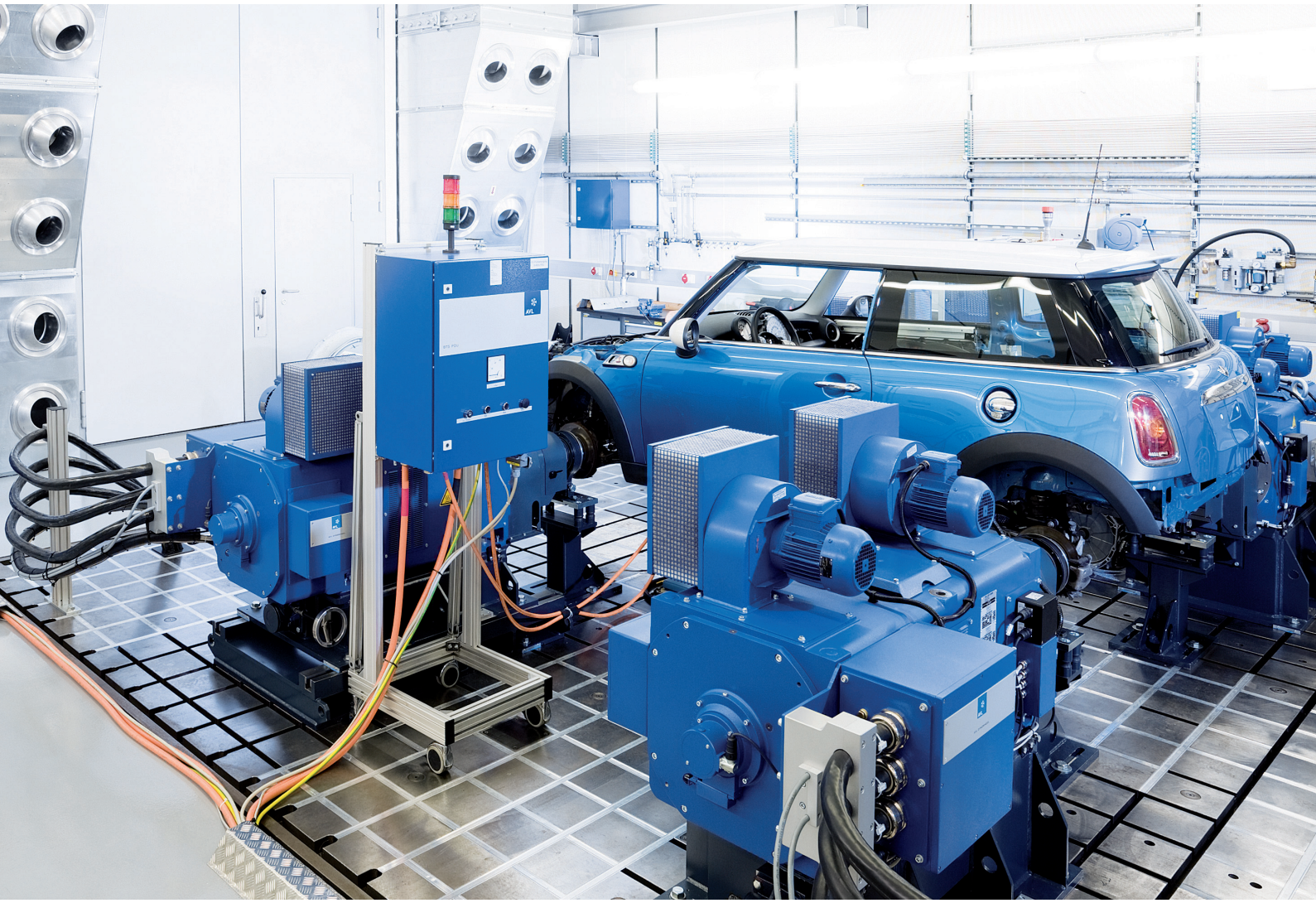
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Jet Power

It might only be a technology demonstrator, but the **C-X75** is an eco-friendly supercar that outlines **Jaguar's** powertrain direction



WORDS: **DEAN SLAVNICH**



Jaguar says C-X75 is to electric mobility what XJ13 was to the then new V12

Determined for history not to repeat itself – Jaguar has already had to play catch up to its German premium rivals when it came to offering diesel products and estate derivatives – the British big cat marque stunned visitors at the Paris Motor Show last month with a surprise range-extended electric supercar concept.

The talk prior to Paris was that Jaguar would showcase some sort of EV technology, but most assumed it would be the XJ sedan that was born out of the Limo Green project with Lotus Engineering. How wrong we all were.

Unveiling the C-X75, Dr Ralf Speth, Jaguar Land Rover CEO, proclaimed: "This car demonstrates that the company is still leading the field in automotive design and technology." And the C-X75 is a real engineering showcase. Shorter and lower than the current crop of supercars on the market, C-X75 features a propulsion system that has four powerful electric motors – one placed at each wheel of the tech demonstrator – to produce 144kW (195bhp) each. In total, that's 780bhp on tap!

At the center of the two-seater Jaguar sits two advanced, mid-mounted gas-turbines that have been developed with Bladon Jets, and these twin turbines act as the range extender to the four electric motors. The miniaturized turbine blades – the first ever viable axial-flow micro-turbine – increases the compression and overall efficiency of the micro gas-turbines to the point at which they can be used as a realistic power source. Each of the micro gas-turbines weighs just 35kg and produces 70kW of power at a constant 80,000rpm, all of which means that the two turbines require 35,000-liters of air a minute, which is why the C-X75 has several carefully honed intakes.



Bladon Jets supplied two micro gas turbines that produce 70kW

VITAL STATISTICS

PROPULSION SYSTEMS

Electric motor: Four traction motors developing 145kW each

Generator: Two switched reluctance generators

Range-extender power: Two gas micro-turbines developing 94bhp each

Batteries: Lithium-ion

Transmission speed: Single-speed

Final drive ratio: 3.1:1

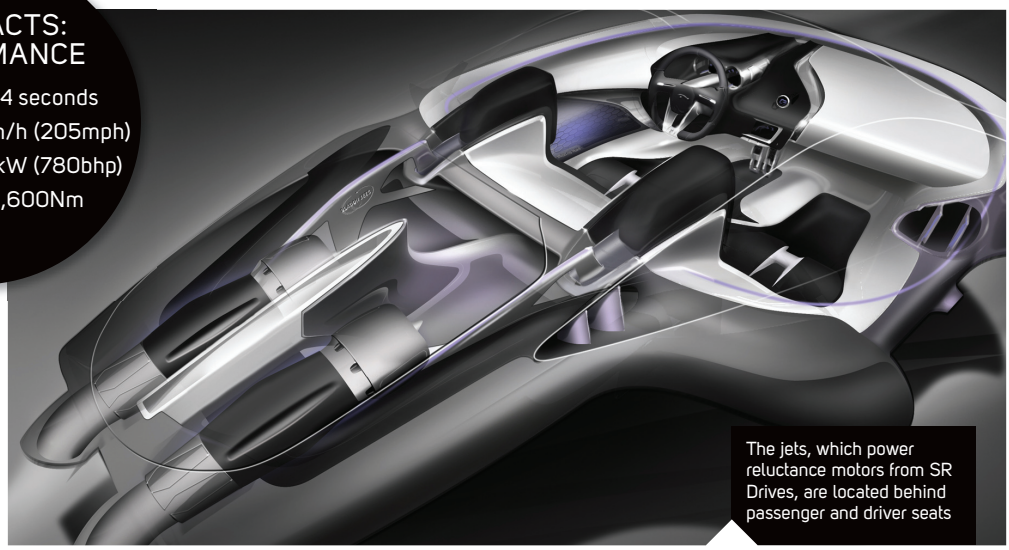
In addition to such punch, the turbines also have ample power to charge the Li-ion batteries and extend the range of the car to an impressive 560 miles, which in the real world is a London to Berlin run on one tank! The turbines are sealed in an airbox behind the driver and passenger seats. A six-hour plug-in charge of the Li-ion batteries enables an all-electric driving range of 68 miles.

Jaguar claims that the turbines have a number of advantages over a reciprocating piston engine when powering range-extended generators. With fewer moving parts and air bearings, the turbines do not need oil lubrication or water-cooling systems, all of which offers key weight-saving

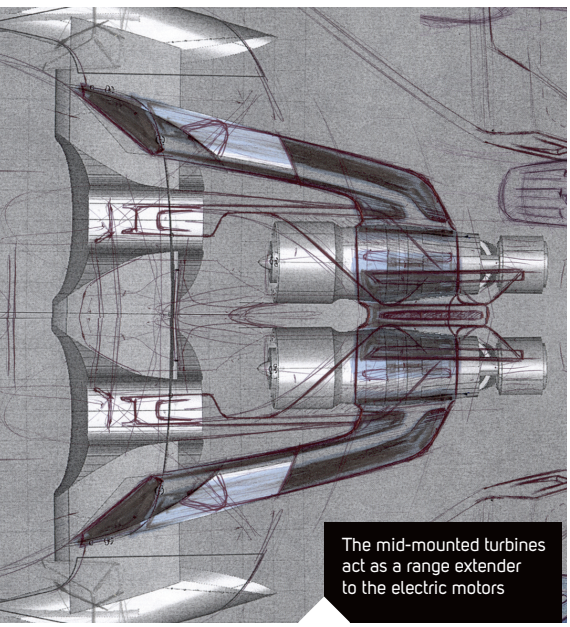
FAST FACTS: PERFORMANCE

0-100km/h: 3.4 seconds
Top speed: 330km/h (205mph)
Max power: 580kW (780bhp)
Max torque: 1,600Nm

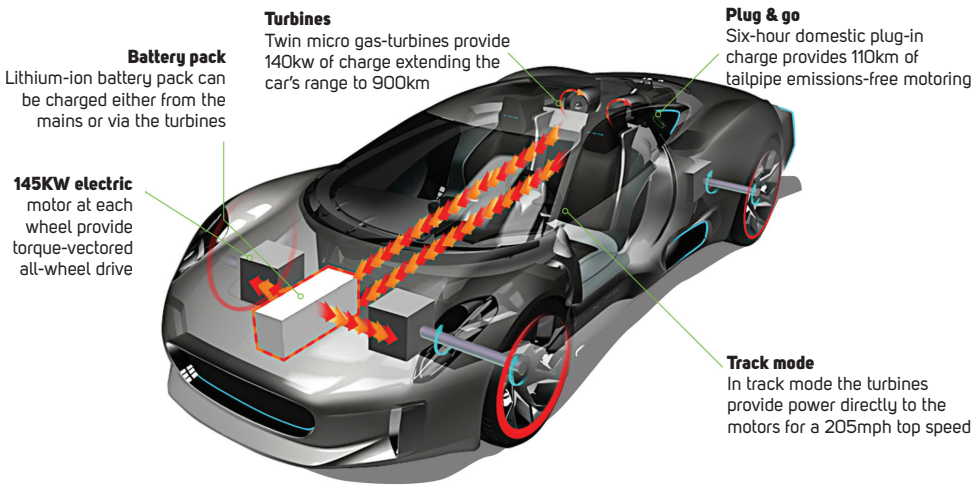


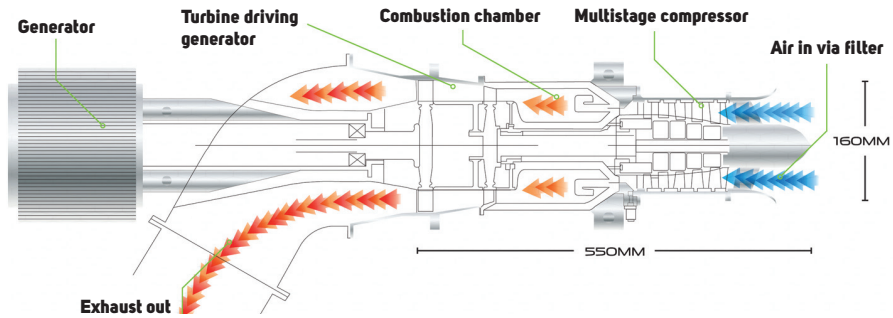


The jets, which power reluctance motors from SR Drives, are located behind passenger and driver seats



The mid-mounted turbines act as a range extender to the electric motors





benefits. The turbines can also run on a range of fuels including diesel, biofuels, compressed natural gas and liquid petroleum gas.

The micro gas-turbines power two switched reluctance motors that come from SR Drives. The four electric motors – which weigh 200kg in total; 50kg each – provides torque-vectored, all-wheel drive traction and grip, a key feature for a car that generates 1,600Nm of torque. It might all sound pie-in-the-sky, but Jaguar engineers insist that just as the XJ13 acted as a testbed for a new engine, so the C-X75 offers a similar role for "potential solutions to the challenges posed by environmental concerns".

The combination of huge power and even greater torque means that Jaguar's official performance data on the C-X75 must be taken as given: the concept sprints to 100km/h in just 3.4. Top speed is in excess of 200mph. Such is the huge, instantaneous power on tap, the C-X75 will accelerate from 80-145km/h (50-90mph) in just 2.3 seconds. The quarter-mile sprint takes 10.3 seconds at a terminal velocity of 156mph. Acceleration peaks at 0.88G.

As expected, C-X75 emits zero emissions in all-electric mode, but even when relying on the range-extended micro gas-turbines, the supercar spews only 28g/km of CO_2.

FAST FACTS: ECONOMY

Fuel tank capacity: 60 liters
Extended range: 560 miles
CO_2 emissions: 28g/km
EV range: 68 miles



Sonata Hybrid features a lithium polymer battery that offers good isolation of high-voltage parts

Seoul mate

The Sonata Hybrid will not only be Hyundai's first hybrid product in the USA when launched next year, it will also be a hybrid with a real difference, using breakthrough lithium polymer batteries

The Hyundai Hybrid Blue Drive is a full parallel hybrid-drive system developed after ten years of R&D. Hyundai says it delivers the same power with 35% less weight, 40% less volume and 12% better efficiency compared with NiMH battery units. In the Sonata, Hyundai is forecasting 40mpg on the highway, with 0-60mph in about 9.2 seconds.

Polymer perfection

Project leader Dr H. S. Lee says that the lithium polymer system offers easy assembly, high levels of serviceability, and good isolation of high-voltage parts. The battery sensing system continuously monitors voltage, current and temperature, state-of-charge and power limit, as well as offering built-in active and passive battery protection. Hyundai's partner in this long-term R&D project is LG Chem, which has a blossoming subsidiary in the USA called Compact Power. Hyundai's proprietary full parallel architecture differs from the power-split technology used by most companies, thus enabling significant efficiency advantages at higher speeds. Hyundai's novel idea is the first such system using lithium polymer battery technology, effectively leapfrogging the current competitive NiMH and lithium-ion applications. This engineering setup is unique in its use of the company's six-speed transmission fitted with a clutch instead of a torque converter, modified with a hybrid starter-generator, an electric motor, and a low-friction oil pump, all of which eliminate the need for a traditional torque converter.

Frugal fleet

According to the EPA, Hyundai has led the US auto industry in fuel economy for the last two years, and is currently the only OEM with an average fleet fuel economy of more than 30mpg.

Enhancing this stat is that Hyundai says the Sonata Hybrid delivers best-in-class highway fuel economy, while still delivering a 40% improvement in city fuel economy compared with a Sonata equipped with a 2.4-liter Theta II GDI engine.



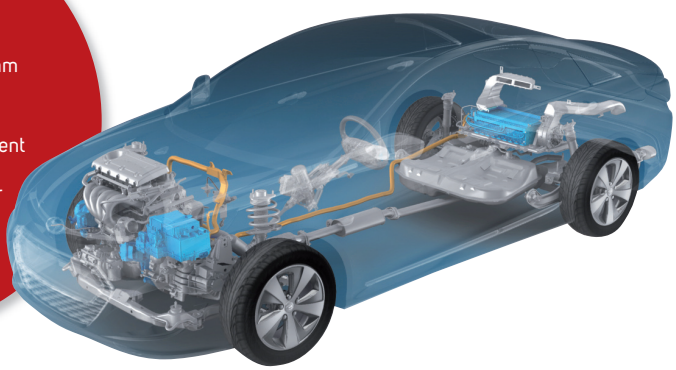
The system's two propulsion units develop a total output of 209bhp at 6,000rpm and 265Nm of torque, with 205Nm coming from the standard 2.4-liter GDI engine.

Where the competition uses a power-split system with a planetary-gear CVT, the Sonata Hybrid gains a key advantage: competing hybrid models use electric motors that have to power a planetary gear set. By utilizing a full parallel drive system, Sonata Hybrid uses the power from the electric motor to control the vehicle directly, enabling it to be operated at much higher speeds than the competition in EV-only mode.

The lithium-polymer battery is rated at 5.3Ah, 270V, and 1.4kWh, using 72 individual cells at 3.5 volts per cell. Hyundai says a clever design allows their powerpack to weigh less than 50kg and take up less than 55 liters of volume. The battery cooling system features a multiple-curve flow duct receiving cooled air from a compact cooling fan. The Sonata hybrid will also weigh less than a conventional vehicle, use electric air conditioning, and feature regenerative braking.

VITAL STATISTICS

Engine – DOCH CVVT 2.4-liter Theta II
Bore/Stroke – 88mm x 97mm
Compression ratio – 13.1
Hybrid type – Parallel
Motor type – Interior-permanent magnet synchronous
Battery – Lithium-polymer
Battery weight – 43.5kg
Voltage – 270V
Capacity – 5.3Ah



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Diesel strikes back

And now for something a little different: Introducing the industry's first, mass-produced, diesel hybrid powertrain

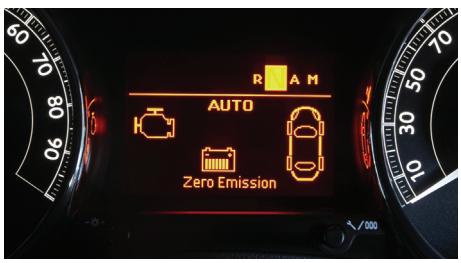


It's been a long time coming – five years to be exact – but PSA Peugeot Citroën is finally ready to launch the world's first mass-produced diesel hybrid vehicle.

The powertrain will debut in the new 3008 Hybrid 4 crossover, which was presented to the world's media at last month's Paris Motor Show, and will go on sale in the second quarter of 2011. But such has been the investment in the diesel hybrid technology that it will likely find itself in a raft of Peugeot Citroën vehicles, including the RCZ coupe.

And for once the technology lives up to the marketing hype. By combining a 2-liter HDi diesel that develops 163bhp with a 37bhp permanent magnet electric motor, the 3008 Hybrid 4 has the potential to achieve 74.4mpg on combined mode, while it emits a mere 99g/km of CO_2. Impressive is an understatement in this case.

Car makers have long since flirted with the idea of a diesel hybrid powertrain for a passenger car application. The likes of Volkswagen, General Motors, Toyota, Audi, and even Subaru are all known to have looked into the idea, but cost and cost alone has stalled production progress. For this reason, the industry should all applaud PSA's foray into the unknown.



The electric driving mode results in zero emissions output

Price to pay

But first, the bad news: although unconfirmed, the 3008 Hybrid 4 will probably hit showrooms with an US$30,000 bumper sticker. So, state-of-the-art engine technology does not come cheap.

Fantastic fuel consumption and very low emissions are a given – especially with an electronically controlled sequential manual transmission, regenerative braking and a second-generation stop/start system from Bosch. The Bosch unit has a maximum output of 8kW and can generate enough power to supply the electric motor if required. In fact, the 3008 Hybrid 4 has plenty of power: the combined 200bhp of the diesel engine and electric motor is further supplemented by 500Nm of torque, which is split so that 300Nm comes from the front of the vehicle via the HDi heart, and a further 200Nm is generated at the rear by the electric motor. The booster modules come from Continental.

Supply and demand

PSA turned to Bosch for help when developing its electric motors and powered electronic subsystems. Other ancillary equipment, including the inverter and converter, has also been fitted to the rear of the vehicle. PSA says such intelligent packaging helps reduce costs by optimizing the production process at its French plants in Sochaux and Mulhouse.



The Hybrid 4's technology makes use of the inverter and converter to control the electric power levels. The setup is such that the former controls the torque of the electric motor by regulating the electrical current from the high-voltage battery pack. It operates in a 150-270V range. The converter, on the other hand, reduces the 200V from the high-voltage battery pack to 12V to supply the vehicle's onboard systems.

The NiMH batteries, which Sanyo helped to develop, are found under the boot floor near the electric motor. Inspecting the car at the Paris Motor Show, neither the boot nor the rear seats of the crossover seem to be impacted by the high-voltage battery pack, which works alongside the standard 12V battery under the bonnet. Somewhat interestingly, PSA maintains that nickel metal hydride batteries – in the medium term at least – will be the most appropriate power source in terms of cost and industrialization for vehicles produced in large volumes.



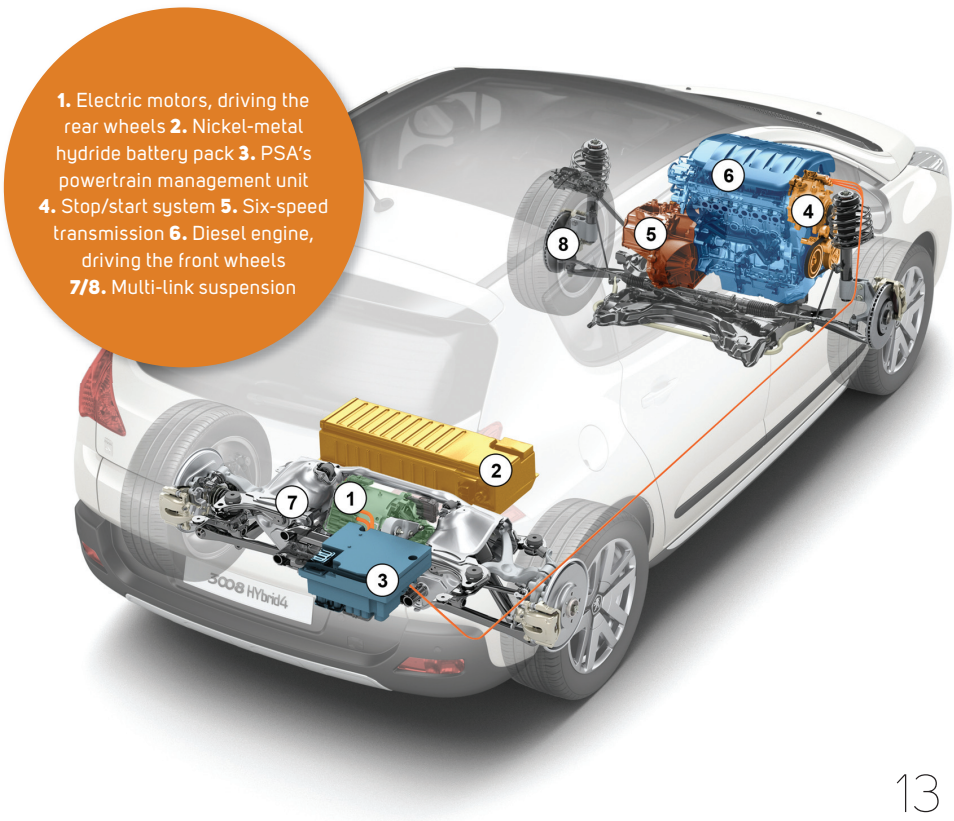
Peugeot is first to market with a mass-produced diesel hybrid vehicle, but will such technology be a success?

And the diesel?

The 1,997cc diesel engine develops lots of torque with Peugeot's latest extreme conventional combustion system. This clever combustion chamber incorporates a variable-geometry low-inertia turbocharger, a high-pressure injection pump that allows for a maximum pressure of 2,000 bar, and solenoid injectors with eight apertures. All this is combined with the latest Eolys additive-enhanced diesel particulate emission filter system to ensure the HDi engine is EURO 5 compatible.

To manage performance and economy, the 3008 Hybrid 4 offers the driver four different operating modes, which are managed by the ECU. Operating modes include auto, zero-emission vehicle (which allows for all electric driving), sport, and four-wheel drive. This is a viable option for the Peugeot diesel hybrid application as the HDi unit drives the front wheels while the electric motor in the rear drivetrain powers the rear wheels.

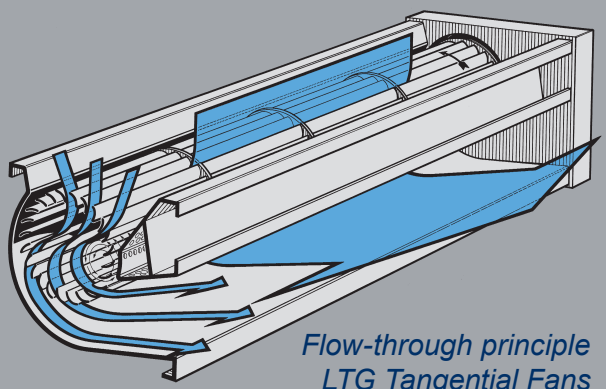
PSA says that a diesel hybrid makes perfect Peugeot sense. The car maker has a rich history of high-tech diesel development, but what's not as well known is that the French manufacturer has had some success in the electric vehicle powertrain field too. To date, the 106 Electric, marketed between 1995 and 2003, remains the world's best-selling zero emissions car (in total nearly 10,000 vehicles were produced). And in a few months' time, Peugeot will launch a fully electric vehicle in Europe, the Peugeot iOn, which is largely based on the Mitsubishi iMiEV.



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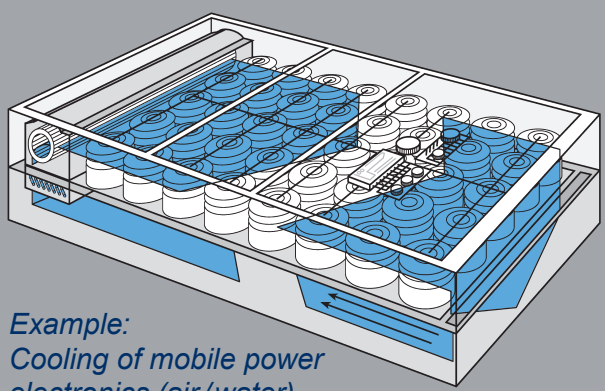
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City slicker

Renault will pitch the Twizy to customers who want scooter-style urban mobility with a roof over their heads

Renault is jumping feet-first into the electric car market with four new models to be launched in the next two years. Fluence Z.E. and Kangoo Van Z.E. are based on existing production cars, while ZOE is a stylish, electric-only hatchback.

The fourth member of the family is perhaps the most intriguing. Twizy is a two-seat quadricycle, a radical design that Renault is offering as a more comfortable, safer, and far torquier alternative to the two- and three-wheelers that are so popular in major European cities. The plan is for Twizy to compete on cost with the three-wheeled scooters from the likes of Piaggio, which retail for around US$4,500, although the battery will be an additional lease cost.

With its combination of two- and four-wheeler design and engineering, Twizy's bespoke platform is a new departure for Renault, explains Matthieu Tenenbaum, the company's deputy program director for electric vehicles. "We're trying to get to something that has the compactness and agility of a two-wheeler, yet has the same comfort and reassurance that a car gives you: doors, steering wheel and pedals," he explains.

"In engineering terms, you're always somewhere in between two- and four wheels, and trying to find something that's already mass-produced to keep the price down. Some parts are carried over from our other cars – steering wheel, dashboard controls and the Kangoo parking brake, for example – but we also have some off-the-shelf components that come from the two-wheeler market, such as brake discs, shocks, and springs."

A 7kWh lithium-ion battery from AESC is under the seating area, lowering the center of gravity. Behind it, between the rear wheels, are the electric motor, transmission, and power electronics. Both motor and transmission are off-the-shelf from undisclosed suppliers; it's thought the motor is already used in other electric quadricycles.

"It's a 15kW motor so it won't do for a normal car," Tenenbaum acknowledges, "but if we extend our line-up of small vehicles like this, not only at Renault but also Nissan within the Alliance, then it could be used again."

Twizy is the only rear-wheel-drive vehicle Renault produces apart from the giant Master van. Combined with the electric drivetrain, this means its ride and handling provide a quite different development challenge to the car maker's usual cars. "We have a team from Renault Sport working on the chassis tuning," Tenenbaum reveals.

Twizy's 3.4m turning circle certainly promises maneuverability. The steering is unassisted, but with such a light front end that shouldn't be an issue. Meanwhile, the Continental tires – the smallest in the supplier's car line-up – are wider at the rear, Smart-style, which should help keep the car planted firmly on four wheels.

Twizy will be built at the Valladolid factory in Spain. Renault has already commissioned production tooling ahead of its market launch at the end of 2011. That includes tooling for many of the large, plastic body panels, which, again, incorporate materials already used elsewhere in the car range, albeit on a larger scale.

VITAL STATISTICS

Dimensions: 2,320mm (L) x 1,191mm (W) x 1,461mm (H)
Wheelbase: 1,684mm
Front/rear track: 1,050mm/1,036mm
Curb weight: 450kg (including 100kg battery)
Safety: Deformable front structure; lateral beams for side-impact protection; driver's airbag; four-point harness in the front, three-point safety belt in the rear
Battery: AESC lithium-ion. 60-mile (100km) NEDC combined cycle range; 3.5-hour charge time
Transmission: Direct drive with reducer and forward/reverse inverter
Tires (front/rear): 125/80 R13; 145/80 R13
Max continuous power (EEC): 4kW (45km/h version)/8kW (75km/h version)
Peak power (EEC): 7kW (45km/h version)/15kW (75km/h version)
Max torque EEC: 57Nm
Top speed: 47mph



Renault believes Twizy buyers are likely to be sensitive to new design trends and so they will be able to customise their vehicle thanks to a wide choice of graphics available from launch



VITAL STATISTICS

Length: 4,225mm
Width: 1,968mm
Height: 1,163mm
Acceleration (0-62mph): 5.1 seconds
Aerodynamic coefficient: 0.25 CdA
Wheelbase: 2,582mm
Top speed: 112mph

Show stopper

It's no secret that Renault wants to be the number one electric vehicle player in Europe, but what's not as widely publicized is the French car maker's eco-friendly supercar aspirations.

At the Paris Motor Show last month, Renault showcased the all-electric ZE range, which included the Kangoo, Fluence, Zoe, and Twizy, but taking center stage was the DeZir, the first in a long line of stylish electric concepts that will eventually lead to a production electric sports coupe.

Looking not too dissimilar to Audi's E-Tron supercar demonstrators, the DeZir is powered by an electric motor mounted in a mid-rear position, which allows for weight optimization across the vehicle. It is the same E-motor that is used in Renault's new crop of electric vehicles, which further adds production credibility to this concept. For the DeZir, though, the E-motor has been uprated to develop 150bhp and 226Nm of torque. The vertically mounted 24kWh lithium-ion battery has been placed behind the benchseat of the sports coupe and provides a driving range of 100 miles. To further improve efficiency, the DeZir also employs KERS.

And it's not just the E-motor that has been carried across from other Renault models. The majority of the DeZir's suspension – including the double wishbones – is taken from the Megane Trophy. Weight has been kept to a minimum – 830kg – and that in part has been achieved by building the DeZir's body from Kevlar and a tubular steel frame developed by DuPont, which is another feature taken from the Megane Trophy.

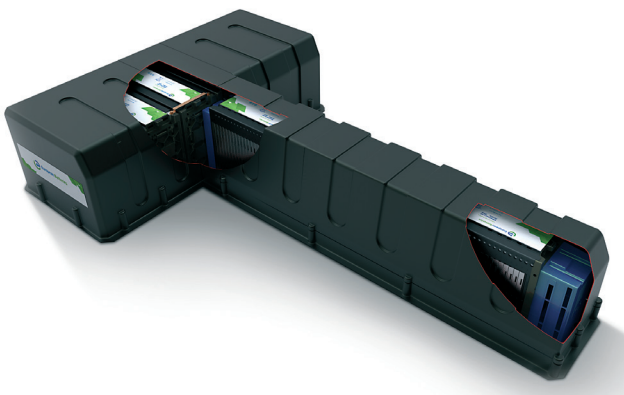
Renault's immediate focus is to get the likes of the Twizy et al into the showrooms, but a model like the DeZir – minus some of the extravagant styling, such as its asymmetrical scissor doors – is not too far off. Watch this space.

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A fleet of fuel cell-powered taxis could be in service in time for the London Olympics in 2012

TECH SPEC

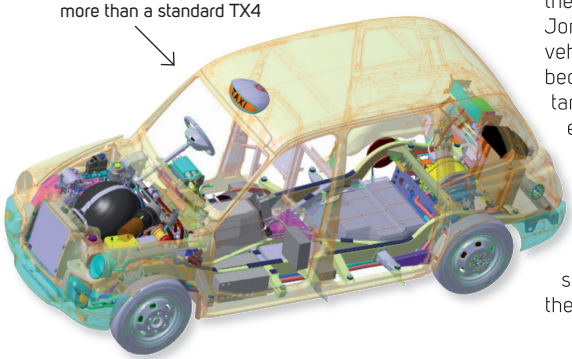
Motor: 100kW (peak), 55kW (continuous)
Fuel storage: 3.7kg compressed hydrogen @ 35MPa
Operating temperature range: -18°C to +37°C
Acceleration: 0-30mph in 4.5 seconds
Acceleration: 0-60mph in 14 seconds
Maximum speed: 81mph
Range: 250 miles

The eyes of millions around the world will fall on London in the summer of 2012 when the Olympic Games comes to the UK for the first time since 1948.

Hundreds of thousands of visitors are expected in the city for the event, with obvious promotional opportunities. BMW has already signed up to be the official automotive partner and will supply 4,000 vehicles to the Games – possibly including some of its forthcoming MegaCity electric cars – but a cooperative project funded by the UK government's Technology Strategy Board looks set to deliver something more typical of London.

A consortium of four companies has worked together to develop the Fuel Cell Black Cab. Taxi maker LTI provided donor vehicles; Intelligent Energy contributed the hydrogen fuel cell; TRW Conekt led the safety analysis program, including the braking systems; and Lotus Engineering was contracted to design and package the vehicle.

With the heavy fuel cell subsystems, the prototype fuel cell cab weighs around 200kg more than a standard TX4



A key part of the exercise was not to intrude on the normal passenger space of the LTI TX4 taxi. The resulting solution packages the filament-wound carbon-fiber 350 bar hydrogen tank under the hood where the 2.5-liter VM Motori diesel engine normally sits. The tank can be filled from empty with 3.7kg of gas in three minutes via a filler nozzle at the top of the nearside front wing. The fuel cell is in the transmission tunnel next to the driver, and the lithium polymer batteries and control system are packaged under the floor.

The batteries themselves are from Dow Kokam. They give a total of 400V that can be recharged from the mains via a plug-in system. The single electric motor has a peak power output of 100kW, or 55kW continuous. It's mated to a single-speed gearbox with a differential, all of which is housed in a Lotus-designed subframe.

The taxi required considerable reworking around the rear axle to accept the powertrain. "In the packaging studies we looked at various options, including putting a motor in the transmission tunnel driving into the original diff and leaving the whole rear suspension as it is," explains Jonathan Sharp, prototype build engineer for vehicle development at Lotus Engineering. "But because we had to fit both the massive hydrogen tank and fuel cell in – as well as the batteries and everything else – we ran out of space, so a new rear end was the best solution.

"The standard taxi has a live axle with trailing arms," he continues. "We've retained the trailing arm forward hardpoints on the chassis, so the trailing arms are a very similar design to standard, but we've made the suspension independent by adding two transverse control arms. The trailing arms bolt on to billet-machined uprights but one trailing arm is machined from billet while the other is fabricated." Also at the rear of the vehicle is an inverter to control the motor and an EMI filter to filter out any electrical noise on the high-voltage electrical system.

The motor is also being used as a generator under a regenerative braking setup. The ABS controller and the main Lotus-supplied powertrain controller work together to blend regenerative braking with regular hydraulic braking. The cab runs electro-hydraulic ABS put together by TRW Conekt that features TRW's slip control boost (SCB) technology.

Other additions or changes to standard TX4 systems include an electric aircon compressor from Ford in the USA, electric gas and water pumps, an electric power-assisted steering system from TRW, and a DC/DC converter to drop 400V down to 14V to run all the vehicle's regular low-power systems such as its lights and instruments.

Changes to the interior are minimal. In the back, a Prius-style display screen shows passengers how the power flows around the vehicle. Up front, there's a simple go-stop-reverse push button setup in place of the normal gear lever. Lotus's hybrid controller, which integrates all of the vehicle's systems, sits to the side of the driver. "It's a first-off prototype unit so it will probably be shrunk down and hidden behind a panel on the production version," Sharp notes.

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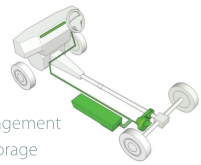
Ashwoods are currently working with a number of international OEMs on hybrid & electric drive train solutions and bespoke component development

Highlights & Industry Experience

- The UK's leading supplier of hybrid commercial vehicles and hybrid drive systems
- Sole supplier of hybrid vans to the UK Government's Low Carbon Vehicle Procurement Programme (LCVPP) run by Cenex
- Awarded £1.8 million Technology Strategy Board (TSB) grant to advance the development of hybrid & electric drive systems with Citroen UK
- Licenced development & distribution in the USA
- Hybrid van supplier to the Scottish Government's LCVPSS
- Winner of Fleet Van World Honours Innovation Award 2010

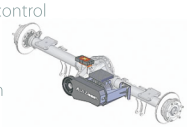
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Development capabilities

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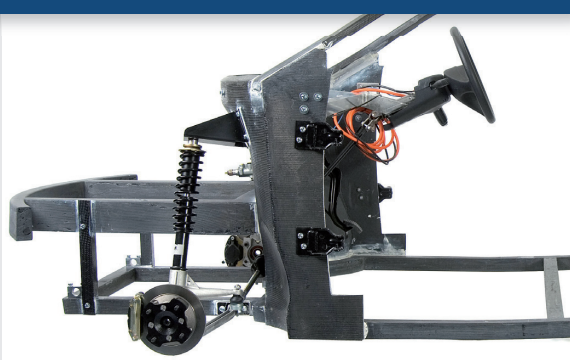
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Spyder's web

While PSA Peugeot Citroën is about to hit mass production with a diesel-hybrid powertrain, **Audi** continues to explore the technology with a Spyder concept



Another Motor Show and another E-tron concept, is there anything new?
Yes! The E-Tron Spyder comes with a real difference: the electric motors are married to a state-of-the-art bi-turbo diesel heart, already used by Audi in production vehicles. Such a combination allows the two-seater, plug-in hybrid sportscar to deliver an astonishing 128mpg on combined mode, emitting 59g/km of CO_2.

And zero-emission driving?
It can do that too. In urban areas, the concept is powered by its electric drivetrain, thus disabling the six-cylinder diesel, which is mated to a seven-speed, dual-clutch transmission. The 9.1kwH battery at the front of the car has enough power for up to 31 miles on electric-vehicle mode, thus realizing zero emissions.

Is it as fast as it looks?
Oh yes! In fact, *E&H* has learned that Audi will bring to market an EV sportscar soon, but that discussion is for another time. E-Tron Spyder boasts a V6 TDI lifted from the A8, but this heart is good for 300bhp, some 50bhp more. The two electric motors generate 64kW of power. A total torque output of 650Nm is developed by the diesel unit, with an additional 325Nm coming from the twin electric motors, all of which adds up to over 1,000Nm of torque! In the real world, that means 0-62mph in just 4.4 seconds. Top speed is electronically capped at 155mph.

A hybrid system and a diesel engine must mean this is one heavy unit?
Well not quite. E-Tron Spyder does tip the scales at 1,450kg, but remember there's a heavy V6 diesel in there, and two electric motors, along with all their subsystems. Spyder's short wheelbase helps ensure a near 50:50 weight distribution, à la BMW. The body structure is based on the Audi space-frame technology, with the hood and numerous aerodynamic components made from carbon. The body's supporting structure is made of extruded aluminum sections and die-casting.

Will it ever make production?
Talking to Audi engineers off the record at the Paris Motor Show, there's a real sense of achievement in creating the E-Tron Spyder, but cost will probably prevent the Ingolstadt-headquartered OEM ever pushing such a concept into production, but that should not detract from this significant technology demonstrator.

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Transparent development

Car makers and suppliers are looking to every aspect of vehicle development to reduce emissions and improve fuel consumption – and that includes glass. ***E&H*** takes a look at three pioneers in this field



The groundbreaking eXasis concept from Rinspeed is powered by a lightweight, 150bhp Weber engine driven by CO_2-emission-reducing bioethanol. But more noteworthy than that is the car weighs only 750kg because of its lightweight plastic and glass construction. In fact, one horsepower has to shift only 5kg!

Glaze ahead

Having become a 100% subsidiary of Saint-Gobain Sekurit Group in 2007, Freeglass offers the industry innovations in the glazing sector. Located near Stuttgart, Germany, the company engineers three-dimensional parts that are produced and delivered to the automotive industry using the latest technologies. Freeglass says its fixed side glazing and glass-like attachments have many advantages, including a weight reduction of about 30%; flexible and time-saving assembly; and cost-optimized manufacturing that takes place in one production step. Freeglass also has the capacity to produce windows and seals in a two-component injection molding process that complies with glass standards.

In another recent development, Saint-Gobain Sekurit engineers have developed the zenith windshield for the new Citroën C3. Boasting a height of 1,525mm, the innovation is the largest two-in-one windshield produced for this segment. The single piece of glass covers the front of the vehicle as well as the roof.

Solar control

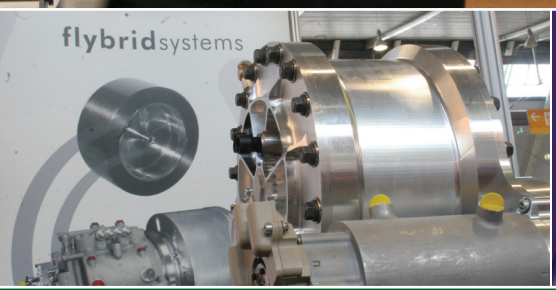
NSG/Pilkington makes a wide range of automotive glazings for new vehicles. The company's recent projects include solar control glazing that reduces solar heat build-up inside the car, thus reducing the need to use the air conditioning unit (which improves fuel economy by lightening the engine load). In fact, NSG's solar control glazing is so advanced that it also filters ultraviolet transmissions, increasing the lifespan of the materials in the cabin.

Innovative coatings

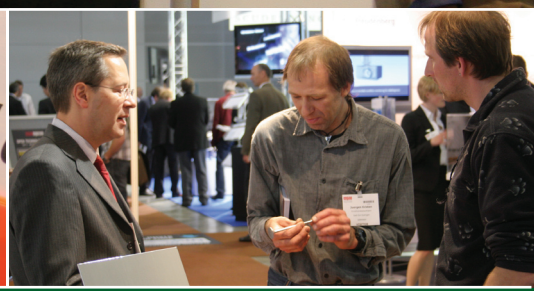
With a rich history dating back to 1967, KRD Coatings is a specialist in the manufacture and development of abrasion-proof functional coatings. The company's strength lies in fast turnaround due to its capacity to manufacture KASI coatings in-house. KRD is also set up to meet individual client needs and have a flexible approach. KRD's innovation includes KASI PC flex coating, which is an abrasion-proof coating on polycarbonate that improves on UV stability levels. The company's KASI UVP coating, meanwhile, is an abrasion-proof coating that hardens under EV for polycarbonate and PETG.

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Hybrid shoot-out



Toyota Auris Hybrid (Hybrid Synergy Drive III)

VS.



Honda CR-Z (next-generation IMA)

It might not look it, but Auris Hybrid is an important development for Toyota: it marks the introduction of the company's Hybrid Synergy Drive (HSD) to one of its mainstream models, and in doing so, Auris becomes the only full hybrid powertrain product in Europe's lucrative, diesel-dominated C-segment.

SUM OF ALL PARTS

There are 1,753 components in Auris Hybrid, of which a quarter are specific to this product. But it's under the bonnet where we're most concerned with, and for the large part, Toyota has plucked the Prius powertrain and dropped it into the Auris engine bay. Power (134bhp) and torque (142Nm) remain identical between the two hybrids. The four-cylinder, Atkinson cycle unit helped ensure Auris Hybrid resulted in an impressive 62mpg, but that was way short of Toyota's 74.3mpg claim. CO_2 emissions stand at 89g/km.

COUNTING THE COST

Having a HSD print means Auris Hybrid is privy to the acclaimed systems that we raved over in the new Prius. Cooling EGR, VVT-i, shift-by-wire E-CVT and the high-performance, permanent magnet, synchronous electric motor/generator (producing 60kW), are all not to be forgotten. The problem is that Auris Hybrid's essentially a more compact Prius, and so if you want a good hybrid, then it's hard to look past Auris's bigger brother.

Cylinders: Four **Cubic capacity:** 1,798cc
Bore/stroke (mm): 80.5 x 88.3 **Compression ratio:** 13.1

Much PR puff surrounded the CR-Z prior to its launch date, with Honda claiming to have developed an exciting and sporty hybrid coupe. Yeah, right!

HUMBLE PIE

But the CR-Z is a rare example of a product living up its billing. All here at *E&H* agreed that this is one of the best cars we've tested this year. CR-Z looks stunning and is fun to drive. Well done Honda!

SHARED EXPERIENCE

The CR-Z is the first car to combine a 1.5-liter i-VTEC engine and Honda's IMA system. It's also the first hybrid car to sport a six-speed manual. The result is 126bhp and 174Nm of torque, while emitting 117g/km and averaging 55mpg (which is nearly spot on with Honda's official data). The petrol engine is lifted from the Jazz, but modifications had to be made, as in its original form the unit would not fit under CR-Z's low bonnet. As a result, the i-VTEC gets a new intake manifold and a flat air-cleaner assembly, both of which allow for sufficient clearance. Basic block elements – such as sump pan – have been taken from Honda's 1.3-liter engine. The updated IMA is shared with Insight, but software has been altered to interact with CR-Z's three-mode system and the manual gearbox. There's just one word of warning: while this parallel hybrid is impressive on many fronts, those seeking a practical hybrid should look elsewhere!

Cylinders: Four **Cubic capacity:** 1,497cc
Bore/stroke (mm): 73 x 89.4 **Compression ratio:** 10.4

Steeped in (hybrid) history

Back to the future

Although many looked to the CR-X as a compact and agile coupe, what's less known is that one of the major purposes of this car was to break the 50mpg barrier and top EPA ratings. No surprises to learn then that such goals shaped CR-Z, as Takonobu Ito, Honda CEO, notes, "My first assignment came in the early 1980s. I was a young engineer, developing the chassis for the first-generation CR-X. I remember CR-X as a vehicle that demonstrated that a car can be both sporty and fuel efficient. Times might have changed, but the idea of developing vehicles that are both fun-to-drive and fuel efficient is alive and well."

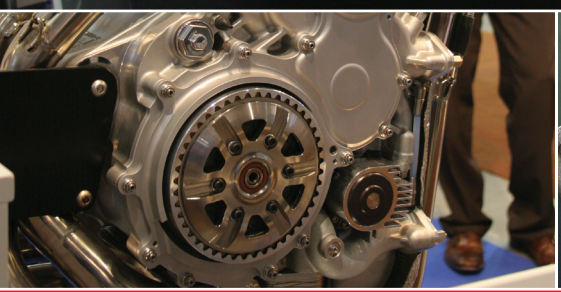


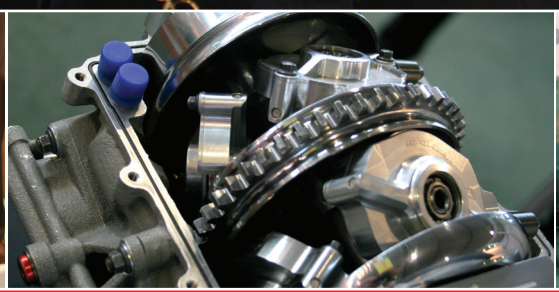
Inspirational Insight

The first-generation Insight was the first hybrid to be sold in Europe and the USA, and like the CR-Z, was a three-door coupe with a five-speed manual transmission. The 1999 Insight was also available with a CVT transmission, which showcased the flexibility of Honda's IMA parallel hybrid unit. A decade on, and Honda's now arrived with the CR-Z using the same technical principles. Next stop: Jazz Hybrid.











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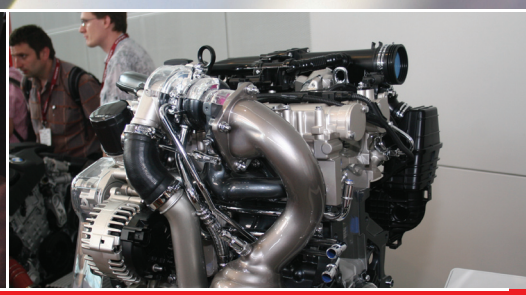
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INTERNATIONAL engine of the year awards 2011

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PROFILE: FRANÇOIS BANÇON

Job title: General manager, exploratory and advanced product department
Company: Nissan

What career did you want when you were growing up, and what was your first job?
In terms of career progress, my first interest had little to do with engines and engineers; it was actually focused on art and the history of art. As a result, my first job was about photography and graphic design, and I worked for various agencies in this field. Following this, I was keen to join the automotive industry because of my interest in mobility rather than just cars. I've been a car architect for many years, first joining Renault, and then progressing to Nissan in 1999.

When did you first start playing around with powertrains?
Powertrains were not my first priority when I joined the automotive industry, focusing instead on concept design activity. However, powertrains are a key element when it comes to how competitive any vehicle can become, and beyond the performance characteristics, the powertrain has become a critical factor in influencing and defining sustainable mobility within the global automotive industry. One can't forget that the powertrain continues to play the greatest role in allowing new vehicles of all sizes to comply to stringent regulations, such as the emissions standards across most of Europe and the MPG-Cafe legislation in the USA.

What are the best and worst elements of your job?
My favorite part is being allowed to have a holistic approach regarding sustainable transportation. The worst element of my job is having to share this mobility vision of the future with necessary trade-offs in terms of investments and priorities, especially if all this is taking place in a crisis environment.

What car do you currently drive?
After having a Murano, I'm now driving the new Nissan Cube.

Emissions legislation aside, what would be your ideal engine design specification?
From a long-term perspective, the electric powertrain is definitely a key solution when it comes to sustainable transportation. In terms of today, downsizing a petrol engine to around 1.6 liters in size and pairing that with a 50kW electric motor hybrid is a very attractive option.



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> As we stand, downsizing a petrol engine to around 1.6 liters in displacement size and pairing that with a 50kW electric motor hybrid is a very attractive option

What do you think is the best engine that has ever been produced?
One of my favorite engines is the 2.5-liter V6 developed by Alfa Romeo. It's a powerful, efficient, and compact engine, all of which allows it to be a very innovative package.

Which manufacturers do you have particular respect for in terms of their engine development, and why?
Aside from the hard work that Renault Nissan Alliance powertrain engineers do on a daily basis, I'd choose BMW for creating engines that realize high levels of driving performance. Yet when it comes to creating engines that are efficient, I'd have to select Volkswagen, especially when one takes into consideration their development work in the area of internal combustion engine downsizing and new dual-clutch transmissions.

What is your proudest career achievement?
A couple of concepts that we created within our department have helped to define Nissan's production models, such as the all-new Juke. We have also created concepts that have played a key role in Nissan's zero-emissions strategy, which has led to the creation of the Nissan Leaf.

What personal career goals do you have for the future?
In terms of future goals, the truth is I don't exactly know, but it's probably something that merges product, concepts, and marketing, since I am also a marketer and I'm convinced that marketing will play a vital role in what technologies succeed within our industry.

In your opinion, what will be powering passenger cars in the year 2025?
Electric motors are the obvious answer when looking to the year 2025, but of course the automotive industry and the marketplace will have other engineering options, such as a plug-in hybrid with downsized internal combustion engine. Thinking ahead by 15 years, I think – and I certainly hope – that electric motor technology will, by then, be capable of providing a much larger driving range in full zero-emissions mode.

What would you like to see the legislators and manufacturers do in the immediate future to improve engine efficiency?
I think there needs to be a clear definition where and when exactly zero emissions for vehicles become mandatory. The legislators around the world also need to define the level of fuel consumption and CO_2 emissions through realistic profiles that make sense for all concerned, including the end consumer.

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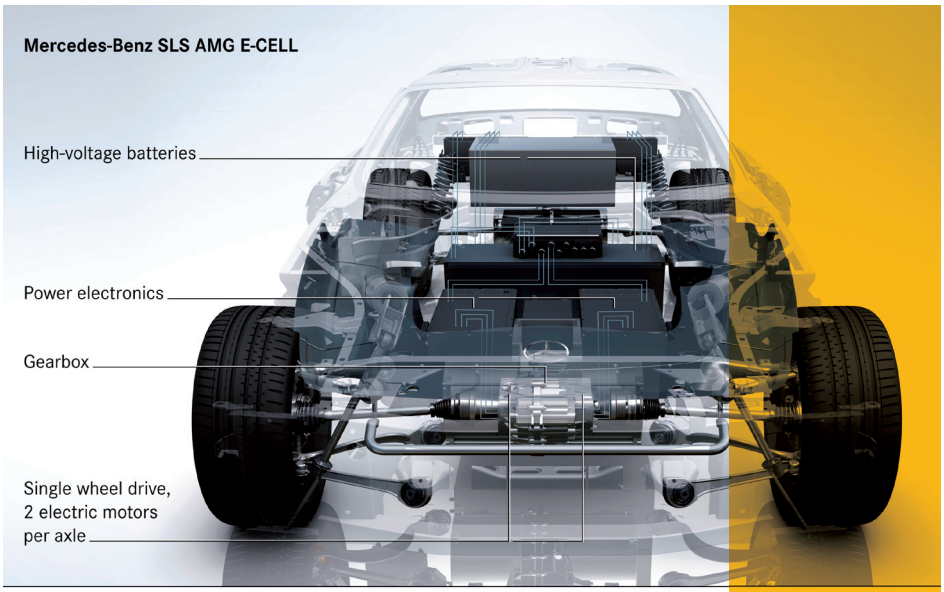


Ten-year time bomb

Pure electric vehicles will soon flood the market on a grand and global scale – but what will happen to the battery units when their power runs dry?

WORDS: **SAUL WORDSWORTH**


ULTRALIFE



The Mercedes SLS AMG E-cell makes use of a high-voltage lithium-ion battery that provides 40Ah

Traditional lead-acid batteries have been recycled more than any other waste product in history. These blocks of valuable metals have always provided a good return, particularly as metal can be infinitely recycled without losing any of its intrinsic properties. But that landscape as we know it is about to change. Analysts forecast that by 2020 there will be close to nine million pure electric vehicles sold around the world, twenty times today's number. OEMs have estimated that one in ten vehicles in the West will be pure EVs. Each of these will contain not a nickel metal hydride battery as used in today's Toyota Prius hybrid, but most likely the smaller, lighter, energy-dense lithium-ion battery. The market is about to be swamped with next-generation pure EVs, meaning that in ten years' time, hundreds of thousands of lithium-ion batteries will have run their course. So, the question that needs to be addressed is, what then?

"I predict that the recycling of lithium-ion batteries is set to become a huge market," states Christian Rosenkranz, power solutions EMEA manager for Johnson Controls, provider of lithium-ion batteries for the Mercedes S-Class Hybrid. "We don't expect the electrochemistry to change much and anticipate multiple generations of lithium-ion battery technology."

Despite being far more expensive to manufacture, the monetary value of the constituent parts of this new generation of batteries is markedly lower than its previous generation. As a percentage of weight, most contain only small amounts of lithium carbonate, a material that is relatively inexpensive compared with other metals, selling



Christian Rosenkranz, Johnson Controls

"I predict that the recycling of lithium-ion batteries is set to become a huge market"



> The Chevrolet Volt's battery will have significant capacity to store electrical energy, even after its automotive life
>
> Micky Bly, General Motors



Chevrolet Volt will have an eight-year, 100,000-mile battery warranty

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for only a few dollars per pound/kilogram. A lithium-ion battery system is valued in the region of US$800 /kWh but contains only 40¢ of different metals, meaning there is not much financial potential in straight recycling. Ian Goodman is CEO of LiFeBATT, one of the world's leading providers of lithium-ion batteries. Goodman has a particular interest in this area: "There is no consensus within the automotive industry as to what will happen to these battery systems at the end of their lifespan," he says.

"The industry can barely agree on what type of connector they should put on the outside of the vehicle. However, there are two likely outcomes. One is the disassembly, recycling and selling off of its constituent parts. The other is not to recycle them at all but to effectively re-task the battery systems for other applications."

Back to square one

Many believe that creating a planned recycling infrastructure will ease concerns that the adoption of electric vehicles featuring lithium-ion technology could lead to a shortage of lithium carbonate and thus a dependence on countries that control the bulk of global lithium reserves, namely China, Russia and Bolivia.

"A lot of people are worried that we are going to trade our dependence on foreign oil for a dependence on lithium and other rare earth metals," says Dan Kinsbursky of Toxco, a world leader in battery recycling. "One of the concerns of the United States' Department of Energy (DOE) is that future supplies and commodities of these battery systems won't be available."

This partly explains the DOE's awarding of US$9.5 million to Toxco for the expansion and development of the company's plant in Ohio in order to create an advanced lithium battery recycling facility. Toxco already recycles nickel and lead batteries, and possesses the only facility in North America with the capability of recycling both primary and secondary lithium battery systems.

"We are not expecting to receive a high number of batteries for five to ten years," explains Kinsbursky. "Right now we are only just starting to see lithium-ion battery packs hit the road. The uptake of these vehicles will be slow at first and once they get adopted you still have the lifespan to consider. The cars are likely to be on the road for 100,000 miles, eight to ten years and 1,500-2,000 cycles (full charge and discharge) before we will see a proper influx."

Toxco, a leader in battery recycling, plans to create an advanced, new lithium battery recycling facility in North America



Second life

The other potential use of lithium-ion batteries as cited by Goodman is their reconfiguration for use in other applications. "This involves disassembly, grading and reassembly, but the cell remains untouched," says Thierry Koskas, Renault's program director for electric vehicles.

"After disassembly and once the cells have been graded, they can be rebuilt into other battery systems, probably in residential areas where weight and space are not an issue. The key is their ability to use and store energy and then discharge it at a potentially higher rate. The OEMs will

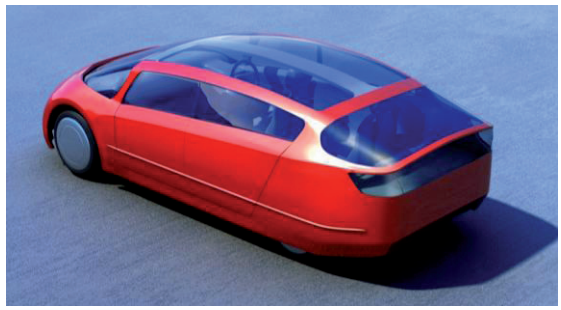
THE CHEMISTRY

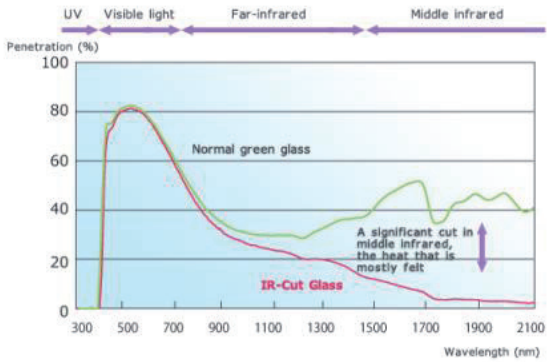
Since 1992 Toxco, has been recycling both single-charge and rechargeable lithium batteries at its Canadian plant in Trail, British Columbia. This facility can handle different sizes and chemistries of lithium batteries – the only one in the world to do so. When the spent batteries arrive they are fed into a hammer mill and are shredded. This allows components made of aluminum, cooper and steel to be easily separated. Larger batteries that may still hold a charge are cryogenically frozen with liquid nitrogen before being hammered and shredded. At 160°C there is no chance of reactivity from the cells. The lithium is then extracted by flooding the battery chambers in a caustic bath that dissolves lithium salts. These are then filtered out and used to produce lithium carbonate. The remaining sludge is processed to recover cobalt.

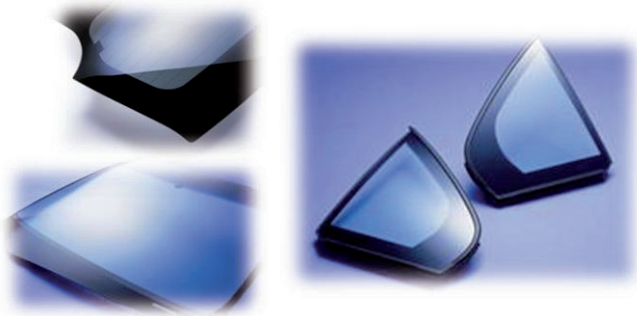


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then look to sell these to energy companies who would find them very useful for short period power surges."

Two recent announcements have been made in this direction. The first concerns General Motors and ABB Group who revealed last month that they will work together to develop pilot projects for reusing batteries from the Chevrolet Volt electric vehicle to explore their use as a source of renewable energy that could improve wind and solar power generation.

"We are working to determine how the Volt's 16-kWh lithium-ion battery, once it has fulfilled its automotive lifespan, can be used to provide a stationary electric grid storage system," says Micky Bly, GM executive director of electrical systems, hybrids, electric vehicles and batteries. "The Volt's battery will have significant capacity to store electrical energy, even after its automotive life. We predict that these batteries, which will end their vehicular lifespan with 60-80% of their capacity left, may have another five to ten years potential usage in their second-life."

Engineers from both companies will work together to study this potential in four different areas: renewable energy storage where power generated by both wind and the sun can be stored in Volt battery systems and used when required; grid load management whereby utilities will be able to use the Volt batteries to store electricity generated during off-peak periods to supplement high-peak demand; back-up power supplies for communities during power cuts; and time of use management where industrial customers can store off-peak, lower-priced electrical power in these batteries for use during peak demand. Today a pure EV costs between $500-1000 per kilowatt hour (kWh). It is generally accepted that this number needs to fall to $200-300 per kWh to get it close to the cost-neutral status that the IC engine enjoys, what with oil prices at less than $5 per gallon. According to Bly the uses of reconfigured lithium-ion batteries are likely to have a single-digit percentage impact on the future price of these batteries. Not incredible but not negligible either.

"This direct management of the battery's entire value chain should help to ensure EV customers do not bear the full cost of the battery," adds Bly. "However, when it comes to predicting the future of this market there is a big crystal ball with a lot of cloudiness in it."



Nissan's plan is to give batteries a second-life as energy storage systems. The Japanese car marker is working with Sumitomo to resell, refabricate and recycle lithium-ion systems



Mark Saxonberg, Toyota

The 4R rule

In a similar vein to GM, in October last year Nissan and Sumitomo Corporation revealed joint plans to 'reuse, resell, refabricate and recycle' lithium-ion batteries, thus also giving them a second-life as energy-storage systems. Last month the two companies announced the creation of a joint-venture company, 4R Energy, for commercializing lithium-ion batteries. In Europe, Nissan will work on the 4R business model with Renault.

By 2020, the demand for second-life batteries in Japan is expected to reach the equivalent of 50,000 electric cars per year, principally based on the anticipated success of the Nissan Leaf, scheduled to be released in Japan in December. Lithium-ion batteries belonging to both Nissan and Renault will be sent to 4R Energy, based out of Yokohama City, from 2011. On arrival, each battery will be inspected and, depending on its condition, reconstituted, recycled or, if faulty, disposed of. Recycled components will then be passed back to Nissan (or Renault) for the manufacture of new battery systems.

Transportation needs

Whether lithium-ion batteries are to be recycled or reconstituted they still need to be transported to the relevant plant. Historically, 97% of all lead acid batteries are recycled each year, and this is the challenge for the new generation of battery systems.

"The issue is transporting these batteries safely, efficiently and at the lowest possible cost"



Some car makers say that by 2020, one in ten vehicles in Europe and North America will feature high-voltage storage battery modules with lithium-ion battery cells. The question is what to do with the units at the end-of-life stage?

"The issue is transporting these batteries safely, efficiently and at the lowest possible cost," says Mark Saxonberg, environmental health and safety and service compliance manager for Toyota. "We intend to manage these batteries the same way we have always done. We'll get them from both the dealers and the dismantling yards. The challenge is the latter. Our strategy is to partner with the dismantling industry and set up logistics networks to get them from small to large dismantlers, then into collection centers. We are gradually putting processes in place. Through end-of-life-vehicle-solutions (ELVS) we are setting up logistics networks. Aside from leveraging existing logistics routes for nickel batteries, you will see car makers working together to help establish logistics networks to recover batteries from dismantlers. "

It is thought that over time, similar to what's in place for e-waste recycling, recycling requirements for lithium-ion batteries will likely come from state authorities, along with grants and incentives to encourage companies to recycle lithium batteries.

"We view lithium-ion batteries as similar in process to the nickel metal hydride batteries," says Saxonberg. "The only difference is that right now there aren't any real clear regulatory standards for packaging and shipping these batteries in large format. If the industry knows what's good for it, we'll work together to solve these problems."

Lithium-ion batteries are powering a technical revolution through their use in iPhones, iPads, BlackBerrys and laptops – and are on the cusp of powering another. Yet lithium is a very reactive element; lithium-ion battery systems are not as durable as nickel metal hydride or nickel-cadmium designs and can be dangerous if mistreated. If any cells rupture they can cause a fire or an explosion. These batteries already have a record full of such incidents. As a result, lithium-ion batteries must be stored and transported with extreme care and caution. Although these batteries contain safety devices to protect the cells from disturbance, contaminants inside the cells can defeat these devices. "At the moment these batteries are mainly shipped as hazardous materials," says Saxonberg. "But like any business we will find a way to solve this problem together."



Ian Goodman, LiFeBATT

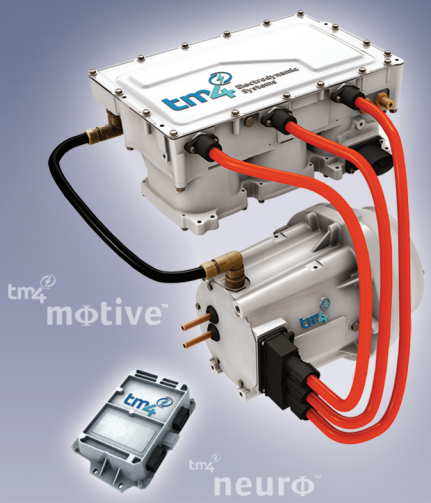
Poker face

In this embryonic industry many of the leading players are reluctant to show their hand. "Everyone is being very cautious," says Goodman of LiFeBATT. "No one wants to tell competitors what they are doing or how they are doing it for fear of being undercut." Some organizations have put their heads above the parapet. However, there is no question that the automotive industry as a whole is gearing up to what looks to be the largest automotive revolution in 100 years.

"Everyone is being very cautious. No one wants to tell competitors what they are doing or how they are doing it for fear of being undercut"

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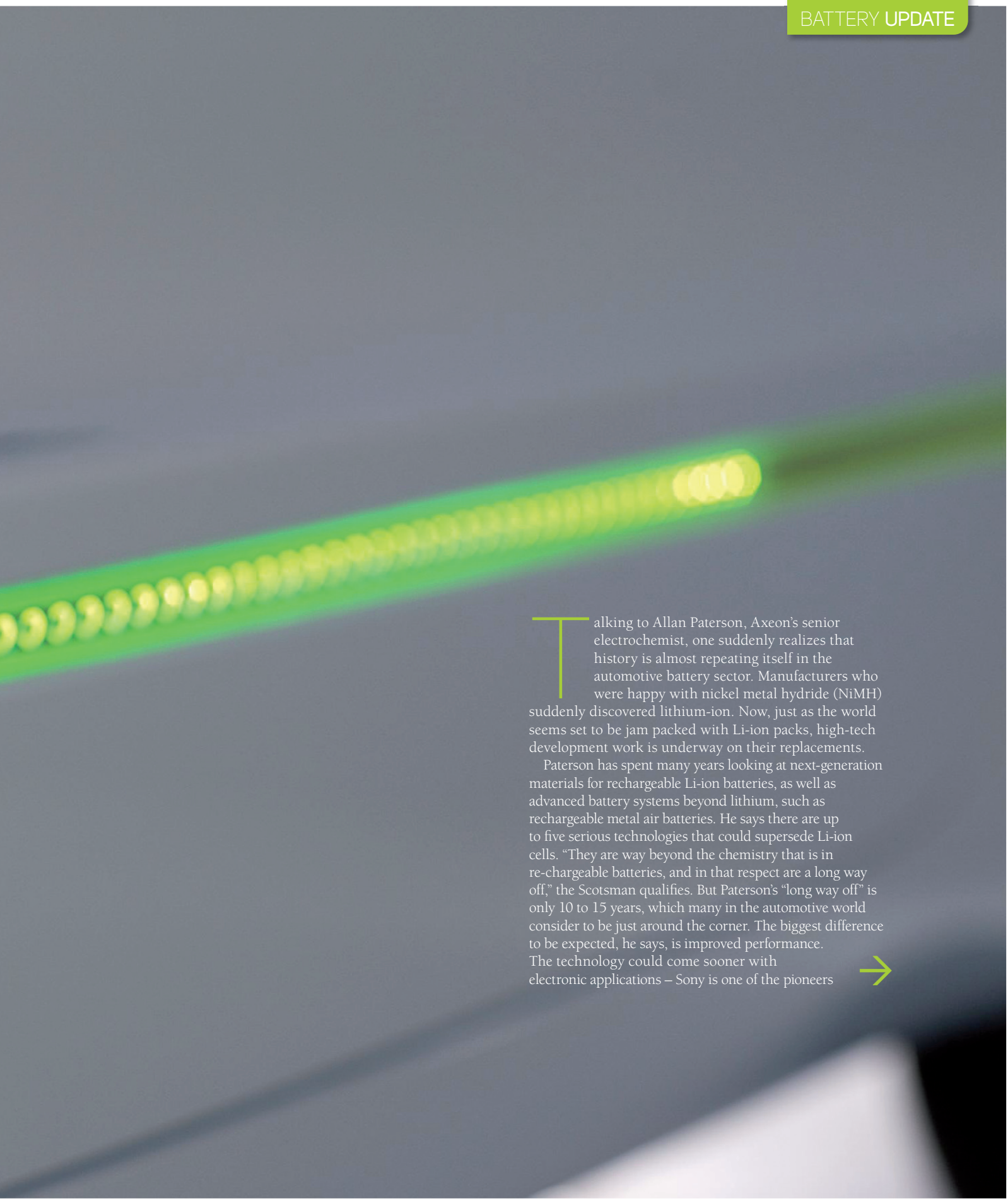
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Battery battle

Lithium-ion technology might only just be gaining a foothold in hybrid and electric vehicle applications, but there are already a number of pretenders to the crown

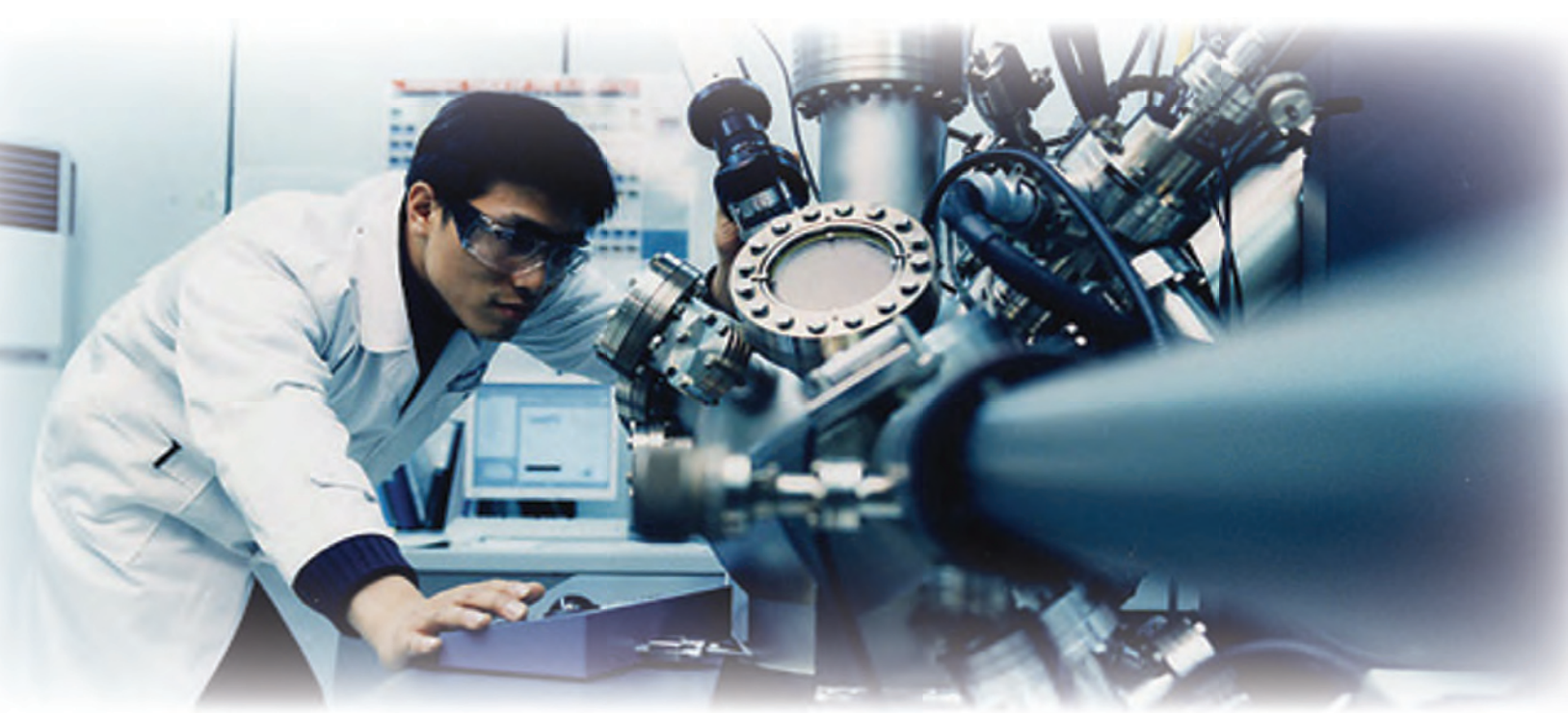
WORDS: **JOHN CHALLEN**





Talking to Allan Paterson, Axeon's senior electrochemist, one suddenly realizes that history is almost repeating itself in the automotive battery sector. Manufacturers who were happy with nickel metal hydride (NiMH) suddenly discovered lithium-ion. Now, just as the world seems set to be jam packed with Li-ion packs, high-tech development work is underway on their replacements.

Paterson has spent many years looking at next-generation materials for rechargeable Li-ion batteries, as well as advanced battery systems beyond lithium, such as rechargeable metal air batteries. He says there are up to five serious technologies that could supersede Li-ion cells. "They are way beyond the chemistry that is in re-chargeable batteries, and in that respect are a long way off," the Scotsman qualifies. But Paterson's "long way off" is only 10 to 15 years, which many in the automotive world consider to be just around the corner. The biggest difference to be expected, he says, is improved performance. The technology could come sooner with electronic applications – Sony is one of the pioneers



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of lithium-alloy – but the challenges of larger applications such as EVs are huge. "Sony uses silicon alloy and tin alloy-based anode materials, but the main problem is the volume expansion," says Paterson. "It is difficult to make large cells [that operate effectively] for new technologies such as EVs and hybrids, because the charge doesn't last long."

Paterson says these blue-sky technologies are either in development now or are just reaching prototype stage. One of the latter group is silicon alloy. "It doesn't have a specific cycle life yet, but it does provide a much higher energy density," he explains. "It is also cheaper to produce than those available now due to the cost of the graphite contained in the cells. Then there is lithium-air, lithium-sulphur, and a group of high energy-density systems – conversion reaction cells – which is still lithium chemistry, but a different form of it."

Material world

Paterson reckons that the key driver to success is energy density, but admits power density is just as important. "People are looking at a range of materials, and there's a lot of investment in the chemistry R&D for nano materials that charge quickly," he reveals.



Axeon uses a range of cell chemistries and is independent of all cell suppliers, choosing the most suitable supplier for the application

"If manufacturers can source the materials cheaply enough, they will definitely make these products into hybrid cells. But for energy cells, and EV applications, the next-generation high energy density, voltage, and amount of charge per unit mass are all important factors, too."

Despite these different strands of lithium being deployed in a variety of possible battery pack solutions, Paterson is quick to confirm supply levels are so vast that they won't run out like fossil fuels. "There is a lot of lithium in the world, but it is a long and complicated process after you get it out of the ground." Paterson reckons that from extraction to deployed cell takes about 18 months. Lithium-carbonate is the natural resource and it is traditionally mined in South America. "The growth of these batteries is why the Chinese, for example, are trying to buy lithium mines around the world," he notes.

But it's not quite as simple as one lithium material replacing another, as Paterson explains: "The current lithium-ion packs will be around for a long time, and the lithium-cobalt that makes up over 90% of most packs may be cheap but it is also toxic.

"Chemistry plays a huge role in the next-generation technologies but there are 20 or 30 strands of the chemical out there. Those technologies will continue to develop until emerging technologies mature to make it into the mainstream."

Testing times

Paterson continues: "Li-ion isn't a long-term prospect. It may become dominant over NiMH but by that time the other technologies will have reached the point of maturity when you might see some kind of change. There are so many possibilities out there, and you want to be testing them all and know how they work."

And some of the test work that Paterson mentions falls to Dr Annika Ahlberg Tidblad, global technical manager for energy storage solutions at Intertek Semko. Despite more

CLASH OF THE TITANATE

Axeon's Paterson may promote lithium-air and other associated next-generation products, but the number of vehicles that currently use these power sources is zero. The same cannot be said for lithium-titanate, which Altairnano has deployed in a transit bus for Proterra in Colorado.

"They are high-power and can charge/recharge very quickly," says Tom Kieffer, Altairnano's marketing manager. "Proterra [the transit bus company] can run the whole route on one charge and, while the driver takes a break, the batteries are completely recharged," he says with enthusiasm. For hybrid applications, the rapid rate of recharging means regenerative braking is maximized, which is a major attraction.

Brad Hanauer, director of battery system engineering at Altairnano, explains the science: "Lithium-ion uses graphite at the negative electrode and a combination of nickel/colbalt/manganese/aluminum at the positive. However, lithium-titanate can be used as a positive anode instead of graphite. Switching means changing the negative properties in relation to the electrode potential, which is close to that of graphite and lithium metal."



But as lithium metal is not compatible with the electrolytes used in lithium-ion, there is an initial reaction that causes a solid electrolyte interface (SEI) layer to form. "This layer is like a barrier between the graphite and electrolyte," explains Hanauer. "It helps make lithium-ion work but often a reaction of around 120°C generates enough heat to raise the temperature level to a point where a more violent reaction could occur."

So lithium-titanate is good at high temperatures but it's just as impressive at the other end of the temperature scale, as Hanauer is eager to point out: "At cold temperatures, the SEI layer is a barrier too, so at around 0°C and below, while you can steadily recharge a lithium-ion battery, you can't actually charge it. With lithium-titanate, there's no such problem.

Paterson also has experience with lithium-titanate. "We've been talking to Altairnano about building packs with them. As an anode material, it's very good for safety but it has an impact on energy density and volume; if you cram the same amount of kilowatt hours (kWh) into a lithium-titanate cell it could be double the size. It might only weigh a little more but it will be bigger, and you'd need more cells." Longevity is another advantage, but it comes at a price. "If you want to build a pack that will last 10 years, lithium-titanate is the best option, but it will cost you four times as much."

EXIDE-MENT BUILDS FOR LEAD ACID

Exide Technologies has a vision of the future, founded not on lithium-based products and niche-based products, but mass-produced products that will bring down CO_2 levels.

"We are currently deeply involved with batteries for stop/start micro-hybrids, and we expect that to be good for us in Europe and the USA in the next few years," reveals Paul Cheeseman, the company's VP for global engineering and research. And the next five to eight years is central to the reinvention of lead-acid, says the battery industry veteran.

"There are many technologies in adjoining industries that can help lead-acid, such as carbon, which is used in many materials that can transform their performance," Cheeseman adds. "We have programs that are developing advanced lead carbon products for HEVs. Lead carbon enhances the battery by adding carbon to the negative electrode, which can improve the surface area by a factor of six."

Exide's relationship with lithium-ion is limited to a small program focused on industrial applications, says Cheeseman, who adds: "Lead-acid has a reasonable chance of contributing to the [HEV] marketplace. When you add in the electronics, casing, and cooling needed for lithium-ion, a lot of their weight advantages are lost."



The industry is pressing on with Li-ion development, but already there is talk of what will be the next-generation technology

and more Li-ion applications emerging, Tidblad maintains there is plenty of work to be done. "Lithium-ion batteries still have to prove that they are capable in an automobile – especially so when it comes to the calendar life of the pack. There have been a lot of testing programs in the USA and Europe looking at specification and test methods. It is a young technology, and the demands in automotive are different from other markets."

Two current focuses of Tidblad's work are temperature behavior and longevity. "We are looking at what temperature is available, and studying a lot of drive cycles to see how the energy is being used and put back into the battery. We are also undertaking confirmation evaluations that prove if 10-15 years is a realistic lifetime for the actual battery." In this area, Tidblad believes there is a method to gaining more life: "You need to ensure you have a homogeneous pack, with efficient cooling and heating systems," she maintains. "The temperature gradient within the whole pack needs to be very small, otherwise the cells that are exposed to more heat will age more quickly and degenerate, causing pack imbalance that will shorten the life of the whole pack."

Sweet spot

And Tidblad has her own wish list when it comes to battery testing: "I'm hoping for safety testing methods targeted at the chemistry, such as where the weak spots are in each individual cell," she reveals.

"We are testing for this, but more diverse work is needed to identify and remove potentially hazardous materials from the market."

But does she believe this will actually happen? "It depends," she admits. "Many of the methods used today are based on the history. The automotive world is very conservative, where the rate of change depends on two things: how willing people are to think out of the box and find alternative approaches, and what resources are



"People are looking at a range of materials, and there's a lot of investment in the chemistry R&D for nano materials"

Allan Paterson, senior electrochemist, Axeon

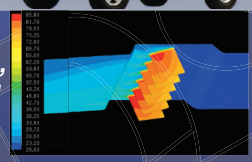
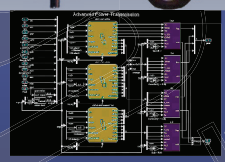
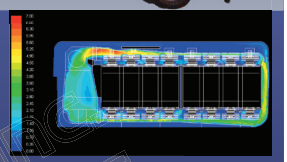
available. Testing is one part of the process but it is costly and time-consuming, and there are always reasons to keep it to a minimum."

And Paterson's own vision of the future? He is not putting his money behind any one of the next-generation solutions he's mentioned, insisting that the field is wide open. "It might be that you have hybrid packs, such as the lithium-ion pack, or a supercapacitor that gives instantaneous power, and which works with an energy dense battery such as lithium air or a fuel cell to reduce the costs and make the concept work.

"There are three or four groups of chemistry sitting on that pile, and if you have lifecycle issues that prevent these things from working it could be something else. It could be lithium sulfur, or even something else."

HDS
Hybrid Design Services Inc.

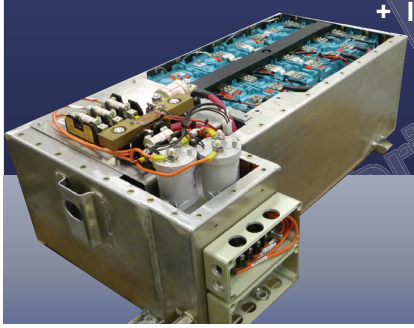


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w / Heavy Load Booster Support Function

PATENTED

● Possible solutions of the Energy Independence and Security Act

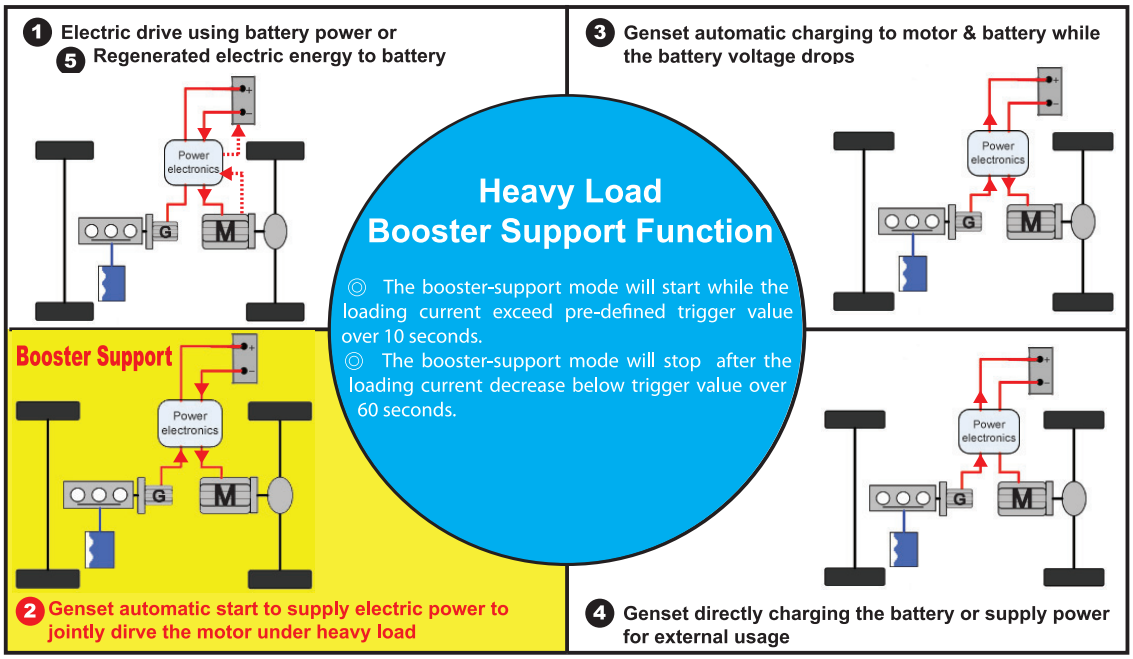
◎ No high capacity main battery
◎ No external power source battery charge (optional plug-in charge)

■ Feature:

◎ Patented function of automatic ICE-genset starting under heavy-loading operation, which increasing energy efficiency by saving energy loss of battery charging/discharging operation, and reduce the impact on battery life.

◎ Onboard ICE-genset providing electrical energy with high flexibility by traditional refueling infrastructure.

◎ Driving range significantly extended by onboard genset, the battery is optionally chargeable with home-plug.

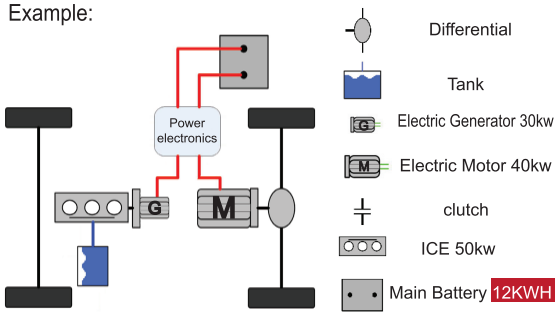


■ Architectural Adventages of Plug-In EV with heavy-load / booster support function

	Unit	Conventional plug-in hybrid electric vehicle	BS-PEV
City driving range (by battery)	km	80	50
Feul consumption	l/100 km	100%	90%
Battery capacity & weight	kwh • kg	100% (example: 12kwh)	60% (example: 8.4 kwh)

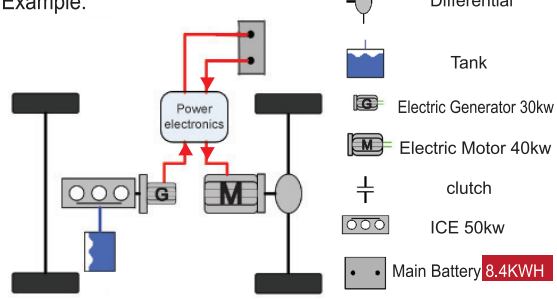
■ Conventional plug-in hybrid electric vehicle

Example:



■ The BS-PEV

Example:



Contact:
Giant Lion Know-How Co., Ltd.
giantleo@ms24.hinet.net

The BS-SHEV Series Hybrid Electric Vehicle

w / Heavy Load Booster Support Function

PATENTED

● Possible solutions of the Energy Independence and Security Act

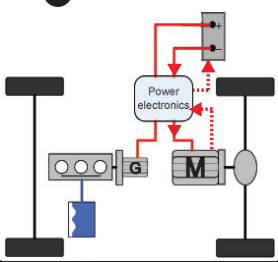
◎ No high capacity main battery
◎ Upgraded energy efficience (comparing with conventional SHEV)

■ Feature:

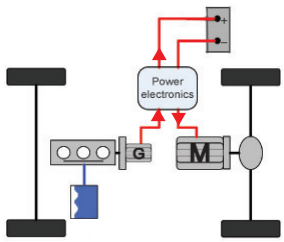
◎ Patented function of automatic ICE-genset starting under heavy-loading operation, which increasing energy efficiency by saving energy loss of battery charging/discharging operation, and reduce the impact on battery life.

◎ Onboard ICE-genset operates at BSFC high efficiency area to save fuel.

1 Electric drive using battery power (urban range＞30km) or **5** Regenerated electric energy to battery



3 ICE-genset automatic driving to motor & charging battery while the battery voltage drops



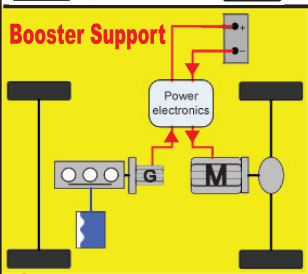
Heavy Load Booster Support Function

◎ The booster-support mode will start while the loading current exceed pre-defined trigger value over 10 seconds.

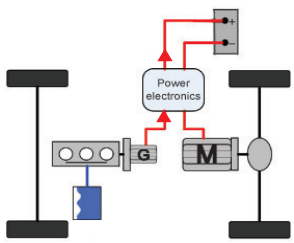
◎ While the battery charging reach 95% SOC and the loading current decrease below trigger value over 60 seconds, the booster-support mode will stop.

◎ The booster-support mode decrease the required battery pack capacity of powertrain.

Booster Support



2 Genset automatic start to supply electric power to jointly dirve the motor under heavy load



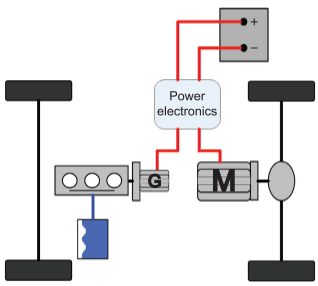
4 ICE-genset directly charging the battery or supply power for external usage

■ Architectural Adventages of SHEV with heavy-load / booster support function

	Unit	Conventional series hybrid electric vehicle	BS-SHEV
City driving range (by battery)	km	80	30
Feul consumption	l/100 km	100%	90%
Battery capacity & weight	kwh • kg	100% (example: 12kwh)	60% (example: 6kwh)

■ Conventional series hybrid electric vehicle

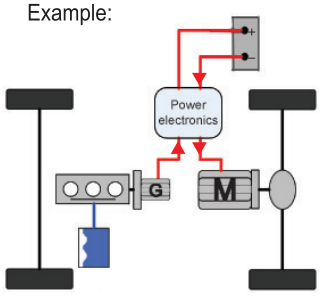
Example:



- Differential
- Tank
- Electric Generator 30kw
- Electric Motor 40kw
- Clutch
- ICE 50kw
- Main Battery 12kwh

■ The BS-SHEV

Example:



- Differential
- Tank
- Electric Generator 30kw
- Electric Motor 40kw
- Clutch
- ICE 50kw
- Main Battery 6kwh

Contact:
Giant Lion Know-How Co., Ltd.
giantleo@ms24.hinet.net

Ticket to ride

EVs and HEVs will play an ever-greater role in our automotive future, so here are the 20 hottest new technologies and projects that are helping to inspire a new breed of eco-friendly vehicles

WORDS: **ADAM GAVINE**



1. WIRELESS MONITORING SYSTEMS

To accelerate the testing and refinement of advanced Li-ion battery systems, Ford has implemented two monitoring methods that embrace internet and wireless technology. These methods enable engineers to collect real-time performance data from batteries in the lab and in the field via a secure internet server, and wirelessly update system software.

"Remote monitoring allows us to access real-time data and make continuous improvements very quickly. This degree of efficiency would have been unthinkable a few years ago," states Sherif Marakby, director of the electrification program and engineering at Ford.

Marakby's team is focusing on Li-ion technology's ability to recharge under a range of conditions, including state of charge, battery age, and environmental temperatures, to determine system control algorithms that will enable quick, efficient recharging and minimize cell deterioration. They are also conducting rigorous lifecycle tests.

The system collects real-time data and finds opportunities to implement software updates to manage thermal load and maximize power capability, energy capacity, and lifecycle durability. System-specific engineers are notified via email whenever these software update opportunities occur, based on adaptive event monitoring that can detect the conditions of interest and automatically collect data.



Jas Dhillon, electric-fleet manager, adds, "What used to be logistically complicated and time consuming can be accomplished now with a click of a mouse."

2. SIMULATION PLATFORMS

Ascertaining the practical driveability of mass-produced hybrid and electric vehicles as early as the design stage, before expensive prototypes are built, would be a great way of saving time and money as no changes would be required to the physical drivetrain. IAV GmbH is working on doing just that, developing the InDriVE Simulator, which comprises two systems for simulating such vehicles as part of a joint US$4 million project funded by the Federal Ministry of Economics and Technology.

IAV's engineers have modified a conventional IC engine vehicle in a way that largely gives it the handling performance of a hybrid vehicle and allows it to be tested on the road. A computer converts driver input in real time, making the car behave in the same way as a prototype of the new model would. To do, engineers do not require an actual prototype – merely mathematical models of its behavior.

As a second simulation platform, an EV is configured to simulate a wide range of drive concepts. The computed model of any target vehicle can be uploaded to the simulator vehicle's real-time computer. The simulator vehicle then drives in the same way as the target vehicle, so engineers can examine its driveability under full, real-life conditions.

Both platforms afford the capability of comparing drive concepts, rating system components, and developing optimum operating strategies and processes at an early phase in the development project.



3. RECIPE FOR SUCCESS

Kentucky-Argonne National Battery Manufacturing Research and Development Center, the US Federal Government's lead laboratory for applied advanced battery research and development, is working to electrify America's motorists.

"The ultimate goal of this facility is to help establish a strong and profitable US-based battery industry by helping domestic manufacturers bridge the gap between research and commercialization of advanced batteries for EVs," states Argonne's director, Eric Isaacs.

"The USA is behind the rest of the world in developing EVs and batteries for them, and it will be difficult to catch up," explains Dr Harvey Brodd, who heads up the center. "Advanced batteries and the materials in them are key to vehicle electrification."

The center's engineers are focusing on the transition of advanced battery technologies for vehicles, from basic and applied scientific R&D to real-world applications.

"We'll take battery materials, such as those developed by Argonne, and work with battery companies to scale-up their battery materials production from the research bench level to the commercial scale," Brodd says. "Research organizations and universities produce significant quantities of battery materials for study and experimentation, but they measure in grams or kilograms. Commercial manufacturers will produce hundreds and thousands of tons of materials. The problem with scaling up battery-materials production is that the battery chemistry's phenomena may differ from what is produced for lab use. The center will play a pivotal role in resolving this."

4. USER-FRIENDLY SYSTEM

Engineers dream of using a single system to test a complete HEV driveline, or any vehicle subsystem, including complete emissions testing, and Sakor Technologies believes it has made this dream a reality with its hybrid vehicle-test system. The system can run a wide variety of road load profiles and simulations, and is designed for testing to all international standards, including existing and proposed EPA, CARB, and Euro standards.

The user-configurable system can be adapted for R&D, performance evaluation, and durability testing of high-power electric motors and inverters, high-voltage batteries and battery management, transmissions and mechanical components, as well as complete powertrain and emissions testing.

Randal Beattie, president of Sakor Technologies, explains that the system, "is specifically designed to accommodate the differences in testing hybrid and electric drivetrains compared with standard testing of internal combustion systems."

The system includes special considerations that account for the use of regenerative braking, the high harmonic content generated by inverters, and the need for high power density to get the maximum power from the smallest size and weight.

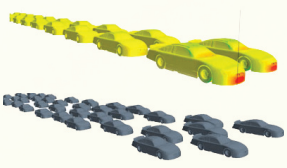
"We handle these issues by combining our core capabilities into a single hybrid vehicle test system," says Beattie.



5. COUPLED LITHIUM-ION SIMULATION

Achieving coupled simulation capability is the aim of a collaboration between CD-adapco, a specialist in simulation tools for fluid dynamics and heat transfer and battery design as well as a provider of battery modeling software.

The collaboration will add an additional simulation capability to CD-adapco's STAR-CCM+ simulation tool, providing, the company claims, the first comprehensive tool to enable the study of interaction between a cell or battery and its automotive environment. Initial applications will focus on thermal management issues, which influence battery temperature and safety. "Extending Battery Design's models into a full 3D environment will further enhance our understanding of installation effects and the behavior of large-scale battery systems," says president of Battery Design LLC, Robert Spotnitz. "The collaboration between CD-adapco and Battery Design will deliver an analysis tool that will accelerate product development and support vehicle programs."



"The rapid growth in the electric vehicle market and the need for a powerful analysis capability has resulted in the partnership with Battery Design and the development of a tool for fully coupled simulation from the cell to the pack and installation levels," adds CD-adapco's automotive director, Richard Johns. "We have also given considerable attention to developing an engineering process that will allow our customers to perform simulations based on data that is realistically available to them from Li-ion cell producers."

6. BATTERY SERVICE

Companies looking to outsource their EV/HEV test work, or not wishing to invest in their own facilities, may be interested in the recently opened battery test and development suite at MIRA's dedicated component-development center in the UK. The suite has been designed to allow parallel development of primary traction battery systems, which run alongside the overall vehicle development program to provide the broadest development window.

High voltage (500V) traction batteries can be exercised directly using a 400A, 200kW unit. When teamed with a separate battery simulator, MIRA can also test ancillary EV components. This capability provides the opportunity to develop EV components prior to prototype battery packs coming on stream. Multiple battery cells/modules can be exercised simultaneously on a secondary system operating up to 72V.

"This investment in the latest equipment brings vital technology within easy reach of the majority of the European automotive sector," states MIRA's environmental test services manager, Eamonn Martin.

The latest high voltage, high-power exercisers are configured to be coupled with MIRA's existing environmental test equipment. These simulate real-world meteorological conditions and draw on representative road-load data to add an extra layer of complexity and realism to battery development programs. The equipment can be tuned to support proprietary and third-party peripheral devices on industry-standard protocols.



7. VEHICLE ENERGY FACILITY

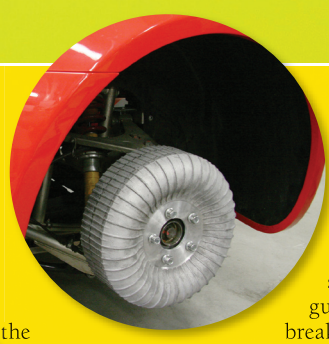
Work is underway on a US$ 3.61 million vehicle energy facility, which is claimed will be the UK's only purpose-built hybrid powertrain test and characterization facility not owned and operated by an individual automotive company. The facility is being built in WMG (Warwick Manufacturing Group) at the University of Warwick and is scheduled to be ready for a formal launch in December 2010, maybe providing competition for MIRA.

Much of the new vehicle energy facility (VEF) is being constructed by specialist powertrain test-equipment manufacturer Froude Hofmann. The equipment includes two dynamometers with a Genysis control system, a battery simulator, a battery test station, full exhaust emissions-measurement capability, and a robot-driver. The two dynos are being installed in parallel, the first to test electric motors, and the second to test engines based on gasoline, diesel, ethanol, and biofuels.

"The VEF builds on the research work of WMG's Hybrid Vehicle Research Group which, alongside its industrial partners, has created technical and cost-modeling tools for hybrid-vehicle development," says Professor Paul Jennings from WMG. "These include WARPSTAR (WARwick Powertrain Simulation Tool for ARchitectures), which can be used to model the performance of any hybrid vehicle architecture, and is being enhanced to include real-world driver behavior through an EPSRC-supported project, as part of Warwick's Innovative Manufacturing Research Centre."



8. TEST PLATFORM

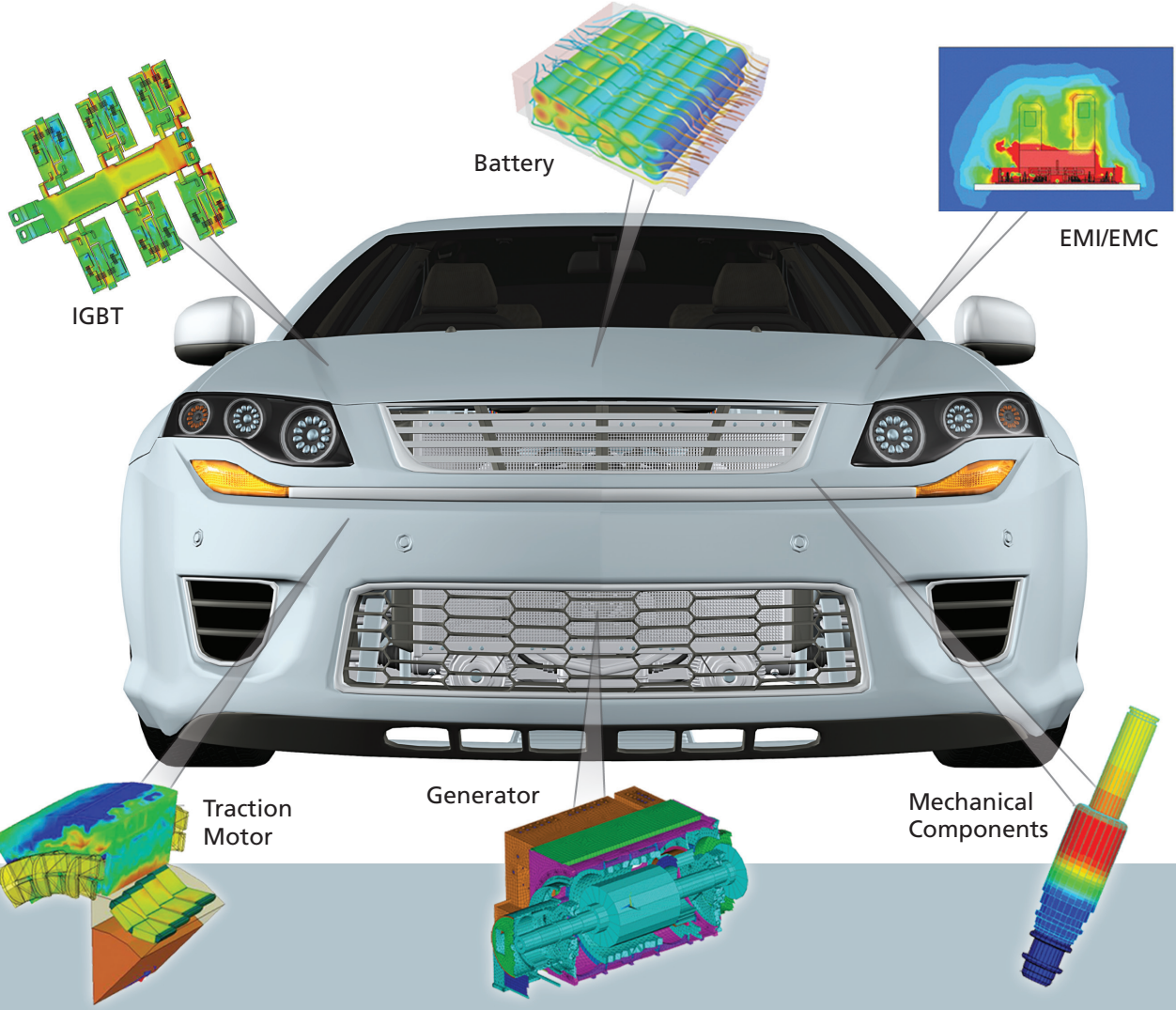


Wheel-hub motors are the future of EV propulsion, according to researchers at Fraunhofer. They make no demands of under-hood space, transmissions, or differentials. To test such motors, various individual components, and the system as a whole, the researchers have developed Frecc0, a scientific test platform, based on the Artega GT. Starting in 2011, automobile manufacturers and suppliers will also be able to use the Frecc0 for testing new components.

"We are developing a wheel hub motor that integrates all essential electric and electronic components, especially the power electronics and electronic-control systems, into the installation space of the motor," says Fraunhofer's Professor Matthias Busse. "Thus, no external electronics are necessary and the number and scope of the feed lines can be minimized. There is a marked increase in power compared with the wheel-hub motors currently available on the market. Moreover, there is an innovative security and redundancy concept, which guarantees drive safety – even if the system breaks down."

Many critics have found fault with the effects of wheel hub motors on vehicle handling, but Dr Hermann Pleteit, project manager at Fraunhofer, refutes this, following use of the Frecc0.

"The motor is extremely compact," he says. "The high power and torque densities merely cause a relatively low increase in unsprung mass. But by configuring the chassis in different ways – like the muffler settings, for example – you can compensate for these effects. There is no impact on drive comfort."



You Don't Have 100 Years to Design the Hybrid Electric Powertrain

It's taken about a century to perfect the conventional IC powertrain. Even though the hybrid electric powertrain is being engineered almost entirely from scratch, you don't have anywhere near that long to develop it.

The company that gets to market first may well drive the future of automotive development — not to mention reap a sizable share of the profits. How do you deliver a better technology, faster? The best practice is to use engineering simulation from ANSYS to thoroughly explore design options and optimize the one that best meets all those often-competing demands.

ANSYS offers an integrated platform that enables you to simultaneously evaluate individual components and subsystems under various physical conditions — fluids, structural stress, thermal, electromechanics and more — as well as the interactions between them at the system level.

ANSYS solutions address hybrid electric powertrain concerns:

- Battery
- Electric traction motors
- Generators
- EMI/EMC
- Power electronics
- System integration

ANSYS®

For more information, visit www.ansys.com/HEV
Or call us at +44 (0) 114 281 8888

Generator image courtesy Kato Engineering

9. EV DRIVE CYCLE

"Maximum energy density, currently 170Wh/kg, is expected to increase to 270Wh/kg. It is imperative that OEMs test and develop motor/inverter efficiency and power-management strategies and there is an understanding where the inefficiencies are in EV powertrains, which, in turn, will help OEMs to meet demands for greater range," states Gary Spinks from the powertrain test division of Lotus Engineering.

"It is important that the industry establishes a drive cycle specifically for EVs so that buyers are confident it represents real-world use.

"Accurate measurement of drive system efficiency is a primary concern for EV drive system designers. The most productive route to achieve repeatable and accurate results and reduce development is HIL testing. This method negates the use of extensive mule vehicle tests, plus can have the added advantage of testing in parallel to vehicle build.

"EVs also have a limited onboard energy storage system (battery), which depletes very quickly under high load testing. The time required to recharge the high voltage battery depends on the kWh of the battery pack but on average via a domestic supply it would be a minimum of five hours. Therefore, a facility to emulate the vehicle's energy storage system during testing becomes advantageous."

Lotus has designed and commissioned its EV test cell to perform HIL testing of a whole hybrid drivetrain.

10. HOT TOPIC

An important question concerning electric vehicles is whether the safety risks differ from those presented by conventional vehicles. New test methods are being developed by the SP Technical Research Institute of Sweden to ensure that electric vehicles do not contain toxic or hazardous substances, or produce any, and do not present new risks if the vehicle crashes or is involved in other incidents.

According to Professor Peter Leisner, manager of SP's electronics department, the designers are in unmapped territory when it comes to investigating the risks of batteries in electric vehicles.

"Better knowledge would make it easier for vehicle manufacturers to develop electric vehicles that are safe and reliable," says Leisner.

Batteries have been crash-tested and fire-tested in SP's laboratories to determine what particles or gases are emitted in the event of a fire, how a battery fire progresses through a vehicle, what the explosion risks are, and what happens if the battery is hit or subjected to extreme forces in a collision, among other factors. Batteries have also been subjected to short-circuit tests and tested for compression; and chemical risk assessments have been made to see which chemicals might cause harm to the environment.



11. ADVANCED LOGGING EQUIPMENT

According to Andy Eastlake, head of labs at Millbrook, the demands on test facilities to adapt to the changing architecture of electric, hybrid, and fuel cell vehicles pose interesting challenges.

"The powertrain test environment of engine and chassis dynamometers, climatic labs, and tracks have to embrace the complication of accurate measurement of hydrogen emissions in hydrogen combustion solutions and electricity consumption in battery applications," he states.



Accurate monitoring of new fuels and energy sources can be a challenge. One of the latest investments at Millbrook, advanced logging equipment for EV monitoring, is designed to offer robust measurement of complete energy flow and efficiencies from the energy at the plug point, through the charging system, battery balancing and maintenance, to the traction motors and road energy delivered.

"It is vital to drill down into every vehicle system which consumes energy or increases losses," adds Eastlake. "In our safety team we are conducting impact test programs on high-pressure (700 bar) vehicle storage cylinders right to the point of failure. The energy in a 700 bar tank requires a significant area to dissipate when the component finally fails, under extreme test conditions, and our team has developed a safe way to conduct this evaluation using some of our more remote on-site areas."

12. TURNKEY HYBRID SOLUTION

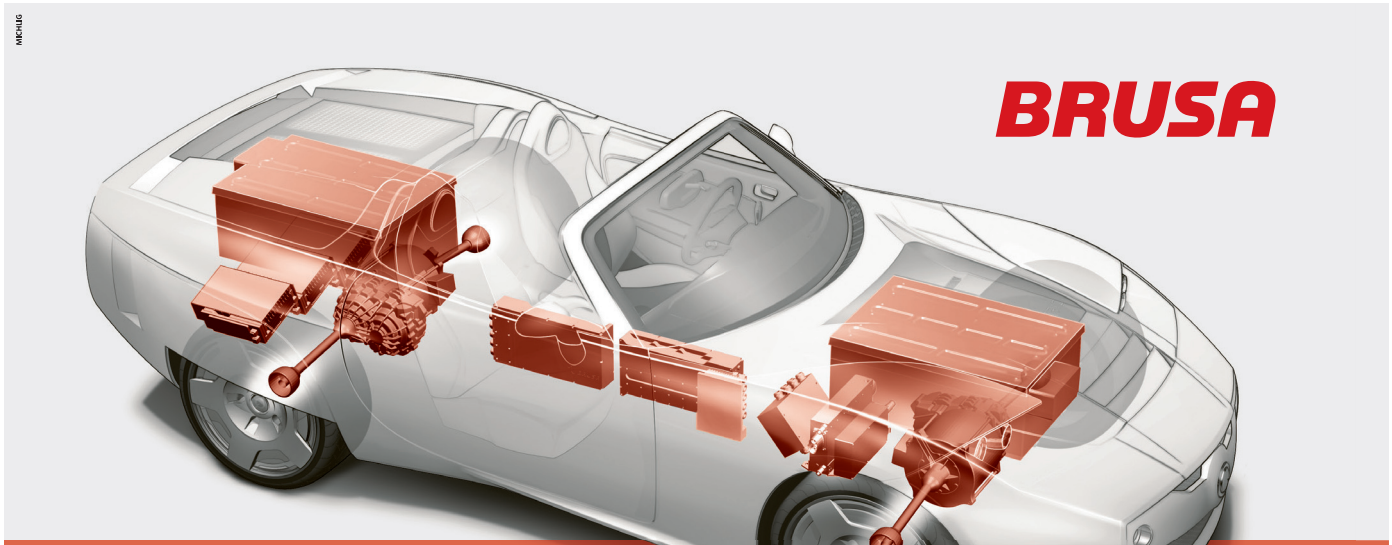


Canadian high-tech developer, D&V Electronics, considers itself at the forefront of hybrid testing. The ever-increasing public interest in hybrid vehicles, means D&V Electronics has never been busier.

"What we have done is develop a software platform and modular hardware system so we can pick and choose the components to quickly develop a turnkey testing system," explains strategic product development coordinator, Phillip Falk. "Behind the actual measuring application, we have introduced a powerful suite of development tools that we use internally to generate new software. So when we develop a new machine, we design the unique measuring application, backed up by a common, universal database with test specs and an Excel output so reports can be generated."

"The segment that is growing fastest seems to be larger vehicles, SUVs, and the like," says Falk. "Looking forward, I think it's possible that in the next one to three years there will be some very interesting vehicles on the market.

"Based on what we know has been tested over the last five years, the power-to-weight ratio and the performance of some of these devices are just incredible. We can't say too much just yet, but there could be hybrid systems which add something like 100bhp to the vehicle."



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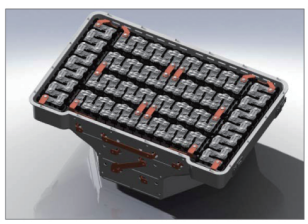
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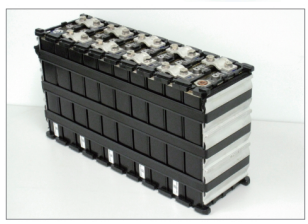




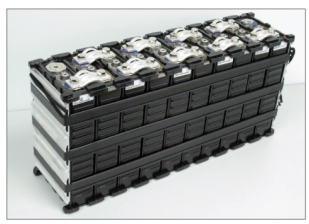




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13. VIRTUAL BATTERY BREAKTHROUGH

Higher battery performance is driving more complex battery management system (BMS) control and diagnostics strategies, with the major areas of focus being cell balancing, thermal management, charging, monitoring high-voltage isolation, safety and onboard diagnostics, according to dSPACE. For such development, a testing environment that is flexible, virtual, safe, and gives the freedom to implement scenarios that accurately portray desired and undesired system behavior is a must.

HIL simulation is being applied to simulate the type of test conditions required to develop the BMS strategy, removing the constraints one would face if testing with actual batteries (for example, not needing to actually discharge a battery to do consecutive, low state-of-charge scenarios).



To aid BMS development, dSPACE has created advanced HIL simulation with the addition of cell simulation hardware. The system is designed to offer cell behavior simulation, coupled with real-time models of batteries and other vehicle components, to provide a test bed for the next generation of advanced battery control.



14. DATA CONTROL

When GM was designing its 33,000ft^2 Global Battery Systems Lab to develop and test nickel-metal-hydride and Li-ion technologies for hybrids, plug-in hybrids, electric vehicles, and fuel-cell powered cars and trucks, it required no fewer than 64 data acquisition and control systems. A test automation system was created to coordinate thermal chambers, power process systems and conditioning units, and interface with battery control modules and lab safety systems.

These systems, supplied by A&D Technology, are based on iTest data-acquisition and control software, and also incorporate iCentral, which facilitates the overall lab management function by controlling the facility's battery cyclers, and environmental chambers. The goal of the system is to enhance the testing capabilities of the lab, as well as the maintainability and serviceability of the systems.

"This is an opportunity to play a big role in an important emerging technology," says director of global sales and marketing, Kevin Kemp. "And our success at GM will enable us to provide high-tech battery and EV development tools."

15. COMPUTERIZED BATTERY TESTING

A range of fully automated, computerized battery test systems has been designed by Maccor, to provide accuracy and high-speed testing capability. From the base Series 4000, features can be added to allow the system to perform virtually any type of cell or battery test, with any battery chemistry, according to the company.

The custom-manufactured system is available in sizes from eight to 256 test channels, can be configured with a wide range of voltage and current ranges, and can be fitted with additional hardware to provide optional features and extensive capabilities.

Supplied as a complete turnkey system, Series 4000 consists of a test cabinet, PC computer and test software, with options of a UPS and printer. The test cabinet and PC computer are connected via a high-speed 10 Base T communications network. As soon as AC power is connected to the test system, it is ready for immediate use.

Single-board computer controllers within the test cabinet provide control of the tests and collect the initial data. Each controller supports from one to eight test channels, dependent on the application. In addition, the test cabinet contains the individually controlled electronic loads, and power supplies for charging purposes.

Each test channel is operated independently, allowing different tests to be performed on different test channels simultaneously, with tests started independently, or in a block. Once started, tests operate automatically until the appropriate test end condition is reached.



16. ADVANCED PACKAGE

Battery packs have also been the focus at Arbin, which has developed tools to aid their research. Each main channel of its HEVBT system, which uses Mits.Net operating software, is isolated, allowing the system to run tests on each cell in a battery pack independently. These tests are critical for durability and reliability of the battery pack in certain driving profiles. Users can now get capacity values from charge/discharge tests, balance cells to a desired level, and run other diagnostic tests on individual cells within the pack without disassembling the battery.

The maximum charge for current and voltage is customizable and is paired with a natural discharge down to the cutoff voltage per single cell. Either thermocouples or thermistors may be selected for the HEVBT system and are set in the pack to monitor, record temperature data, and manipulate testing progress.

The system has safety provisions to protect from power failure, circuitry failure, or environmental failure.



17. MOBILE LABORATORY

As part of its Nido development program, Pininfarina has developed the Nido EV, a moving laboratory designed to fully explore the electrification of a small city car, and to develop a modular floorpan.

The Nido EV is the result of three years' work consisting of the adoption of a hybrid or electric driveline. Research also focused on reducing consumption and wheel-to-wheel emissions, the use of alternative materials that are lighter and recyclable, active and passive safety, and IT, combining the sustainable use of the means of transport with intelligent traffic management.

The body structure of this first prototype is a tubular steel frame, although the final version will have an aluminum space frame. The structure is designed to adapt to four different, completely electric or hybrid vehicles: a two-seater, 2+2, pickup, or a light van.

The Nido EV has two seats and a permanent magneto rear engine. The program also envisages the development of two slightly larger versions. The first will be a hybrid with an endothermic engine, positioned at the front, and an electrical engine at the rear. The second will be electric, with a front engine. In both cases, the position of the engine makes it possible to increase roominess to seat four, and to improve weight distribution.

The prototype is powered by a Zebra Z5 Ni-NaCl battery, which has a range of 140km and a top speed of 120km/h (limited electronically), and accelerates from 0-60km/h in 6.7 seconds. The battery was chosen as it does not contain harmful or polluting chemical substances, and is 100% recyclable.



Nido will also research lightweight components and energy-saving solutions (batteries with outstanding performance) with a high mechanical and electrical efficiency, and braking systems specifically for hybrid/electrical applications.



18. INSPIRED BY F1

Toyota Motorsport GmbH (TMG) began development on its EV component test rig during its time in F1, and this continues with an eye on general automotive application. For the 2009 season, Kinetic Energy Recovery Systems (KERS) were introduced to the regulations and, although Toyota never raced with such a device, a thorough development nevertheless took place at TMG.

In order to test individual components of a HEV system, a specific rig was conceived to enable the testing of power electronic units (PEU), motor generator units (MGU), and batteries in isolation.

A DC battery simulator can provide power supply and user-defined voltage and current levels, as well as charge the battery and supply a current converter. An AC battery simulator runs an electric motor or acts as substitute for the current converter.

Models have been developed to simulate PEU and MGU functions, with ongoing development to allow prototype EV components to be analyzed in isolation. Originally developed for the high-speed, low-torque requirements of a F1 KERS systems, the EV component test rig is being adapted to meet the specific characteristics of a broader range of EV projects.

These facilities are available to hire on a confidential basis. The November issue will feature an in-depth look at how this former F1 facility can benefit automotive manufacturers and suppliers.

19. NEXT-GENERATION TESTING

The American National Standards Institute recently indicated a move toward batteries which allow longer and faster run times, reduce dependence on other energy sources, lessen the 'green' impact of modern technologies, and lead to smaller and lighter electronics.

To assist manufacturers to ensure battery safety, reliability and conformance to regulatory standards, Intertek has invested in new battery/energy storage test equipment throughout Europe, North America, and Asia. This move follows the company's acquisition in 2009 of Sagentia Catella AB, a lab and consultancy for the battery/energy storage industry.

Specifically addressing the rapidly evolving automotive battery market, Intertek's Detroit, Michigan laboratory recently purchased five moderate- and large-format battery cycling systems. In addition to over 500 small-format battery test stations, the new systems offer the ability to test up 30 mid-size and large-format battery packs, for military, electric vehicle, and backup power/UPS applications.

"Combined with our energy storage advisory services, existing simulated durability and environmental test capabilities, Intertek is the only global, full-service provider that enables manufacturers to rapidly develop and launch safer, more reliable products that are dependant on power sources," explains director of operations, Tim Hubbard.



20. VALID BATTERY SOLUTIONS

Although typical simulation solutions mimic basic charge and discharge events, Horiba's Virtual Battery Solution, with its advanced emulation approach, is claimed to offer vehicle, drivetrain, and battery developers the ability to replicate in-vehicle conditions including stress, battery age, battery pack parameters, and driving cycles, as well as the environmental conditions necessary to predict actual battery behavior.

Virtual Battery features five specialized, customizable battery models, each built up from the cell level. Standard models include Lithium Ion, LiFePO4, NiMH, Lead Acid, and a new Ultra Capacitor model, and a Model Generator feature allows for easy creation of unique battery profiles.

The package is offered in two dynamic forms. Test facilities with existing battery cycling systems can add Virtual Battery on top of their existing hardware and software to seamlessly upgrade to advanced battery emulation. For hybrid, electric vehicle, and battery developers seeking a comprehensive approach, Virtual Battery is also available as a complete solution with optimal hardware, software and safety features.

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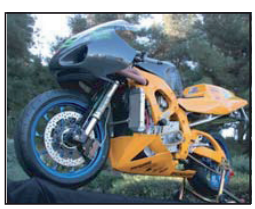


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Lotus reposition

Only three weeks into his new job as Lotus's chief technical officer, Wolf Zimmermann gives one of his first media interviews – and it's to *E&H*!

WORDS: **DEAN SLAVNICH**



> "I don't want this company to struggle anymore; we have the potential to become one of the world's greatest sports car producers"

Wolf Zimmermann needs no introduction. After all, he's the man credited for helping to shape Mercedes-AMG's current product lineup – by far its most expansive and exciting range to date.

Appointed to the Mercedes-AMG board, it would have been very easy for Zimmermann to sit back and enjoy the fruits of his engineering labor having recently secured the green light to develop and produce the electric SLS. But Zimmermann, who has had a big say in every engine AMG has developed since 1994, is a man who likes a challenge or two, so when Lotus – with its all-new management team and cash-backed grandiose plans for expansion – came calling, the 49-year-old German couldn't resist.

"I worked for AMG for 19 years and I did it all there," he says, explaining why he chose to swap Offenbach for Hethel. "It's a big risk for all of us leaving our comfort zone. When I got the offer I was amazed, especially when I saw the future product range and the investment they're planning to bring in. We are upgrading our engineering center by US$70 million! This is one cool project and I had to be part of it."

It's obvious that Zimmermann was hand-picked by Lotus CEO Dany Bahar for his engineering passion and for his extensive expertise, both of which have helped to make AMG what it is today. "We are creating a new brand – a new Lotus. It's not just my first day with a new company, it's everybody's first day – from me down to the people who have been with Lotus for 20 years!"



1: ESPRIT

Layout: Two-seater, mid-engine, rear-wheel drive supercar
Engine type: Petrol; hybrid optional
Hybrid technology: KERS
Cylinder: V8
Capacity: 5-liters
Power: 612bhp
Torque: 720Nm
Rev limit: 8,500rpm
0-100km/h: 3.4 seconds
Top speed: 330km/h
CO_2/km: 250g/km
Transmission: Seven-speed DCT
Weight: 1,450kg
Market launch: Second quarter 2013



2: ELITE

Layout: 2+2 seater, front/mid-engine, rear-wheel drive GT
Engine type: Petrol; hybrid optional
Hybrid technology: Hybrid gearbox with integrated electric motors and KERS
Cylinder: V8
Capacity: 5-liters
Power: 612bhp
Torque: 720Nm
Rev limit: 8,500rpm
0-100km/h: 3.7 seconds
Top speed: 315km/h
CO_2/km: 215g/km
Transmission: Full hybrid transmission
Weight: 1,650kg
Market launch: Second quarter 2014



3: ELAN

Layout: Two-seater, mid-engine, rear-wheel drive sports car (a 2+2 derivative will also be launched)
Engine type: Petrol; hybrid optional
Hybrid technology: KERS
Cylinder: V6
Capacity: 4-liters
Power: 444bhp
Torque: 465Nm
Rev limit: 7,800rpm
0-100km/h: 3.5 seconds
Top speed: 310km/h
CO_2/km: 199g/km
Transmission: Seven-speed DCT
Weight: 1,295kg
Market launch: Third quarter 2013

> If there was ever a car to make you drive the long way home, it's the Elan. Perfect for both road and track, the Elan not only ticks all the boxes, it creates new ones too
>
> Dany Bahar, Group Lotus CEO

Defining DNA

Zimmermann admits that it will take a lot of work to get Lotus to where he wants it, so he's putting in 15-hour days to start the ball rolling. The aim is for Lotus to have similar business stability, revenue, and products to Ferrari and, to a lesser extent, AMG. These are lofty aspirations, but how will such dreams be realized? The new CTO is eager to outline his vision: "One of our major tasks is to find Lotus's DNA and develop new products with this DNA." Zimmermann reels off a list of adjectives to describe the Lotus makeup, including: lightweight, intelligent, cool and sexy. "We have to keep these aspects. We also have to figure out the right powertrain for each car. We want each new product to be lighter than its competitors, so our models will have to employ different engine technologies. The powertrain in the Elise, for example, can't be used in our bigger GT."

For Zimmermann, a lightweight car automatically means a lightweight engine, so it would seem that bulky powertrains have no place at new Lotus. "You may see heavy V engines today but they won't be here tomorrow. It's clear that all of our engines will be lightweight."



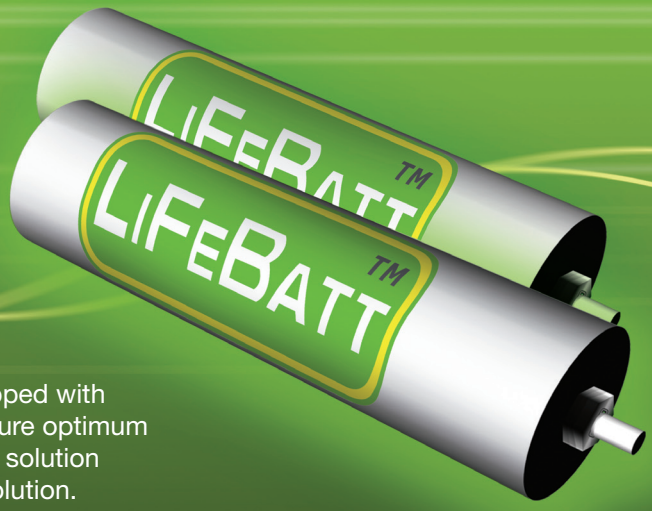
Launched last year, Evora is the first of a raft of new products planned by Lotus

Style and substance

With a rich history oozing automotive innovation and an engineering division that most car makers have turned to in times of need, it's not difficult to support the Lotus revolution. But critics and commentators are quick to point to flaky announcements that have no real substance. Zimmermann agrees in part but he does not want to discuss in too much detail where Lotus will get its new breed of engines, despite unconfirmed rumors that Bahar is keen to strengthen the company's already established powertrain ties with Toyota.

"We will look at Toyota when we come to sourcing new engines," the CTO says when

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pushed, "but we will also look at other solutions. We have to find what works for us as a company and that is something we are addressing right now.

"I was with AMG for over 19 years and I can honestly say our initial focus was always on the engine. It really was powertrain, powertrain and more powertrain."

But will such a spotlight on engine technology development mean Hethel will one day create its own powertrains? "We will see," says Zimmermann guardedly. "We will have bespoke engines not derivatives, that's for sure. The question is should we develop powertrains 100% in-house or seek help from top companies outside? I think I'd prefer high-tech partnerships because at this point in time it makes more sense. I don't want this company to struggle anymore; we have the potential to become one of the world's greatest sports car producers."

With his wispy hair and stylish Italian suit, Zimmermann could almost be heading up Dolce & Gabbana's winter-season product assault, let alone be discussing new engine ideas and electric vehicle concepts for Lotus at a manic Paris Motor Show. But as he proved at AMG, Zimmermann strives for perfection. He wants Lotus to become "the British Maserati or Ferrari". In a revealing statement



4: ETERNE

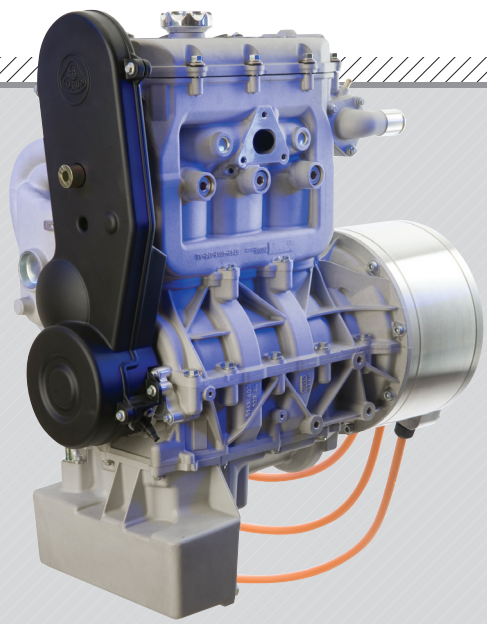
Layout: Four-seater, front/mid-engine, rear-wheel drive sports sedan (an all-wheel drive derivative will also be launched)
Engine type: Petrol; hybrid optional
Hybrid technology: Hybrid gearbox with integrated motors and KERS
Cylinder: V8
Capacity: 5-liters
Power: 612bhp
Torque: 720Nm
Rev limit: 8,500rpm
0-100km/h: 4.0 seconds
Top speed: 315km/h
CO_2/km: 220g/km
Transmission: Full hybrid transmission
Weight: 1,800kg
Market launch: Second quarter 2015

LOTUS AND THE CITY

The Esprit, Elite, Elan, Eterne and Elise grabbed all the attention at this year's Paris Motor Show, but, from an engine perspective, it's Lotus's City Car concept that's most revealing, combining an advanced series hybrid drivetrain and a one-speed transmission with the Lotus range-extender engine.

The Lotus City Car boasts an EV range of 38 miles (60km) – which easily covers the average commute in the European and North American markets. But it's the 1.2-liter, three-cylinder IC engine that's most impressive, boosting the concept's range to 310 miles (500km), thereby overcoming range anxiety. The small engine has been designed for flex-fuel running on ethanol and methanol as well as regular gasoline.

With a total vehicle weight of 1,400kg, and with 240Nm on tap, Lotus claims its City Car sprints to 62mph (100km/h) from standstill in 9 seconds when operating in EV mode. Top speed is rated at 106mph (170km/h), with a charge-sustaining top speed of 75mph (120km/h). The drivetrain returns CO_2 emissions of 60g/km. As impressive as this sounds, Lotus has not yet committed to pushing the concept into production, which is a shame as we at *E&H* are fans!



The three-cylinder, 1.2-liter range extender engine from Lotus Engineering has been designed specifically for series hybrid vehicle applications

VITAL STATISTICS

Drivetrain - Series hybrid, rear-wheel drive
Range-extender engine - 35kW, 1.2-liter, three-cylinder
Battery capacity - 14.8kWh
Power - 162kW peak/54kW continuous
Torque - 240Nm



5: ELISE

Layout: Two-seater, mid-engine, rear-wheel drive sports car
Engine type: Petrol with a stop/start system as optional
Hybrid technology: Mild hybrid with the stop/start function
Cylinder: Four
Capacity: 2-liters
Power: 316bhp
Torque: 330Nm
Rev limit: 7,800rpm
0-100km/h: 4.3 seconds
Top speed: 270km/h
CO_2/km: 150g/km
Transmission: Six-speed manual; DCT optional
Weight: 1,095kg
Market launch: First quarter 2015

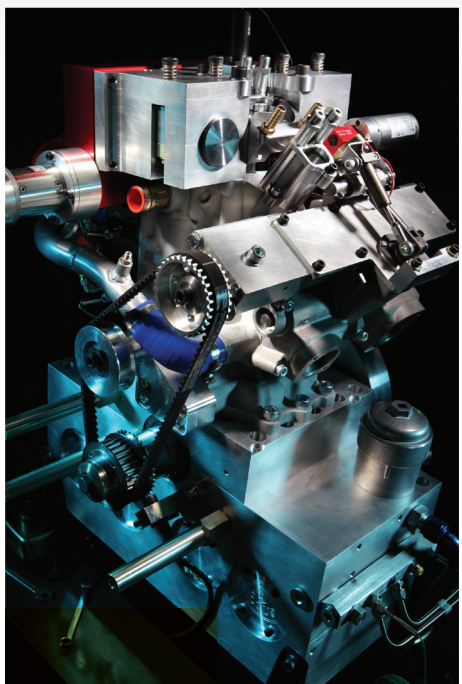


of intent, he adds: "If you look at what we have today – the Evora, for example – this is not what we want in the future. We need emotional powertrains."

And according to Zimmermann, electric supercars – such as the eSLS, which was so close to his heart before the move to Lotus – can also be emotional: "The eSLS is both amazing and really cool," he says. It's at this point that the Evora 414E technology demonstrator vehicle gets mentioned, but Zimmermann, in his expressive way, is quick to get back to discussing pure electric vehicles. "A cool, pure electric vehicle is something that would be a credit to Lotus, especially as it could be ultra-lightweight to give more driving pleasure"

Zimmermann continues: "Studies have shown that the average commute is only about 23 miles, which is nothing, so an electric vehicle can be used on a daily basis! Of course, if you need to go further, electric cars still aren't practical but in the future everything will change. I believe, for example, that the automotive industry will embrace car sharing schemes."

Does this mean that come 2030 most Lotuses will be electric? "I think it will be a 50/50 split," Zimmermann replies after some thought. "We will only have hybrids by then – there will be no pure internal combustion engines for sports cars – and pure electric vehicles. From 2025, I believe every car will be fitted with intelligent hybrid technologies to save fuel consumption and further lower emission levels."



The Omnivore engine realizes 10% better fuel economy than current leading gasoline engines, but where do projects such as these sit within new Lotus?

Having so long been seen as a petrol head – even before his Mercedes-AMG days, is Zimmermann going soft for eco-friendly vehicles? "To compare a 5.5-liter bi-turbo supercar with an electric supercar is not fair," he replies when asked which of the two he would choose. "For example, the V8 turbo supercar would be much cheaper at around US$170,000, whereas an electric supercar with the same performance could cost US$320,000! They can't be compared at the moment because of the extremely high cost of the electric motors."

Perhaps it's fitting that before he rushes off to unveil no fewer than five new Lotus models in Paris, Zimmermann adds: "If I could afford such a car, I'd probably go for the EV. Hey, a car that accelerates from standstill to 125mph (200km/h) in around 10 seconds is pretty cool, right?"

REAP systems



Li-Ion Battery Management Systems

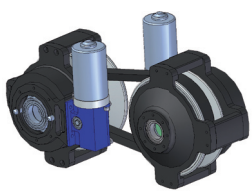
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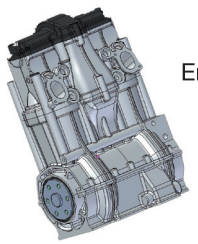
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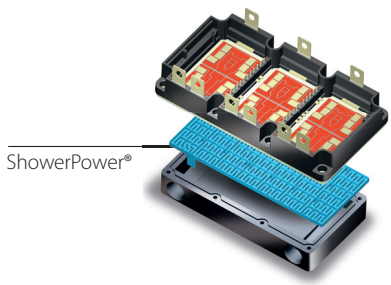
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New reality

It's one thing to develop electric vehicle powertrains, but what about the tires these eco-friendly saviors will sit on?

WORDS: **REX ROY**





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Embedded Success dSPACE

With countries such as China, India and Brazil rapidly expanding as consumer nations, it's expected that the world will see close to a doubling of cars by 2030. This takes the count up from roughly 800 million to 1.5 billion vehicles.

Depending on your point-of-view, the third world's entrance into the consumer age is either an economic boom on which to capitalize, or an environmental horror waiting to emerge. Those with a more positive outlook hope to offer solutions that embrace the former while avoiding the latter. Talk about mission impossible!

The projected growth has the automotive industry investigating sustainability in the areas of fuels and raw materials. These are real issues facing governments, OEMs and powertrain suppliers. But tire companies, in particular, see the additional 800 million world-fleet vehicles from the perspective of 3.2 billion more tire units sold between now and 2030. And to capture their fair share of this expanding market, major tire makers are taking steps now to help ensure a viable future regarding economics, the environment and personal transportation.

Tires and energy

Tires are a major factor in how much energy a vehicle consumes. On a standard car or truck with an IC engine, Continental provided figures showing that tires consume approximately 20.9% of a passenger car's powertrain energy. Components of this figure include rolling resistance (16%), air resistance (4.5%) and inertial resistance (0.4%).

What's more, that total power consumption figure grows as a percentage when the vehicle's powertrain is electric. Many EVs feature optimized aerodynamics and lightweight powertrain parts with less rotational mass, thereby making tires an even greater consumer of power.

And it's these very mechanical facts that underlie the reason why engineers look to tires for energy savings. Beyond how tires perform on a vehicle, one must also consider the energy required to make a tire and to ensure the tire itself lasts the lifespan. Reducing the first is critical moving forward, as is extending the latter. Both will help reduce the overall consumption of energy and raw materials.

Specifically addressing energy consumption related to manufacturing, Continental has been consistently reducing the $C0_2$ output of its facilities relative to product output. For example, company wide, Continental's average $C0_2$ emissions per ton of product manufactured dropped from 0.31 in 2004 to 0.25 in 2008. Their corporate goal is 0.21 by 2012, with similar reductions in both water and energy consumption.



Goodyear's Fuel Max tires reduce rolling resistance by 4%, enough to save 2,600 miles of fuel over the life of a set of tires

"Currently, tiny urban EVs use tires designed for traditional compact cars with IC engines"

Reinventing the wheel

Just as OEMs frequently introduce forward-looking concept vehicles to showcase their vision of the future, tire manufacturers occasionally do the same thing.

At Challenge Bibendum 2010 in Rio de Janeiro, Brazil — a worldwide gathering of companies interested in sustainable transportation — Michelin debuted two unusual tire concepts. Unlike conventionally sized tires made from new amalgams of rubbers, these tires showcase unusual profiles that provide distinct benefits regarding energy consumption levels. The tires are so advanced that they don't fit any production vehicle.

The first concept looks like a wheelbarrow tire. It's designed especially for electric vehicles used in urban environments. Currently, tiny urban EVs use tires designed for traditional compact cars with IC engines. However, for this project the clever engineers

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Michelin's concept EV tire weighs around 1.3kg less than the tire it would displace

at Michelin looked at the performance demands placed on small EVs and recognized that these vehicles would benefit from a tire designed especially for their performance envelope and specific driving cycles.

Michelin dreamed up a tall-sidewall tire that fits around a tiny 10in wheel. The 175/70R10 unit runs opposite the current trend of larger-diameter, wider, and lower-profile tires and provides numerous advantages in the process.

First, the 10in tire weighs about 1.3kg less than the 175/65R14 tire it would displace. This significant reduction of rotating mass dramatically impacts the performance levels of the electric vehicle. Tires consume up to 40% of the energy produced by an EV, so reducing a tire's energy consumption is key to improving overall both EV performance and driving range.

Recognizing the challenges of resource management in the future, the tires also require fewer raw materials to produce and have an exceptionally long service life. Practically speaking, Michelin also pointed out that the tall 70-series sidewall is well suited to absorb major pothole type impacts and curb abrasion, both of which are harsh realities of urban motoring.

Michelin provided a pair of Citroën C2 B-segment cars for Bibendum participants to drive. One was equipped with normal tires, and the other with the concept 10in Michelin rubber. The smaller tires drove as if they were lighter, which makes sense. The modified C2 weighed 40kg less than its conventional counterpart because so many ancillary components could be downsized, including brakes and suspension subsystems. The tiny tires, therefore, also have the ability to improve mileage for conventional compact vehicles, not just EVs.

Ultimately, Michelin believes that manufacturers will design new EVs and other urban-duty cars around these tires. These vehicles would have their chassis and bodies proportionally sized to take advantage of the smaller wheels, thus maximizing the energy saving benefits.

If that's not impressive enough, Michelin's second concept tire was tall and skinny as compared with being short and fat. Designed for conventional cars with high-performance aspirations, the 195/55R21 would supplant a 205/55R16 or larger doughnut.

Currently, the concept and production tires weigh about the same. The taller tire, however, has considerably lower rolling resistance due to its larger diameter — especially as a larger diameter tire absorbs less energy when it rolls than a smaller diameter tire because the tread surface deflects less. In addition, the narrow section width is more aerodynamic. Michelin estimates a fuel saving of approximately 0.05 liters per 100km, with additional savings compared to even wider tires that are currently favored on present-day touring cars and crossover applications. As with the smaller concept tire, automotive

WANTING IT ALL



What do automotive manufacturers want from their tire suppliers? According to General Motor's Terry Connolly, the answer is everything.

Connolly is the Director of GM tire and wheel systems. He works out of a facility in GM's Milford, Michigan Proving Grounds, where his team develops the performance goals for the tires that will carry future GM platforms.

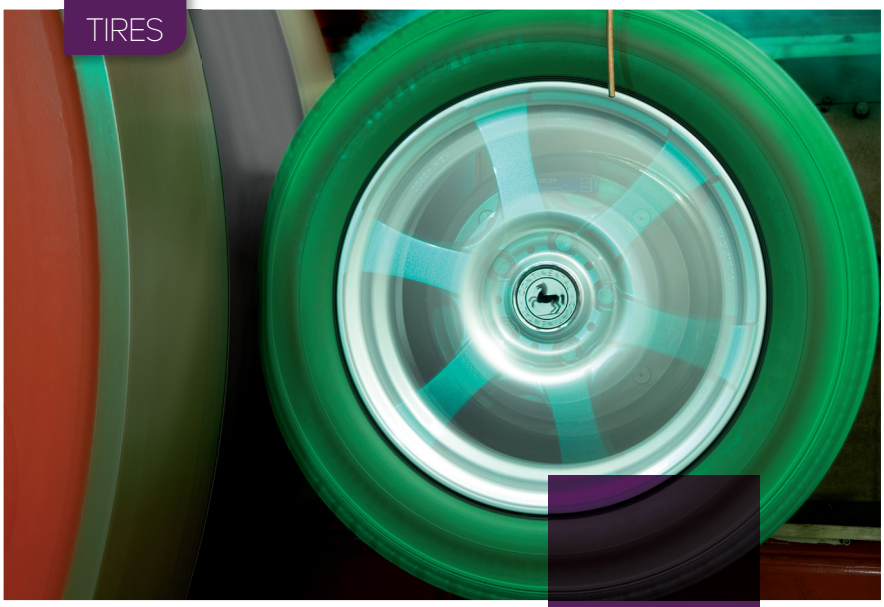
Speaking candidly, Connolly says, "The challenges for tire performance are way higher than we've ever had before because fuel efficiency is more important than ever before. We've demanded, and received, the same level of dynamic performance from today's generation of low-rolling resistance tires as we've had in standard tires." In fact, the improvements over the past four years have been considerable, with Connolly estimating a decrease in rolling resistance on the order of 15%.

"What the tire manufacturers have accomplished is really impressive," Connolly adds. The GM man is quick to point to the Chevrolet Volt's standard Goodyear Fuel Max fitment, which has a 0.0044 rolling resistance coefficient, which represents a 27% improvement over the previous generation Goodyear tire.

Looking into the future, Connolly adds, "We expect to see more improvement over the next five years, but I personally doubt it (new progress) can match the recent improvements. Based on what our best suppliers are telling us, I'd expect to see rolling resistance drop from between 6% and 9%." But for Connolly, these extra improvements would need to be made without sacrificing dry braking or other key handing metrics. He adds, "Brakes don't really stop a car. Tires do. We can't compromise safety for fuel economy."

Connolly sees gains coming from the use of computer modeling, and he knows that certain manufacturers have the ability to simulate prototype tire performance. "We can gauge the level of finite analysis a tire company has by how many prototype tires they submit for testing. Those that use advanced analysis techniques only submit two or three, others sometimes seven or more sets of tires."

Regardless of how tire suppliers meet the goals set by manufacturers, Connolly expects that performance goals will continue to get tougher to achieve. "Our team tests tires to identify performance benchmarks, and then we work cooperatively with our tire suppliers to see what's possible. Sometimes manufacturers come to us with solutions that exceed our goals. While we know plenty about tires, the manufacturers are the experts about how to produce them and make them better."



With the BRIC nations set to embrace mass consumption of vehicles, tire makers are working hard to improve efficiency

designers and engineers will have to design the body of the vehicle around this tall and narrow tire concept.

Natural development

Focusing on what new tires might be made of, Goodyear recently announced a prototype comprised of synthetic rubber produced from sugar instead of traditional oil. Codenamed bio-isoprene, this renewable raw material produced by genetically altered bacteria could provide Goodyear with another raw material option for synthetic rubber and help reduce the company's carbon footprint. Denmark-based Danisco is working with Goodyear, and is expected to have a bio-isoprene plant on line in several years (a 2013 to 2016 timeframe depending on research results) with production tires rolling into the market a year later.

Continental is also conducting focused research on using more natural rubber in its own concept tires. Their most advanced examples utilize 90% natural, renewable raw materials, a figure far higher than current production tires.

A dedicated focus on green engineering is yielding real end-user benefits. For example, Goodyear's line of Fuel Max tires reduce rolling resistance by approximately 4%, enough to save 2,600 miles of fuel over the life of a set of tires (estimated at 65,000 miles). These Goodyears are so efficient that they are the standard tire on the 2011 Chevrolet Volt and one of the original fitments on the Toyota Prius.

Michelin's line of Energy Saver tires rolls down the same road as the Goodyear Fuel Max technology. The company claims up to an 8% advantage over older tires. Additionally, proprietary compounds and contact patch designs help extend tire life by as much 16,000 miles longer than competitive tires. Michelin practically asserts that longer wearing tires save energy and raw materials by forestalling tire replacement.

Not to be left out, Bridgestone recently launched the newest edition of their eco-friendly tire, the Ecopia. Compared to equally sized Bridgestone tires, the new Ecopia EP150 boasts 15% less rolling resistance, helping to achieve a $C0_2$ reduction on the order of 3%. The tire is also lighter than a Bridgestone of standard construction, helping reduce energy wasted on accelerating the rotational mass. Bridgestone originally launched the Ecopia product line in Japan nearly a decade ago. The first tire was designed for Japanese domestic market electric vehicles, and gave the company an early entrée into the green tire market.

As the third world transitions into a consumer economy, the strain on natural resources and energy sources will be genuine. Tire manufacturers are doing their part to ensure a viable future by recognizing and responding to the trends now. The economic reality of 800 million new customers just over the horizon is just too enticing to not plan for. Every major company recognizes planning for the oncoming explosion is the only way to ensure a viable economic and environmental future.

RECIPE FOR SUCCESS

Given the advanced technology developed in this location, retinal biometric scans are not required for access into Continental's recipe room. Located in one of the many buildings in Conti's impressive Hanover campus, it is here that the future of tires begins to take form.

Generally speaking, the basic ingredients that go into tires haven't changed much in a century, so some might think that there aren't any new recipes to be mixed, but they'd be wrong.

One wall of the mixing room is lined floor to ceiling with bins holding various types of natural and synthetic latex. Some look like milky colored ice cubes while



others resemble coal. Another wall holds shelves stacked deep with vials of powders and oils. Fit for an alchemist, experienced technicians follow new recipes written out on small note cards.

Each recipe gets its own small bin to hold the raw latex and a small brown lunch bag. Precisely measured ingredients go into the paper sack.

Miniscule differences in recipes — changes in the amounts of key ingredients or inclusion of new elements such as sunflower oil — can lead to breakthroughs in rolling resistance, traction and longevity. The technicians in Continental's recipe room whip up thousands of unique batches of rubber annually. Their quest is never ending, because there are always new materials to test. One technician added, "This equals job security." Indeed. But it also leads to incremental breakthroughs that reduce worldwide energy consumption, a worthwhile endeavor.



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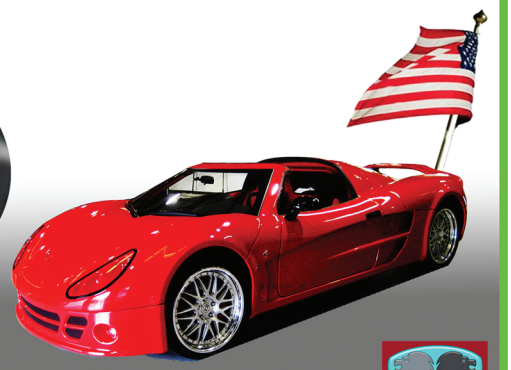
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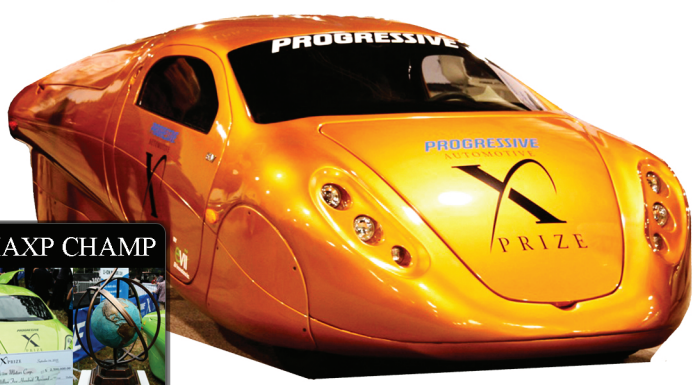
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RANGE: Up to 160 miles / 257km	RANGE: 109/96/104 (City/Hwy/Comb)
	156 Under Ideal Conditions
TORQUE: 1440Nm	TORQUE: 220Nm
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Battery: 37kWh	Battery: 35kWh

BMW
(All electric Mini Cooper)



Stan from Victorville, CA., a past owner of a BMW electric mini,when asked about the power and the drive of the comparison said,
"It (Liv Flash) has a lot of pick up more than what I was used to (BMW electric mini). I leased a Mini-E for a year and gave it back."
When asked how he felt about having room for storage and grocery's verses having no room in the Mini-E, Stan said,
"Yea, I had to drive my wife's mini van when we needed to have room for groceries."

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Green Machines

Electric superbike racing is gathering speed, with the high-profile TTXGP series attracting attention from media and manufacturers alike. But what – if anything – can the automotive world learn from these two-wheeled eco-friendly speedsters?

WORDS: **FARAH ALKHALISI**

The first TTXGP race, which took place in June 2009, saw 16 electric bikes tackle the Isle of Man's demanding bends. Now, a year on, this tournament has some real momentum, with three regional TTXGP championships in North America, UK and mainland Europe, all of which will culminate in the ultimate showdown in Spain later this year. After initial skepticism from the biking fraternity, the electric racers have proved to be as exciting to watch as their petrol-powered counterparts – even achieving comparable speeds – and despite some early problems with batteries and control software, the teams involved are demonstrating their ingenuity and pioneering some cutting-edge technologies and electric subsystems.

Such has been the impact of all this that several major manufacturers are rumored to be expressing an interest in competing in 2011, but, for now, it's all been about new names and start-ups. While some teams are running conversions of established bikes, others are building clean-sheet machines and patenting their technology – and these innovations could well be relevant to the four-wheeled world.

Energy recovery

Keeping the weight down is crucial in a racing superbike but batteries are heavy, hence the use of energy recovery systems such as KERS. "We conducted trade-off analysis on supercapacitors, KERS, hydraulic launch assist, multiple electric motors, AC versus DC motors and gearbox versus no gearbox," explains Chip Yates, engineer, rider and team owner. Funding issues and battery problems forced Yates and his team to withdraw from the 2010 TTXGP, but he's working hard and preparing for a comeback for his Swigz.com team in 2011. "We know there are different ways to candy-coat the problems of today's batteries, but to make meaningful advances in the field of electric vehicles, we needed to focus on the basic building blocks: a strong and efficient motor, the best KERS system possible, complete understanding of the batteries and, via new software, pushing them to their limit."



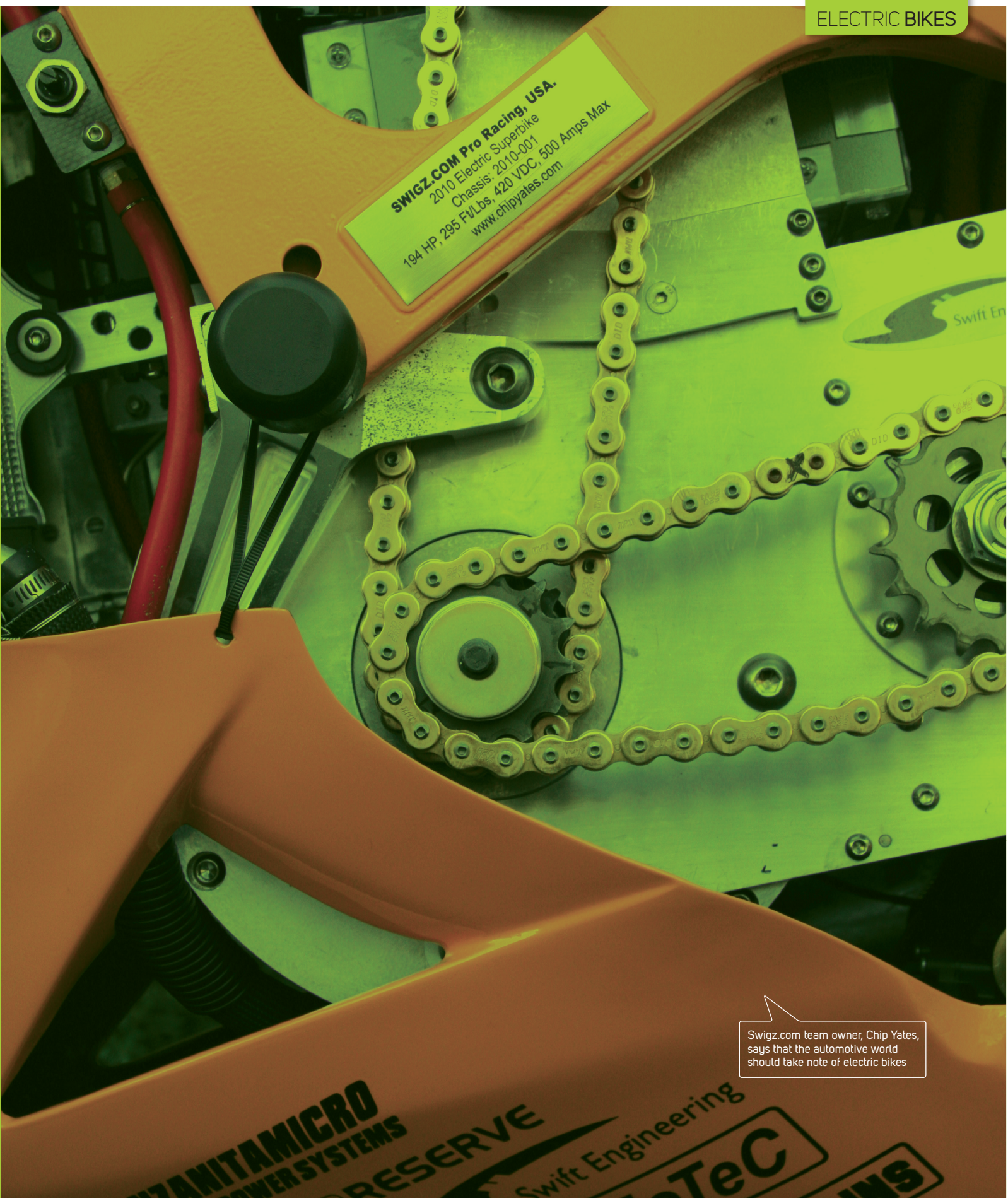
The Mavizen bike weighs 110kg without batteries

Yates notes that "under braking, the rear wheel of a motorcycle, especially a racing motorcycle, is not able to transfer much braking force to the motor because it is so lightly loaded – sometimes even off the ground". His patent-pending KERS, therefore, is a front-wheel system that is tightly controlled "through a complicated algorithm that takes all the salient variables into account, and is based on race simulations that run on candidate cells in the battery tester.

"By doing this," he continues, "we have an advanced understanding of exactly how much we can slam a particular cell back and forth between high discharge and KERS cycles for each lap, and what the resulting impedance build-up and heat rejection requirements are." This algorithm is then synchronized with a race-finishing solution to enable the extraction of full performance at the end of the race, with the race distance programmed in as the necessary range.

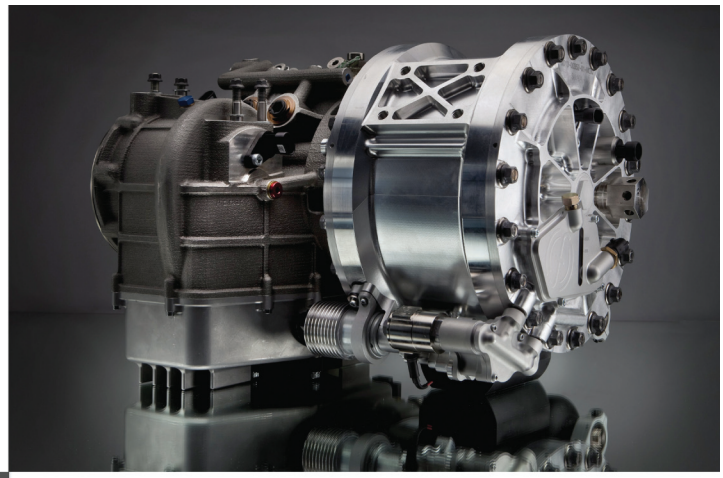
But Mavizen, the technology, advisory and consulting division of the TTXGP and maker of race-ready bikes that can be converted for road use, is sticking with rear-wheel energy capture: "A system is being developed to maximize return, enabling the rider to control the regenerative braking with what would be the clutch lever on a conventional bike," explains spokesman James Owen.

Supercapacitors, however, "are really of no practical value", notes Bill Dube, not himself a TTXGP competitor but the



Swigz.com team owner, Chip Yates, says that the automotive world should take note of electric bikes

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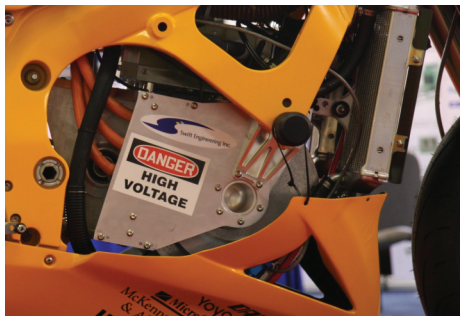


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testing the future







Competing in next year's TTXGP, Chip Yates' new electric superbike is one of the most powerful ever developed, with 194bhp

owner and engineer behind the KillaCycle speed record-breaking team. Dube adds: "Batteries have more than low enough internal resistance, and carry so much more energy per kilogram, so supercaps serve no practical purpose."

Under control

The developments so far are not so much in the batteries themselves as in the way that they are managed. "The Mavizen TTX02 boasts a custom onboard PC system, CHEWII," explains Owen. "It's a touchscreen visual display unit that lets the rider know exactly how the bike is performing, providing real-time information on temperatures, current draw, voltage and power usage. The CHEWII system runs on an Intel chip and has WiFi, Bluetooth, GPS and USB, allowing remote access for checking the battery charge or uploading new settings."

The Mavizen man continues: "One of the beauties of EVs is the ease of changing almost any variable to alter the power characteristics, such as the power available and throttle response curves. This means that configuring a bike for the desired performance and honing it to the rider is a relatively simple process with the onboard computer."

Meanwhile Yates says that his software – including the KERS controller and the race-finishing algorithm, which is versatile and adaptable for other requirements – is "intentionally designed to be applicable to different types of bike, including production bikes, and also to cars. This is another area where we are filing patents." Similarly, TTXGP competitor – and Isle of Man winner this year – MotoCzysz is contributing its software know-how and systems integration tech to a partnership with Remy International for a complete electric powertrain solution called D1g1tal Dr1ve that will be marketed for use in cars as well as bikes.

All packaged up

The basic layout of most motorbikes still harks back to the days when they were simply pushbikes with motors strapped on, which is not the best design when it comes to gravity. However, due to the engineering setup,

STATE OF THE MARKET

Electrically-driven motorcycles are nothing new – engineers experimented with battery power in the earliest days of mechanized transport, and electric scooters and mopeds have long served as economy-oriented local-usage machines. The latest electric bikes, however, are a new breed, promising speed and performance that's on a par with their petrol counterparts, as well as a viable range for out-of-town or on-track enjoyment.

Mission Motors of San Francisco once claimed to have the fastest electric production motorcycle in the world with its 150mph Mission One, which boasts a 150 mile range, and it plans to build a limited run of 50 before launching a lower-cost bike. The company intends licensing its technology – powertrain, control systems and software, grid integration – for a variety of applications, and has said that it is in talks with several automotive manufacturers.

Fellow Californian company Lightning Motors has since achieved 173mph, however, and its superbike is now available to order. Brammo, of Ashland, Oregon, markets two electric bikes: the accessible, stripped-down Enertia and the higher-spec, 100mph-plus Empulse. It is also an OEM supplier of its Digital Drivetrain systems, including battery packs and vehicle management systems. Brammo has also announced a manufacturing partnership with Flextronics. Zero Motorcycles of Santa Cruz has a four-bike range now on sale – and it has just received a US$900,000 grant from the California Energy Commission to develop its powertrain technology further.

electric bikes can take on a better shape. While the TT02 is based on the KTM RC8 chassis, Mavizen's Owen notes that "the main issue is that the frame is essentially designed around the engine and, by removing the engine, you not only lose a massive load-bearing structure, but you also compromise one of the biggest determining factors in the frame design." Though cost has been a limiting factor so far, Owen believes that a clean-sheet design "is clearly the method of the future for designing electric motorcycles to optimize efficiency, weight, distribution, performance and handling. It is only a matter of time."

The obvious application of the superbike world's findings would be in the field of special-interest, ultra-lightweight sportscars, but new and effective ways to package an all-electric drive system could be influential for everyday vehicles as well. "While we opted to start with a conventional frame to keep development costs in line with what we have learned so far in terms of motor and battery placement and packaging, we would definitely be able to create a completely new bike layout," Yates says. "And we believe mainstream cars would benefit from our powertrain layout."

Automotive applications

And Yates is not the only one who thinks the automotive world should sit up and take note of electric bike developments. "As with an IC engine," Owen adds, "there are subtle differences between car and motorcycle powertrains, so it isn't necessarily a simple case of swapping the powertrain. However, with some changes to the controls, power delivery and consideration for gearing – to name just a few variables – the technology is, to a degree, transferable, depending on the application and desired performance. Mavizen is investigating several options.

"The experience gained with electronic drivetrains should allow us to offer something different and competitive to the market."

A BIG DEAL



MotoCzysz, a small family-owned design and engineering consultancy from Portland, Oregon, has already seen on-track success with victories for its E1pc bike at the Isle of Man TT Zero race and the e-Power Red Bull Moto GP at Laguna Seca. In August 2010, it announced a partnership with Remy International to bring a new-generation electric drive system to market, combining its cooling and integration technology with Remy's High Voltage Hairpin (HVH) motor in a compact, lightweight solution called D1g1tal Dr1ve. Remy CEO John Weber says that "MotoCzysz proved their ability to optimize a Remy motor with their astounding test results and win in the TT Zero electric motorcycle race on the Isle of Man this year. Integrating that same groundbreaking engineering with the patented Remy HVH motor is a win for our electric automotive and light-duty commercial customers. Remy and MotoCzysz have the experience and technology to make this remarkable propulsion system the new industry standard for electric automobiles."

As the near-wireless D1g1tal Dr1ve "was originally designed to fit a motorcycle frame" with all components in a single housing, "when applied to automobiles, this weight and size advantage, coupled with disproportionately high performance, will leapfrog other systems and provide OEMs, integrators, and converters unheard-of efficiencies", Weber believes.

The initial product promises 135bhp and 250Nm of torque, and will be available in the second quarter of 2011, but both a more powerful option and a smaller, more compact unit will follow. And while further details on this project are not yet forthcoming, MotoCzysz has also confirmed it "is working with Indian automotive and motorcycle giant Bajaj on a bold solution for a next generation electric car."

Yates – who has already licensed patents for use by Jeep and negotiated technology transfer deals with automotive OEMs and Tier 1 suppliers – is more specific in his aims with regard to the future of electric motorcycles. "We plan to race this bike in 2011 and then sell it on as a maximum performance testbed before licensing the patents to an automotive or motorcycle OEM for their EV program," he states. "I will consider this program a success if we race the bike next year in the USA and Europe, hopefully winning the world championship for electric motorcycles. We'd then like to transfer the program and technology to a major OEM for improving the performance and excitement of mainstream electric vehicles, be they cars or motorcycles."

MINI MOVE

Away from the world of electric superbikes, this year's Paris Motor Show hinted at a new direction for BMW's Mini brand.

The MINI Scooter E Concept is powered by an electric motor that's integrated in the rear wheel. The motor's lithium-ion battery pack can be recharged at any conventional power socket using an onboard charging cable.

When riding the MINI Scooter E Concept, brief stops can be used to top up the onboard energy storage system. Such consistent charging significantly increases the independence and flexibility of the electrically powered two-wheeler. Apart from the compact battery, a charging system and connecting cable are integrated neatly in the rear of the MINI Scooter E Concept. The charging cable has a plug which fits all conventional domestic sockets.

Plugs and cables are accommodated underneath a cover similar to the round tank flap in a MINI car. After opening the illuminated flap, the plug and charging cable can be pulled out to a length of up to five metres and connected to the power system. Then, when the battery has been charged, a button-operated spring mechanism ensures that the cable is retracted and tidily coiled away in a space-saving compartment.



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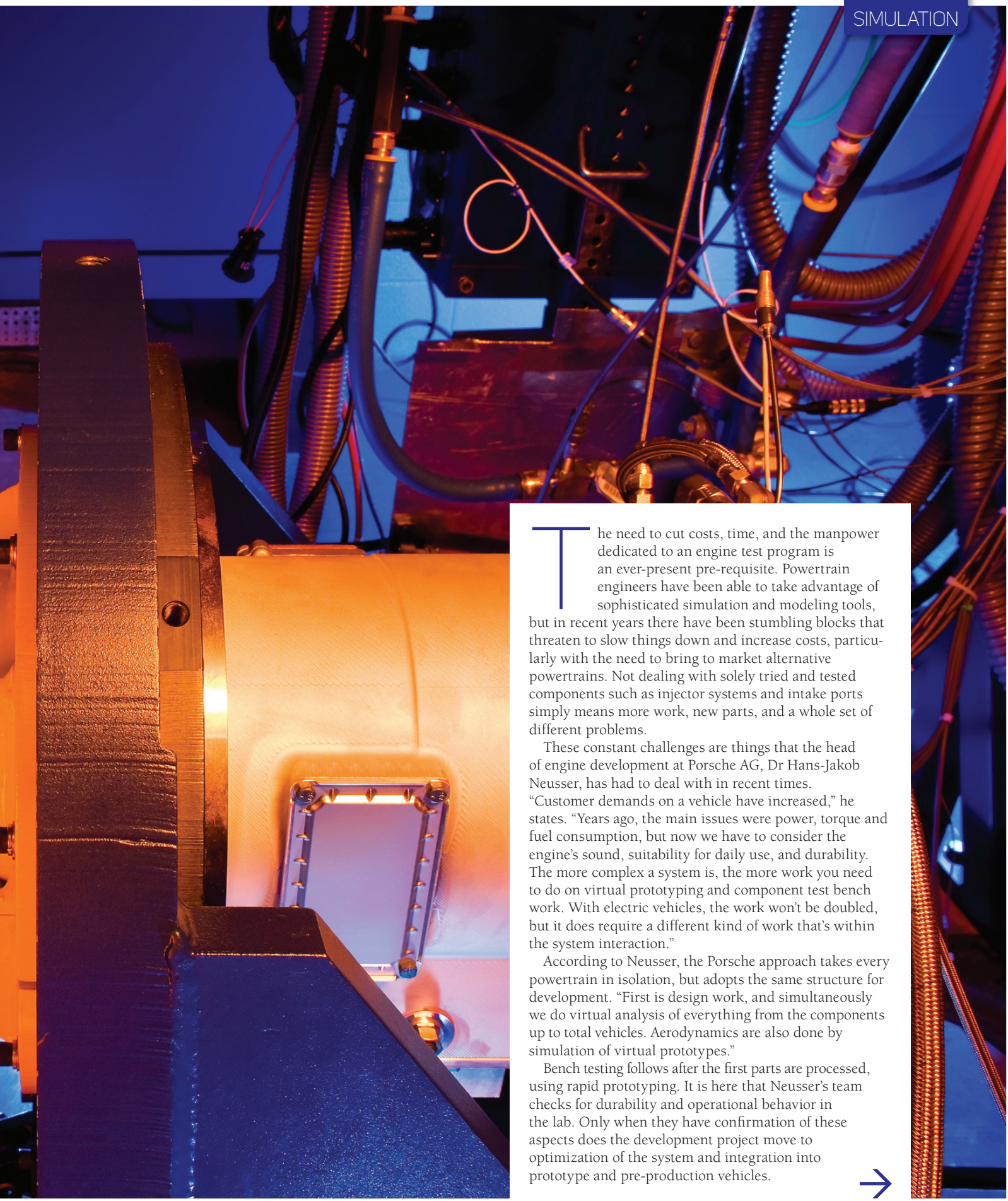


Lab of the Gods

Advances in simulation packages, engine dynos and data acquisition have not gone unnoticed in the automotive world. But will such improvements allow engineers to soon be capable of developing new electric powertrains purely in the lab environment?

WORDS: **JOHN CHALLEN**

A non-fueled hybrid spin cell taking place at GM's in-house powertrain facilities

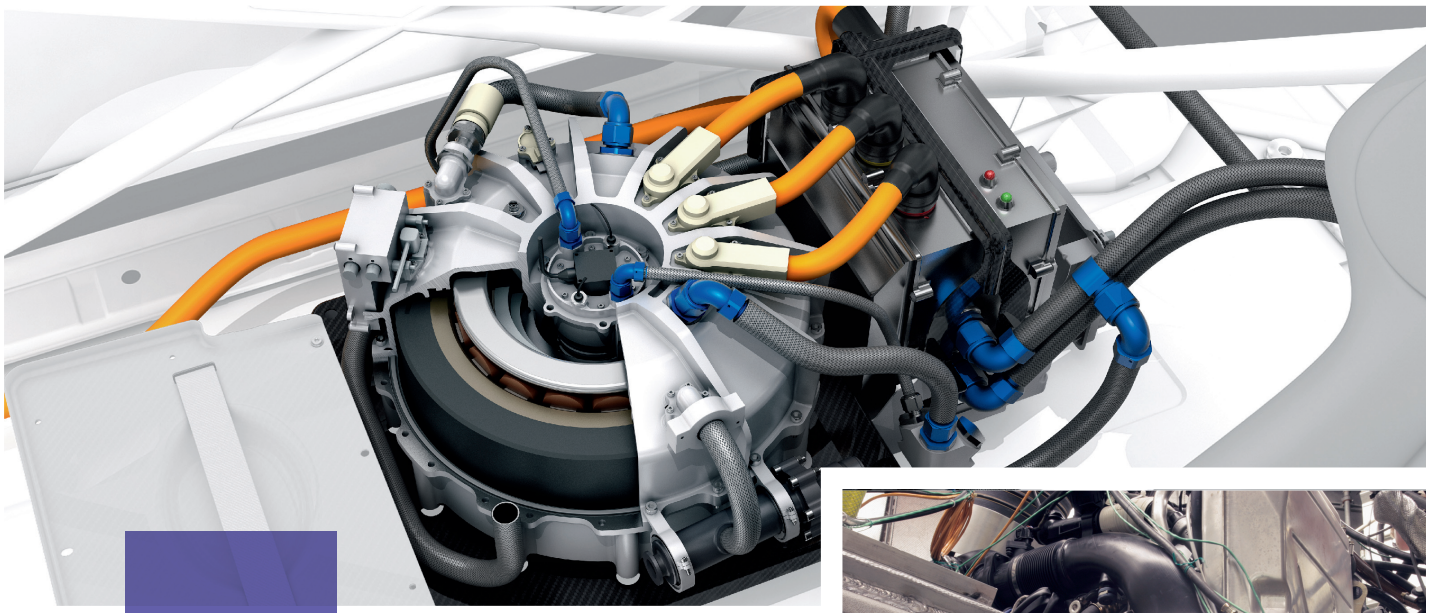


The need to cut costs, time, and the manpower dedicated to an engine test program is an ever-present pre-requisite. Powertrain engineers have been able to take advantage of sophisticated simulation and modeling tools, but in recent years there have been stumbling blocks that threaten to slow things down and increase costs, particularly with the need to bring to market alternative powertrains. Not dealing with solely tried and tested components such as injector systems and intake ports simply means more work, new parts, and a whole set of different problems.

These constant challenges are things that the head of engine development at Porsche AG, Dr Hans-Jakob Neusser, has had to deal with in recent times. "Customer demands on a vehicle have increased," he states. "Years ago, the main issues were power, torque and fuel consumption, but now we have to consider the engine's sound, suitability for daily use, and durability. The more complex a system is, the more work you need to do on virtual prototyping and component test bench work. With electric vehicles, the work won't be doubled, but it does require a different kind of work that's within the system interaction."

According to Neusser, the Porsche approach takes every powertrain in isolation, but adopts the same structure for development. "First is design work, and simultaneously we do virtual analysis of everything from the components up to total vehicles. Aerodynamics are also done by simulation of virtual prototypes."

Bench testing follows after the first parts are processed, using rapid prototyping. It is here that Neusser's team checks for durability and operational behavior in the lab. Only when they have confirmation of these aspects does the development project move to optimization of the system and integration into prototype and pre-production vehicles.



Porsche has spent much time fine-tuning the electrical flywheel energy reservoir of the 911 GT3 R Hybrid

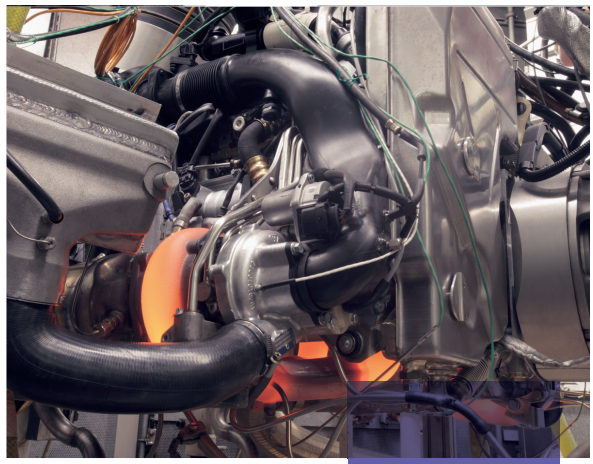


"I would say there is a 50/50 split between lab and total vehicle work, but I see it moving further toward the test rig"

Dr Hans-Jakob Neusser, head of engine development, Porsche AG

"As the dynamic driving behavior of a hybrid powertrain is completely different from a conventional engine, many elements of the test program have to be altered," explains Neusser, who has been working with hybrids for a decade. "The quality of the conventional adjustment and calibration work can be influenced by the electrical parts. This work can be done through virtual prototyping, transferring it to bench testing, and then finally validating it in the final vehicle. For alternative powertrain work, I would say there is a 50/50 split between lab and total vehicle work, but I see it moving further toward the test rig."

For comparison with a conventional powertrain test program, Neusser clarifies that for the company's latest V8s, 80% of the mechanical test program was conducted in the lab, with thermodynamic and application work closer to a 50/50 split.



Half of the thermodynamic and application development work on Porsche's new V8s was conducted in the lab

Race to the finish

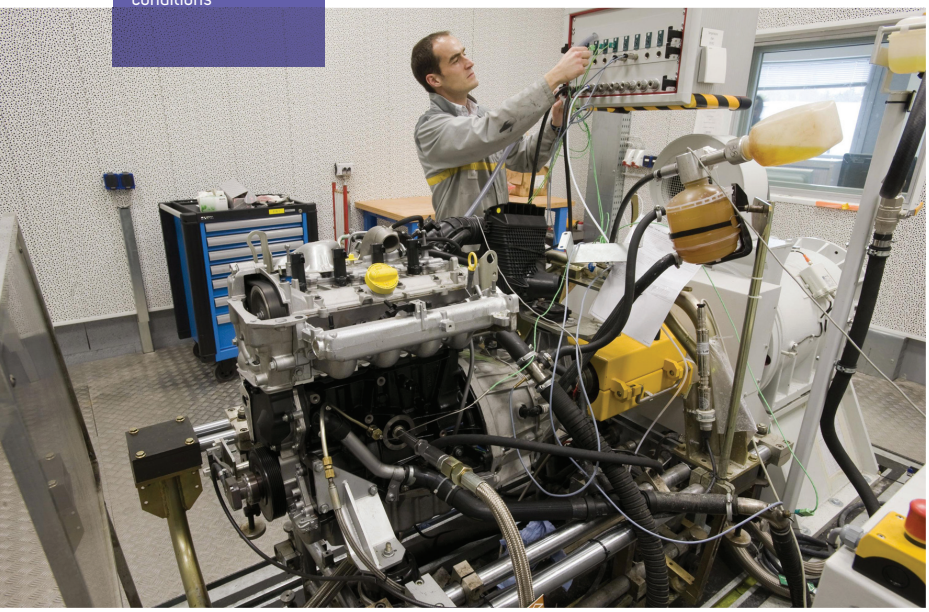
The rise of computer power is also something that Mazda's program manager in the powertrain development division, Yasuhiro Harada, is keen to discuss. "In the future, it seems likely that most of the development process will rely on simulation," he predicts. "Actual engines will only be used to verify the results of computer simulations and to help improve the accuracy of the theoretical models."

Famed for its quick development times – sometimes as short as 12 months for a mid-cycle facelift model – it seems that the same rate of development could be at work in Hiroshima's powertrain test facilities, aided by some advanced lab-based technologies. "Our latest bench testing process involves a dynamometer that can simulate everything from different road surfaces to the forces from the transmission and other vehicle components," explains the Mazda man. "This dyno enables us to test the full range of driving styles and road conditions, just as if we were actually out driving in the field. We can also set weather and atmospheric conditions as desired. For example, we can recreate the low air pressure of a high mountain range, or the heat of a desert.

"When developing an all new engine, we use computer simulation exhaustively from the conceptual phase in order to design the basic structure. Even when the development process enters the detailed design phase, various aspects including performance, reliability, and NVH are simulated with a computer, on the screen."

Harada says that currently, more than half the specifications of an engine are determined through computer simulations, but stresses that this theoretical modeling is not intended to be a replacement for real-world testing.

"It is generally accepted that testing methods will become more and more computer based. But as well as this, I expect that the most notable change in this area will be a shift toward a qualitative improvement of development and testing methods. For example, there is currently a very big emphasis on taking real-world testing and then recreating them theoretically."



Renault's powertrain facility in Lardy can simulate many different conditions

But Harada stresses that caution must be applied when relying on computing power: "It [the industry] is trying to make technological advancements by simply replicating actual tests using computer models. Computer models have a more important role. We use them to try out new ideas, create new designs, and optimize existing ones."

French connections

Renault has made recent investment in a high-tech powertrain facility in Lardy, just outside Paris, as the French manufacturer concentrates more on engine testing and development in the lab. The new complex features state-of-the-art engine and chassis dynos, altitude and climatic chambers as well as very sophisticated HIL capabilities.

"The aim for us is to stay as long as possible in the lab, because it means reduced planning and reduced research and development costs. We can also be able to offer more proposals for our customers in terms of reducing emissions," explains Pierrick Cornet, manager for the powertrain tuning department.

"We try every day to move from tracks to chassis dyno, and from testing to simulation," he continues. "We use off-line engine tuning with one car on which we can evaluate standard conditions such as speed and altitude, and all the tests are made on the chassis dyno. We then have some specific models for the database, which should be on the real-life drivers. This is where we can check to see if our tuning is going to plan."

One of the major capabilities at Lardy is the ability to simulate the load with the transmission, vehicle, and road data, and then feed the test bench with such information. "This setup allows us to simulate the drive cycles for homologation as well as simulating weather conditions from -10°C to 30°C," states Cornet.

"From testing to simulation, specifically for our engine management software, we use HIL validation. The software in engine ECUs work in real-time conditions with simulation and are connected to models and real parts such as the injectors. From the ECU we can make thousands of simulation changes."

In reality, there doesn't seem to be a straightforward yes or no answer as to whether the future of engine development lies solely in the lab, but most agree that it will be validation work, not development work, that is done outside the lab. "By 2020, we plan to carry out the majority of our engine development through computer simulation models," confirms Mazda's Harada. "We will still use actual vehicles and engines for development, but it will be limited to verification."

Renault's Cornet, meanwhile, is a little more certain: "I think it will be possible but it will depend on if it is a grandmother engine (first in a new family), or a child (derivative) engine. For a brand new engine we need collaboration between the simulation and reality and then it is easy to simulate."

It's an issue that divides powertrain engineers. Across the water from Cornet in France is Daniel Kok, a Ford powertrain engineer based at the Dunton Technical Centre in the UK. Kok has a different stance. "Once correlated to good customer usage, rig testing can, to a large extent, be used for design verification at powertrain system and engine subsystem level," he says, adding that formal verification tools can help with robust sign-off of



"In the future, it seems likely that most of the development process will rely on simulation"

Yasuhiro Harada, program manager, powertrain development division, Mazda

RACE READY SIMULATION

It would seem that an idea of a lab-only development of a race-car engine poses as many problems as one for the road. However, in developing the V12 for the Superleague race series, which kicked off in 2008, MCT relied more on computer power than any other project it has undertaken.

"Things we would normally do, such as optimizing the intake systems before you started pouring metal on the flow rigs, we just didn't do," explains Dave Bedborough, MCT's technical director. "And we didn't run a single-cylinder engine to see if that would produce what we thought it would – all that work was based on electronic data."

Bedborough says the brief MCT was given for the engine was just that – brief. "The engine had to have 750bhp, and needed to be no longer than 700mm," he reveals.

"They gave us the chassis it had to fit in, which compromised the auxiliary layouts on the side of the engine, and I set about generating the relevant numbers of power output, bore, and stroke, all of which we then put through our 1D code."

When it was all put together in the computer design package – UniGraphics was the main weapon of choice – Bedborough says he was more than happy with the outcome. "We tried to have one person in command and other people working in specific project areas, responsible for bottom end, heads, intake system, and CAD-wise it came together very nicely."





Two GM engineers review data for a 1.4-liter engine and electric motor in the powertrain test cell

powertrain control software. But with new feature contents, such as stop/start or hybrid electric powertrains, we see a steady increase in the use complexity that a vehicle is subjected to. For this reason, the final product validation will continue to rely on testing the engine in a real world environment."

But Ford's US rival, General Motors, has a much different outlook. Fabio Mallamo, engineering group manager for diesel engines at GM Powertrain, states a clear "yes" in answer to the question, for oil-burners, at least! "All the steps involved in the development process, from establishing targets, through definition of the system, to system calibration, can be effectively executed using software tools," he believes.

"The final result is a software package capable of driving all development activities. The software for the analysis of the combustion process and of the engine performance are, in fact, integrated with tools for the virtual calibration of the system and with tools that can predict all the relevant engine outputs as a function of the system architecture and technology contents."

Mallamo described the products used within General Motors Powertrain as 'smart tools'. "They are easy-to-use, quick – faster than real time, in most cases, accurate and reliable, even with limited input data," he reveals. "Such a comprehensive software package also allows for the performance of system robustness analyses and risk assessments at different steps of the development process. For instance, it is possible to evaluate – directly from the desk and already in the very early stages of the development process – the probability that a vehicle drawn from the production line will pass the relevant legislative tests, leading therefore to a correct definition of the technical engineering targets – and margins with respect to the legal emission limits – to be considered during development activity of the engine." ■



"Such a comprehensive software package also allows for the performance of system robustness analyses"

Fabio Mallamo, engineering group manager for diesel engines, GM Powertrain

STAR PEOPLE

Adding complexity to engine development programs is the need for car makers to create alternative systems, such as hybrid and electric powertrains. CD-adapco is developing an advanced battery simulation module that will be available within its simulation tool, STAR-CCM+, and Steve Hartridge, CD-adapco director for electric and hybrid vehicles, says such a function will provide engineers with a toolkit to quantify and improve battery module designs for electric and hybrid vehicles.

Created in partnership between CD-adapco and Battery Design, the tool brings together over 40 years of flow, thermal, and battery simulation experience into one package. All of the fluid flow and heat transfer capabilities available in STAR-CCM+, such as multiple fluid/solid domains, conjugate heat transfer, multiphase flow and radiation, are coupled to the full range of cell models developed by Battery Design. Engineers have full control over the fidelity of the battery model and also the choice of representative electrochemistry model that characterizes its behavior. The battery characterization is then completed as part of the workflow and passed seamlessly into the 3D environment of STAR-CCM+.

BACK ON TRACK

Millbrook is in a rare position of being an independent proving ground that has ever-increasing laboratory space. Andy Eastlake heads up those labs for Millbrook, and maintains that the real-world will always play a vital role. "You can go further with development in the lab with chassis and engine dynos, but we think of the labs extending onto tracks," he states.

"I recently had a team driving around the USA, getting in-field driveability, altitude and on-road data, because you can't finish that job in the lab."

Eastlake believes there is still a need to feel how a vehicle drives, which, he points out, is difficult to re-create in a laboratory. But the Millbrook man admits there is arguably more pressure for results when you leave the confines of the engine test lab.

"If you take a vehicle out on the road, you have to get more and more information from the test, and the same is true for the lab," he says.

Many of manufacturers use the real world for engine validation rather than strict development, but Porsche's Neusser admits that the Stuttgart-based car maker still has quite a reliance outside the lab. "We find that external testing helps with early summer and winter tests," explains Neusser. "These give us early indications of the performance of the car's ECU, and good results of heat treatment, cold starts, and performance in extreme cold temperatures."



Full Vehicle Simulation for ECU-in-the-Loop Testing

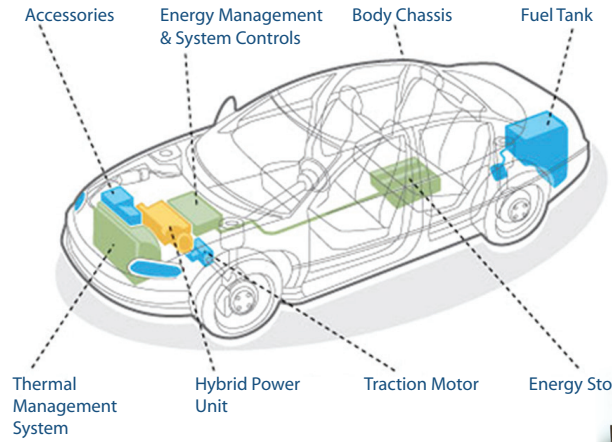
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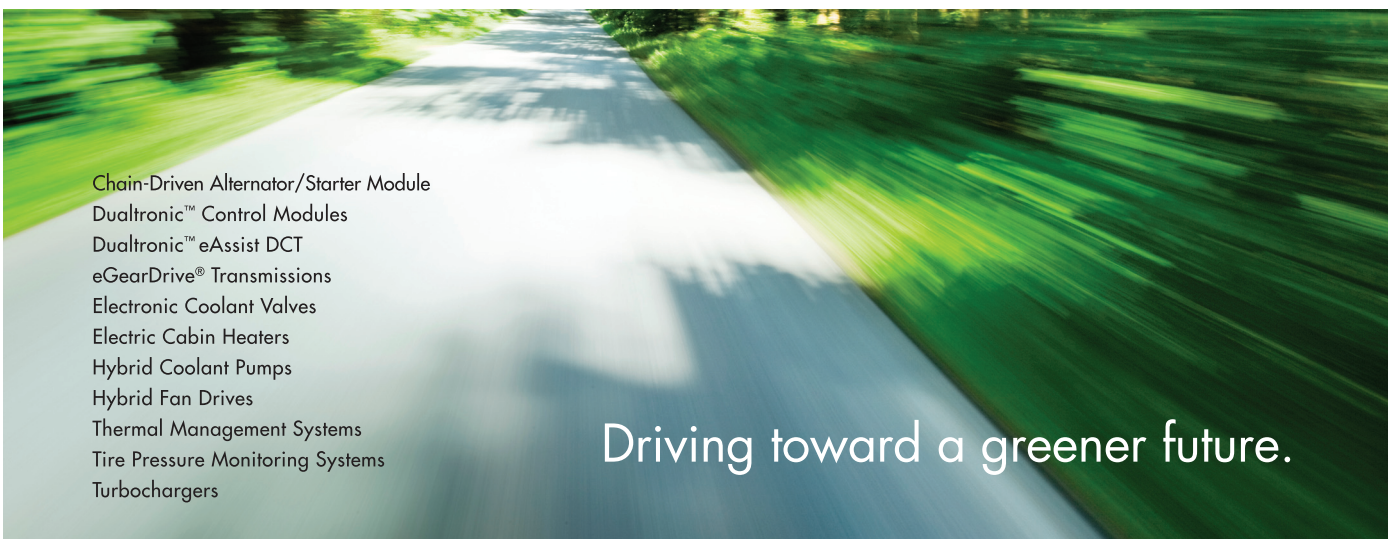
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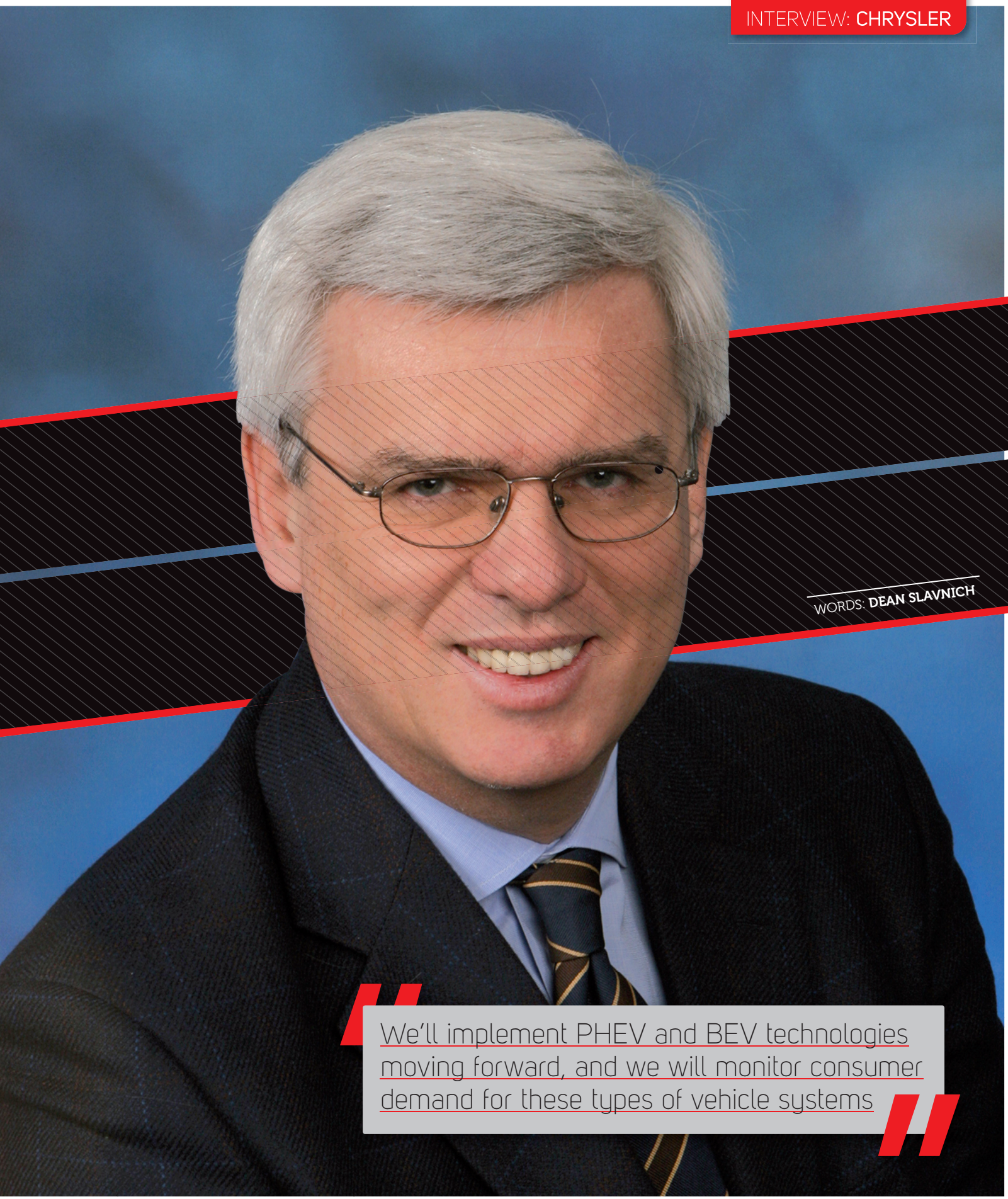
feel good about driving



Shimmering star

One year on from being appointed Chrysler's senior vice president for powertrain, **Paolo E. Ferrero** maps out a bright future for the car maker that's had to deal with a lot of change





WORDS: **DEAN SLAVNICH**

> We'll implement PHEV and BEV technologies moving forward, and we will monitor consumer demand for these types of vehicle systems

How has Chrysler's powertrain direction changed now that the company will be working closely with Fiat Powertrain technologies?

We now have a broader portfolio of both engines and transmissions and we can better align powertrain needs to specific vehicles particularly on gasoline engines. Obviously, we are both going to utilize and share the expertise of each organization. Both Fiat and Chrysler bring much to the table including new dual-clutch transmissions, powertrain electrification, diesels and advanced combustion technology, such as MultiAir, which is readily available for use in the Chrysler line-up.

What technologies will Chrysler use to reduce emissions and improve fuel economy?

We're in the midst of a transition phase with all our powertrains. Our plan is to rapidly introduce Fiat Group technologies including Multiair, start/stop, gasoline direct injection and downsizing through turbochargers. Additionally, on a longer-term basis, hybrids and the electrification of some models will play a key role in meeting CAFE standards and emissions in the future as well as reducing our dependence on foreign oil.

Within a timeframe of 2020, how do you envisage Chrysler's powertrain mix will change?

We've already started to shape our future with our new Pentastar V6. Very shortly, we will introduce the Fiat 500, the first application of MultiAir in North America. Currently, V8 engines make up about 18% of our product mix and more than half is taken by our six-cylinder gas engines. Our product mix will continue to evolve and we expect diesels and four-cylinders to make up more than half of our powertrain line-up by 2014. Eight-cylinder gas engines will account for only 10% of the mix with the balance made up of six-cylinder engines in five years.

Eighteen months ago, Chrysler rolled out an ambitious electric vehicle plan. Has this been scrapped?

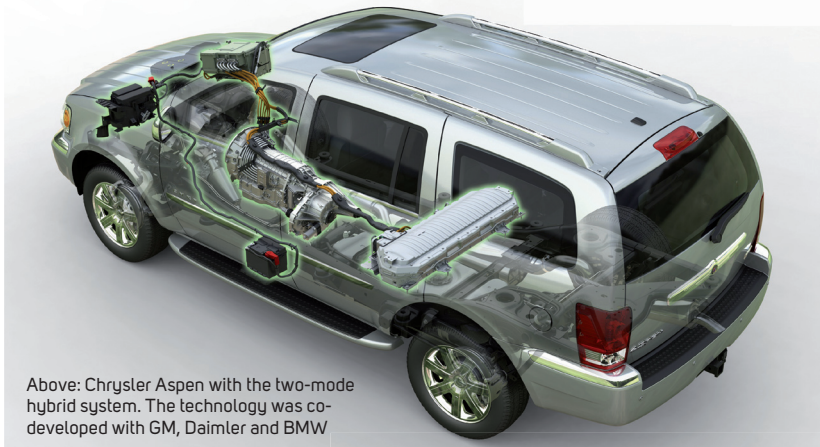
No. We continue to look at fully electric vehicles including full electrification of the Fiat 500 very shortly. We will continue to evaluate the market and determine what makes sense and offer the best benefits for the customer.

Does Chrysler envisage an EV future and if so, what's the plan for the next decade?

We continue to look at fully electric powertrains in selected models where it makes sense. We'll implement PHEV and BEV technologies moving forward and will monitor consumer demand for these types of vehicle systems. Battery technology is still key, both in daily performance and longevity. We are continuing to partner with the government and suppliers to help manage costs as well as create consumer demand.

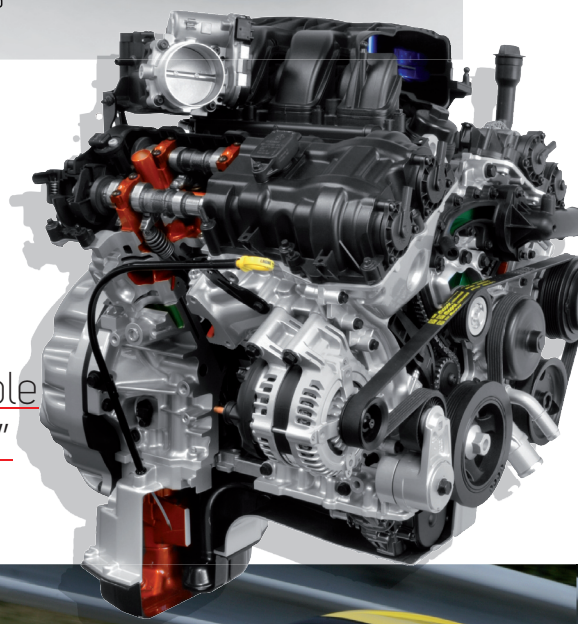
Has the industry forgotten about fuel cells?

Fuel cells are very expensive. A lot of work has been done with hydrogen but the costs just aren't economically feasible at this present time. There's also the matter of a real supporting infrastructure. It's not developed to the point where fuel is readily available.



Above: Chrysler Aspen with the two-mode hybrid system. The technology was co-developed with GM, Daimler and BMW

Below right: The Pentastar V6 with VVT boosts fuel economy. At present, there's no plans to integrated any mild hybrid system



"A lot of work has been done with hydrogen but the costs just aren't economically feasible at this present time"



ITALIAN INFLUENCE

Having scooped the New Engine accolade at this year's International Engine of the Year Awards, it would seem that Chrysler is eager to get access to Fiat's much-praised MultiAir system. But what does the Italian OEM have in store for this emissions-busting powertrain system?

According to Aldo Marangoni, VP of product engineering for FPT, the industry has yet to see what MultiAir might really be capable of. Future developments will see the technology yield further emissions reductions, and performance improvements for any number of engines – gasoline or diesel – from the just-launched TwinAir two-cylinders to even a powerful V6 or V8, he says. First, FPT plans to integrate MultiAir more closely with currently available technologies such as direct-injection and turbocharging. But the next-generation of MultiAir will usher in more radical changes still.

"We think that the current MultiAir is just the first step to controlling the complete combustion," Marangoni says.

"The second step for MultiAir, which we are already developing, is more sophisticated control strategies for the air-intake valve opening and closing. We will introduce internal EGR through control of the inlet valve.

"A system that will be integrated into MultiAir will open the intake valve during the exhaust stroke. This will be far more effective than a traditional EGR system because by doing it internally we can have greater flexibility. We can vary the quantity stroke-by-stroke, cylinder-by-cylinder, and we also can differentiate between steady-state and transient modes, so we'll be able to optimize the engine under all conditions.

"Another feature will further enhance the Miller cycle. Through control of the intake valve, we'll be able to control the real, effective compression ratio of the engine and this really will bring further benefits."

As well as new features for MultiAir, there will also be new applications. With modifications only needing to be made to the upper part of the cylinder head to add the MultiAir system, Marangoni describes it as, "far less invasive on the engine hardware than other technologies," such as variable valve lift. This opens up the possibility of applying it to existing FPT motors such as Alfa's V6, for which a proof-of-concept analysis is already underway.

He acknowledges that efficient larger-capacity engines will be important for the brand's return to North America, but points out that EURO 6 will also make major demands of OEMs in terms of NOx reductions, and that MultiAir could be FPT's secret weapon in the fight to meet the new legislation, scheduled for between 2014 and 2015. Development is already ongoing to fit MultiAir to diesel engines.

"Through the internal EGR approach, MultiAir will provide a great opportunity to reduce the raw-engine emissions," enthuses Marangoni. "For sure, this will help a lot in reducing the EURO 6 limit without dramatic changes in the aftertreatment system, with the related cost. From a strategic point-of-view, it could be a tremendous advantage to comply with the emission limits at limited extra cost."

FPT retains all the intellectual property rights to MultiAir, and believes it will give Fiat Group vehicles a technological advantage for at least another two years. However, Marangoni reveals that discussions are already underway to potentially license the technology to third parties, which could provide a useful revenue stream going forward.

"We think that this system is so powerful and so useful for meeting future fuel-consumption and emissions-reduction targets, that it will be spread in the market," he says. "For us it's very important to be the ones who developed the technology, and so to be the owners."







Last year Chrysler outlined ambitious plans to invest up to US$448 million in order to rapidly bring electric vehicles and plug-in hybrid-electric vehicles to market. The Dodge EV concept, first shown in 2008, remains a concept

When it comes to creating an all-new engine, what's the most important thing on the development agenda: fuel economy, emissions or performance?

All three, and I would add cost efficiency. You simply have to develop and design engines that deliver performance and fuel efficiency. With our current line-up, that includes continually looking for ways to reduce fuel consumption and lower emissions with engines like our Hemi V8. Our new, state-of-the-art Pentastar V6 has more than 300 horsepower without direct injection or forced induction, and that helps to keep costs in line. There's also the addition of transmissions with more forward gears. Keeping the engine operating at lower rpm contributes to fuel efficiency and less wear and tear on the engine. Reduced maintenance levels also are key with many customers. Fuel efficiency has not gone away and we have to continue to develop new ways to make cars perform efficiently. At the same time we also have to work closely with all disciplines. We look at a thing like weight saving as well to lower the weight.

Chrysler recently revealed the new Pentastar V6. With the way things are going, are we in the last straight when it comes to large-displacement V engines?

The new Pentastar V6 affords us many opportunities. For example, we've reduced the number of engine families from seven to one. Performance is up – we shaved more



More:
25% fuel savings

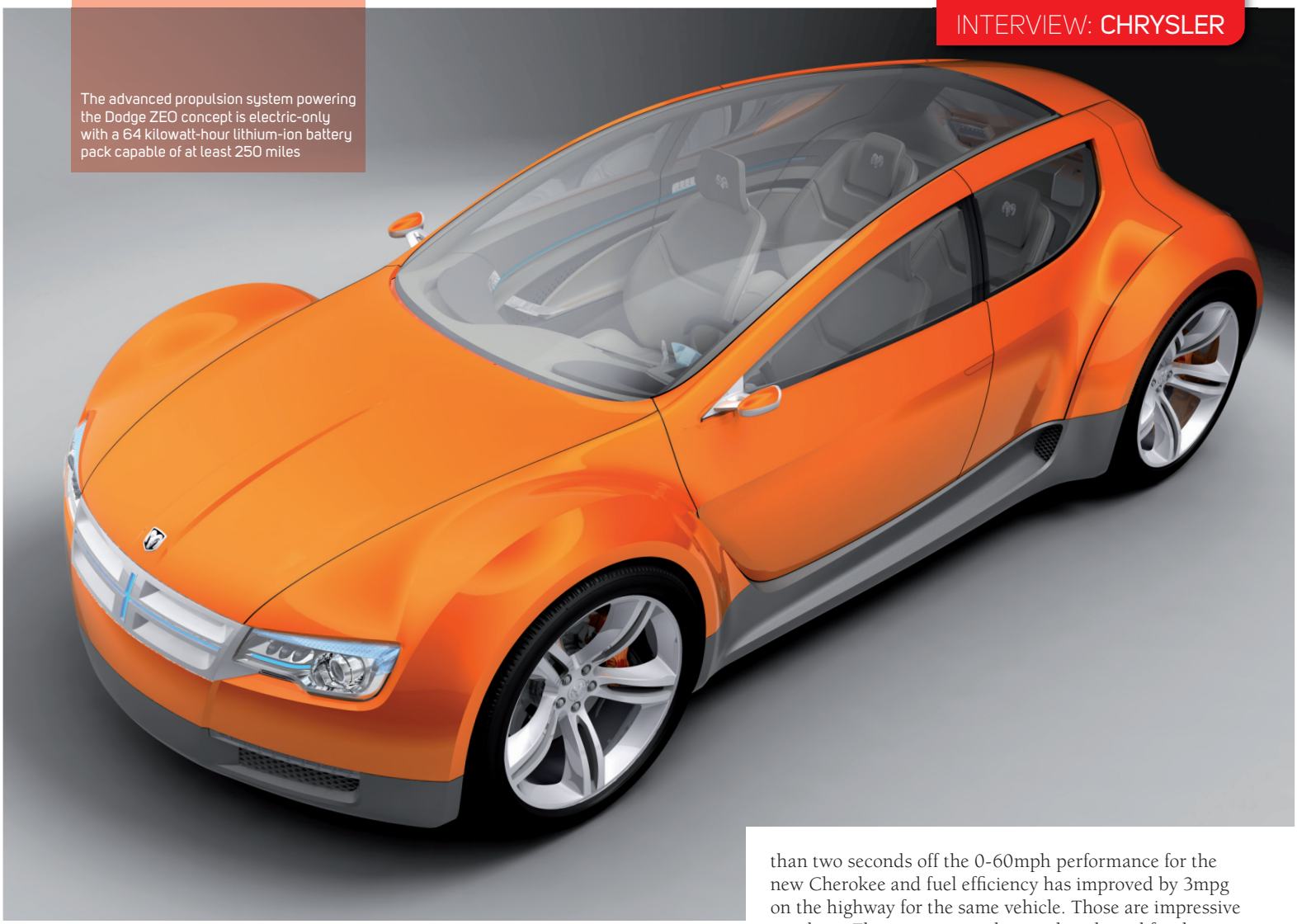
Less:
Fueling stops

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The Hydrostatic Regenerative Braking System HRB from Rexroth helps you bring fuel consumption under control. Virtually complete recovery of braking energy makes HRB especially effective for stop-and-go driving. Heavy vehicles like refuse trucks, buses, or heavy delivery vehicles can achieve reductions of up to 25% in fuel costs and up to 50% in brake wear – protecting both: the environment and your budget. Bosch Rexroth. **The Drive & Control Company**

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The advanced propulsion system powering the Dodge ZEO concept is electric-only with a 64 kilowatt-hour lithium-ion battery pack capable of at least 250 miles

THE MAN SHAPING CHRYSLER'S ENGINE FUTURE



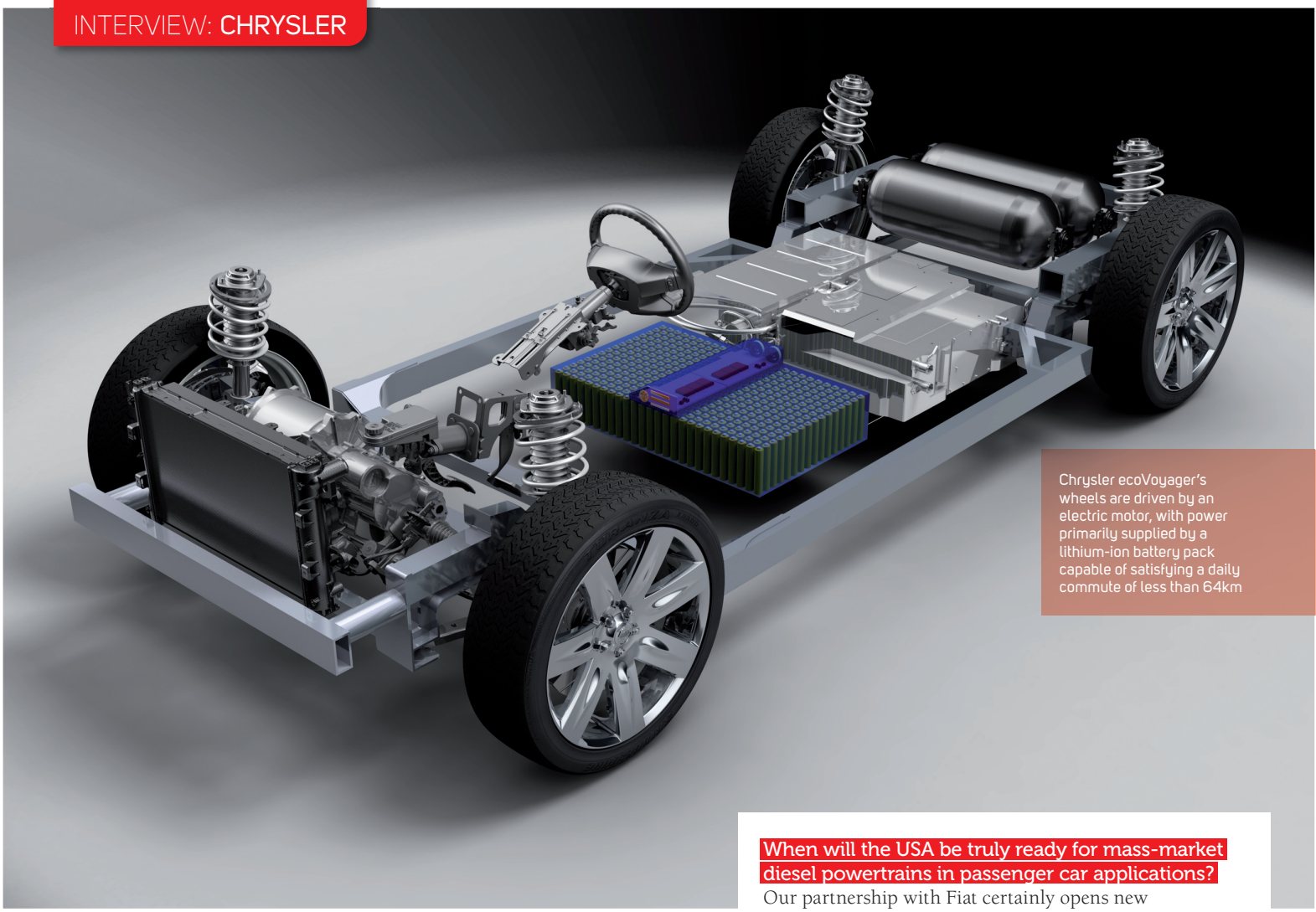
Paolo Ferrero is an engine man with a Fiat background. This time last year the Italian was appointed senior vice president for Chrysler powertrain, following the Italian OEM's take over of American's third largest car maker. He is directly responsible for all powertrain activities for Chrysler Group with a focus on technology sharing with Fiat Powertrain Technologies, a Fiat Group division where Ferrero spent much of his career and left as vice president of product engineering.

Ferrero started his career in 1980 at Fiat in the Abarth racing development division. In this environment, Ferrero was responsible for the design, testing and on-field support of engines for rally vehicles, endurance prototypes, and offshore powerboat racing with the Martini race team. It put Ferrero in good stead to progress. In 1994, he became the head of powertrain testing for Fiat Auto. Eight years later he was appointed engineering executive director for the Fiat-GM powertrain JV, and by 2007, he had progressed right to the top, to become the man in charge of powertrain product engineering for Fiat.

than two seconds off the 0-60mph performance for the new Cherokee and fuel efficiency has improved by 3mpg on the highway for the same vehicle. Those are impressive numbers. The new engine also can be adapted for direct injection, turbocharging and CNG applications. The bottom line is that we expect the benefits of the V6 to help us to meet the fuel economy as well as green environmental goals for many years to come. The market will eventually decide what they want in a powertrain. But with the continual application of technology, as well as advancements in transmissions, including dual dry clutch, engines including the new V6 will be in our line-up in the future. We're also continuing to improve on engines like our HEMI V8 by adapting many of the same technologies that will improve fuel efficiency and reduce emissions.

Is the USA, Chrysler's largest market, ready for the 1.4-liter MultiAir turbo engine?

We continue to evaluate the market and what makes the most sense in a vehicle application. We're looking at many different powertrain combinations, including adapting direct injection, greater use of compressed natural gas, particularly in fleets, as well as getting more power from engines with the inclusion of forced induction systems. There's no question that every OEM is looking to get more power while reducing emissions. Turbocharging is just one way to meet those challenges. The USA is beginning to realize the potential for increased power, fuel economy and lower emissions will come from smaller displacement engines like the 1.4-liter turbo engine.



Chrysler ecoVoyager's wheels are driven by an electric motor, with power primarily supplied by a lithium-ion battery pack capable of satisfying a daily commute of less than 64km

"We continue to look at fully electric vehicles including full electrification of the Fiat 500 very shortly"



The Wrangler Unlimited EV features an electric motor, a lithium-ion battery system, and a small gasoline engine with an integrated electric generator unit

When will the USA be truly ready for mass-market diesel powertrains in passenger car applications?

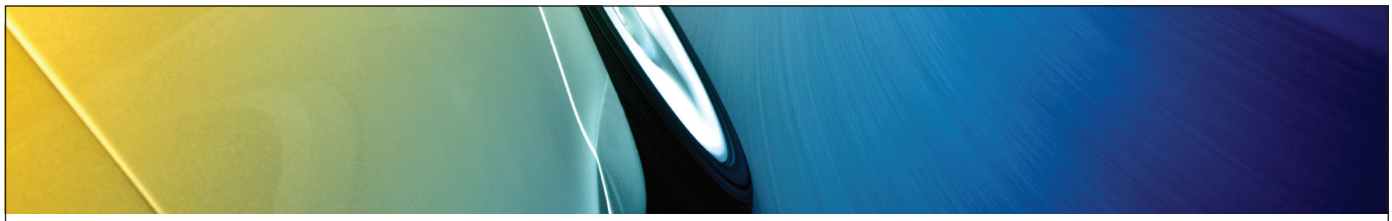
Our partnership with Fiat certainly opens new opportunities in this area, but a lot depends on market demand. Currently, gasoline is cheaper than diesel by about ten cents in the USA – this is an important factor to note. In other parts of the world, diesel is cheaper than gasoline. Coupled with the higher initial cost of diesel engines and annual maintenance costs, the consumer has to put on extensive mileage annually, or over the life of the vehicle, to realize potential saving. However, in saying that, as a company we will continue to develop technology that will make the diesel engines more attractive to buyers in the USA.

A year ago, Chrysler announced that it will use DCTs from Getrag, but this agreement was scrapped as part of Chrysler's reorganization plans. Are DCTs off the agenda?

One of the advantages of the Fiat-Chrysler alliance is it allows us instant access to many new technologies including dual dry clutch transmissions. This provides us with a cost-effective approach for fuel consumption and carbon dioxide reductions.

Where do you stand on the EGR/SCR debate?

EGR is simpler but the real potential for fuel economy with diesels lies with SCR. While SCR is more complex and requires things like a heater for the SCR tank, the potential for better fuel economy and lower emissions was a factor in our decision to move to SCR.



Some talk about the future of hybrid. We're creating the industry today.

Johnson Controls is the global leading independent provider of hybrid battery systems that make vehicles more energy efficient. In 2009, the company was awarded a $299 million economic stimulus grant by the U.S. Department of Energy to build domestic manufacturing capacity for advanced batteries for hybrid and electric vehicles. This award along with our total planned investment in manufacturing, infrastructure development and strategic relationships will allow us to establish a domestic industry that is competitive, economically viable and sustainable.

In 2008, our joint venture Johnson Controls-Saft opened the world's first manufacturing facility for lithium-ion hybrid and electric automotive batteries. And, our first U.S. lithium-ion automotive battery plant is under construction now. We are assembling li-ion battery packs and shipping to customers today, and will launch full cell production by summer 2011.

So while some ponder the future of hybrid batteries and systems, we're busy making this strategic new industry a reality.

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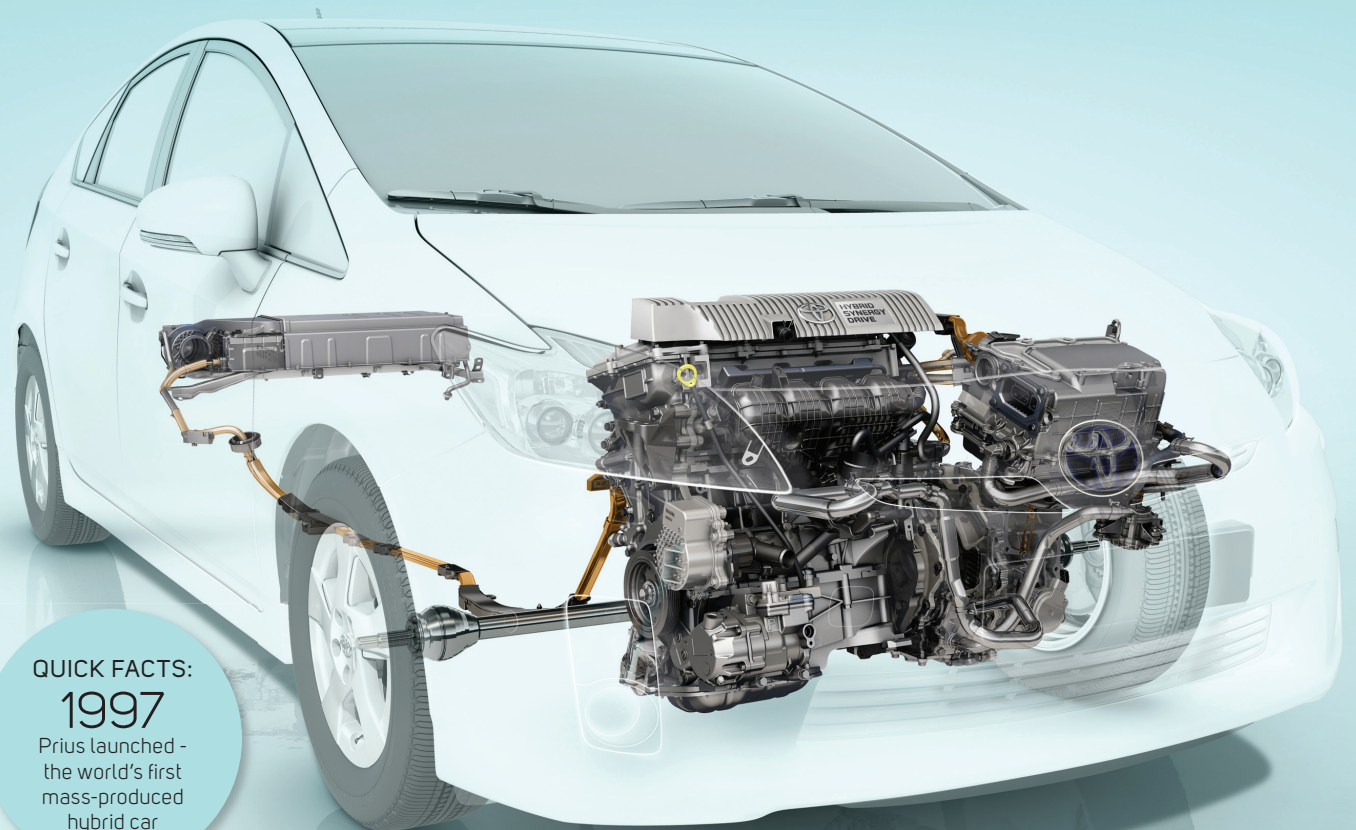


> From the first to the second generation, we reduced hybrid component costs by 70%, and from the second to the third generation, we reduced it by a further 40%. These are very big steps
>
> Gerald Killman, director of powertrain, Toyota Motor Europe

Synergy success

Just over a year ago, Toyota launched its third-generation hybrid powertrain, which marked a giant leap forward compared with the system that made its debut in 1997. So what next for this award-winning technology?

WORDS: **DEAN SLAVNICH**



QUICK FACTS:
1997
Prius launched - the world's first mass-produced hybrid car



Electric & Hybrid Vehicle Technology magazine covered in great technical detail the first-generation Toyota Prius prior to its global launch in 1997

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Throughout the 12-year history of the International Engine of the Year Awards, the Green Engine Award has been dominated by hybrid powertrains. In fact, Volkswagen's surprise victory in this class last year with its 1.4-liter TSI Twincharger not only marked the first such win for a non-hybrid powertrain, but it was also the first time that a car maker had won the Green Engine Award aside from Toyota and Honda. In 2010, normal service was resumed with Toyota's 1.8-liter hybrid setup securing top spot in the category, providing a much-needed boost for Toyota and hybrid powertrains in general.

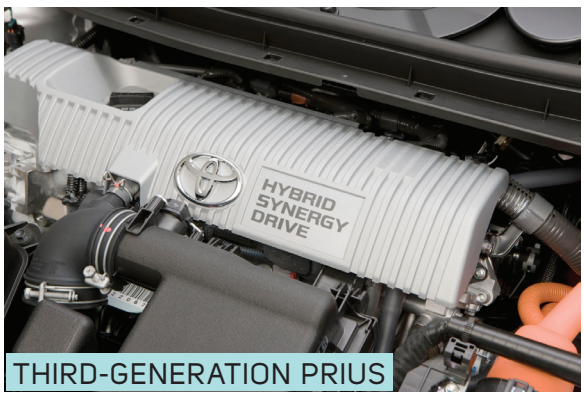
"We are very happy that the environmental performance of this engine has been recognized," said a delighted Gerald Killman, director of powertrain for Toyota Motor Europe. "The big advantage of hybrids is that they have two aspects to their environmental performance: one limits CO_2 emissions to help reduce global warming, and the second improves air quality by reducing other pollutants like NOx, which will be the big issue in the coming years. Our third-generation Prius powertrain realizes both these advantages."

Toyota has now picked up the Green Engine Award eight times and Killman says that such a feat reflects the company's hybrid drive development. "The move from our first-generation system to our second-generation system introduced a key boost converter feature that used a 200V battery, although the system could run up to 500V. Now, with this third generation system, we have boost voltage technology giving us up to 600V using a high-speed electric motor that has lower losses but higher efficiency, and which is 33% smaller.

"In fact, size becomes a key issue here because packaging our third-generation technology is also very important. The whole power control unit – which

"We are very happy that the environmental performance of this engine has been recognized"

QUICK FACTS:
Toyota has helped reduce CO_2 emissions by approximately
11 million
tons



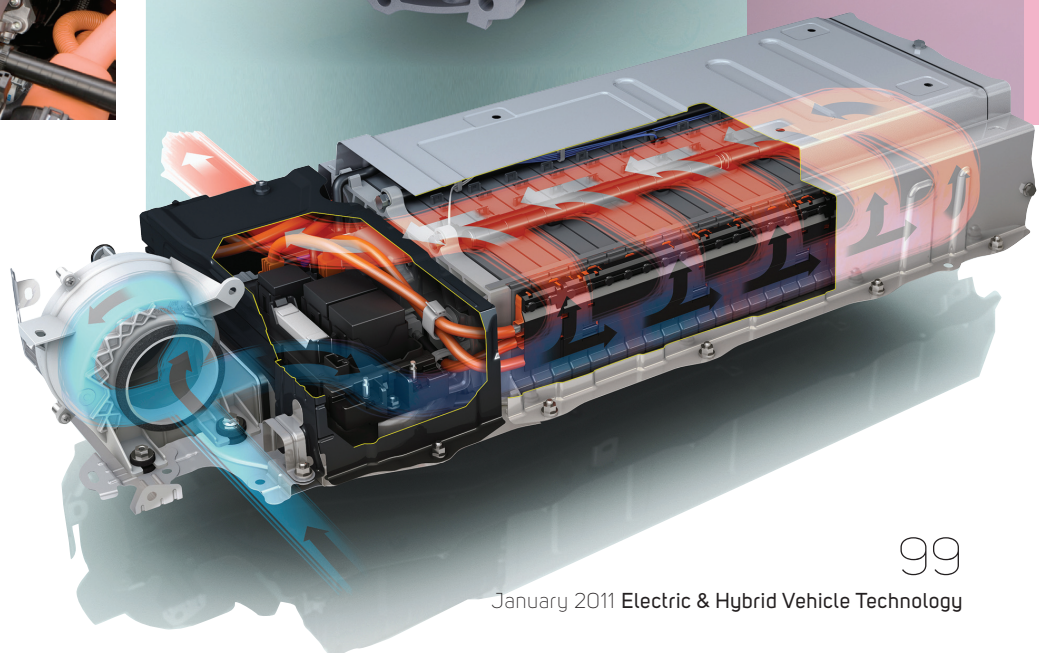
THIRD-GENERATION PRIUS

Engine: 1,798cc petrol
Bore x stroke: 80.5 x 88.3mm
Compression ratio: 13.0:1
Motor operating voltage: 650V
Motor maximum output: 60kW
Motor maximum torque: 207Nm
Battery manufacturer: Panasonic EV Energy
Battery nominal voltage: 201.6V
Battery maximum power: 27kW
Battery capacity: 6.5Ah

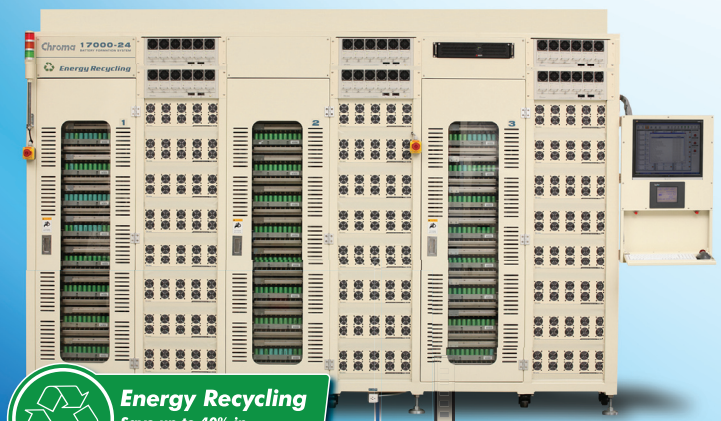


Left: The 1.8-liter VVT-i Atkinson cycle engine has a compression ratio of 13.0:1

Below: The nickel-metal hydride battery has a capacity of 6.5Ah with system voltage being 650V



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Energy Recycling Module: Inter-system DC energy recycling offers up to 3x higher efficiency than AC power line recycling.

Recycling Energy Management: Tracks energy recycling savings.

Automated Optical Inspection



Manufacturing Execution System

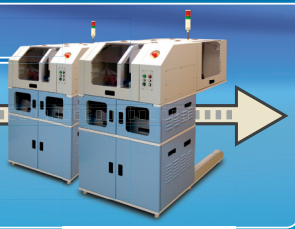


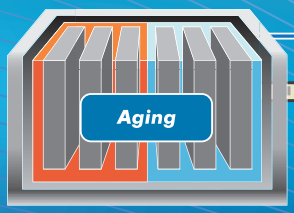
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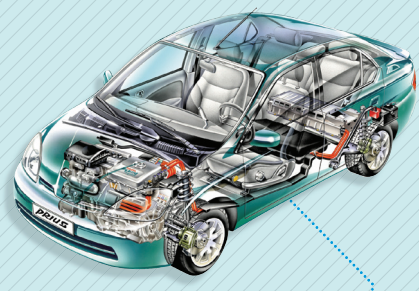
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QUICK FACTS:
By the end of August 2009, over
two million
Toyota hybrids had been sold globally

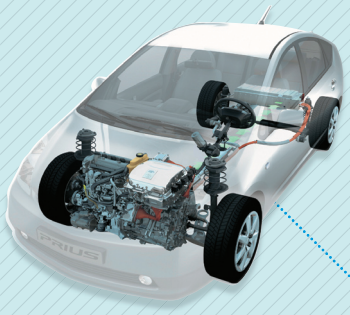
Timeline...



1997 - 1st generation

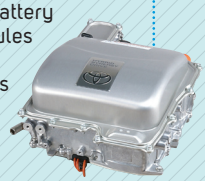
Prius number one features a four cylinder in-line gasoline engine with a 2CM permanent magnet electric motor. Sealed nickel-metal hydride batteries came in the form of 48 modules, with six cells joined together. This Prius has a fuel consumption of 57.6mpg. Emissions were rated at 114g/km of CO_2

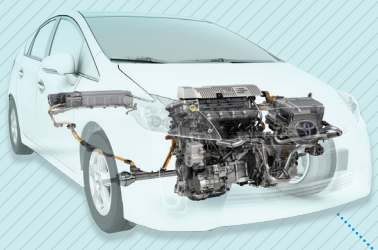




2004 - 2nd generation

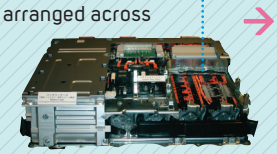
Prius number two opts for a four-cylinder in-line gasoline engine with a high expansion cycle. A synchronous, permanent magnet motor is rated at 500V. The sealed nickel-metal hydride battery is arranged in 28 modules with six cells joined together. This Prius has fuel consumption of 65.7mpg. Emissions were rated at 104g/km of CO_2





2009 - 3rd generation

Prius number three is a series/parallel full hybrid. There's a 2ZR-FXE Atkinson cycle, four in-line gasoline engine with VVT-i. The permanent magnet, synchronous electric motor is rated at 650V. The nickel-metal hydride battery is arranged across 28 modules. This Prius has a fuel consumption of 72.4mpg, Emissions are 92g/km of CO_2



includes the inverter, the converter to 12V, and other such components – has been reduced to the size of a normal 12V battery, which is 20-30% smaller. Looking forward, I think it will be possible to make the unit smaller still, but we have now introduced a specific technology – direct cooling – that cools the switching components. These components are no longer cooled via the heat synch but directly by an aluminum plate and liquid coolant.

"This enables higher dynamic levels but reduces size and cost. Finally, cost reduction was also significant. From the first to the second generation we reduced hybrid component costs by 70%, and from the second to the third generation we reduced it by a further 40%. These are big steps."

LEAF ENTERS PRODUCTION

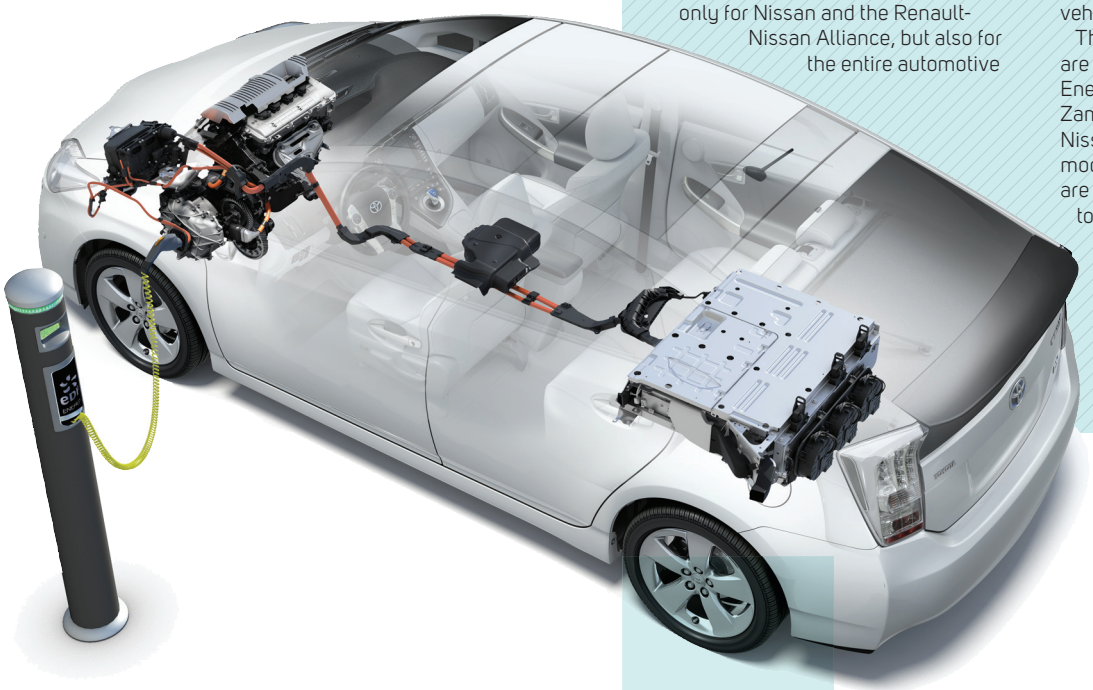
While one Japanese car maker is cracking on with improving its hybrid technology, another is pushing forward to bring to market the world's first, mass-produced all-electric vehicle.

Nissan has started production at its Oppama facility for the all-new electric, zero-emission Nissan Leaf, which is slated to go on sale in December of this year in Japan and the USA, and from early 2011 in select markets in Europe.

"This is a significant milestone, not only for Nissan and the Renault-Nissan Alliance, but also for the entire automotive industry," said Nissan President and CEO Carlos Ghosn at the Nissan Leaf offline ceremony."

Leaf will be produced at the Oppama Plant along with popular gasoline models such as the Juke and Cube. Part of the assembly line has been modified to mount battery modules at the stage of production where fuel tanks are traditionally installed, and motors and inverters are mounted at the point where engines are installed in gasoline-powered vehicles.

The Leaf's lithium-ion battery modules are manufactured at the Automotive Energy Supply Corporation operation in Zama, Japan, which is a joint-venture of Nissan and NEC Corporation. The battery module, which contains four battery cells, are assembled at Zama and then shipped to the Oppama facility, where 48 of them are assembled into the electric car's battery pack.



The next step for the Prius is a plug-in production version. Extensive fleet trails around the world are currently taking place

QUICK FACTS:
The Prius Plug-in marks the introduction of lithium-ion batteries in a Toyota hybrid

It's clear why Killman and his team are so proud of the third-generation hybrid system that powers both the Prius and the new Auris. The next step is a plug-in hybrid project: "At the moment we are at the fleet stage with the plug-in hybrid Prius, in that we have 600 vehicles in total, 200 of which are in Europe. These vehicles will be driven for three years to gather data on customer behavior. Early feedback from this trial will be used for developmental data before we go ahead with mass production in 2012."

At around the same time, PSA Peugeot Citroën will launch a diesel hybrid that some engineers believe will meet all of its power, fuel economy, and emission targets, although Killman is not so sure: "There were technical challenges with diesel hybrids in the past, especially with vibration, but these have been solved. So, while there may be fewer technical hurdles, there are still financial issues – there simply has to be a business case. Toyota's best sales figures are in Japan and the USA, which are both non-diesel markets," he continues. "Recovering the investment and development costs of this technology is not easy in a market like Europe where Toyota is not one of the top three players. At the sales end of things, a diesel engine is more expensive than a conventional transmission, and a hybrid system even more so. On top of this, a diesel engine is already more efficient, so the benefits that hybrid systems realize is lower when applied to diesels over IC engines."

"At the moment we are at the fleet stage with the plug-in hybrid Prius, feedback from this trial will be used for developmental data before we go ahead with mass production in 2012"



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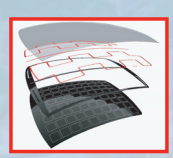


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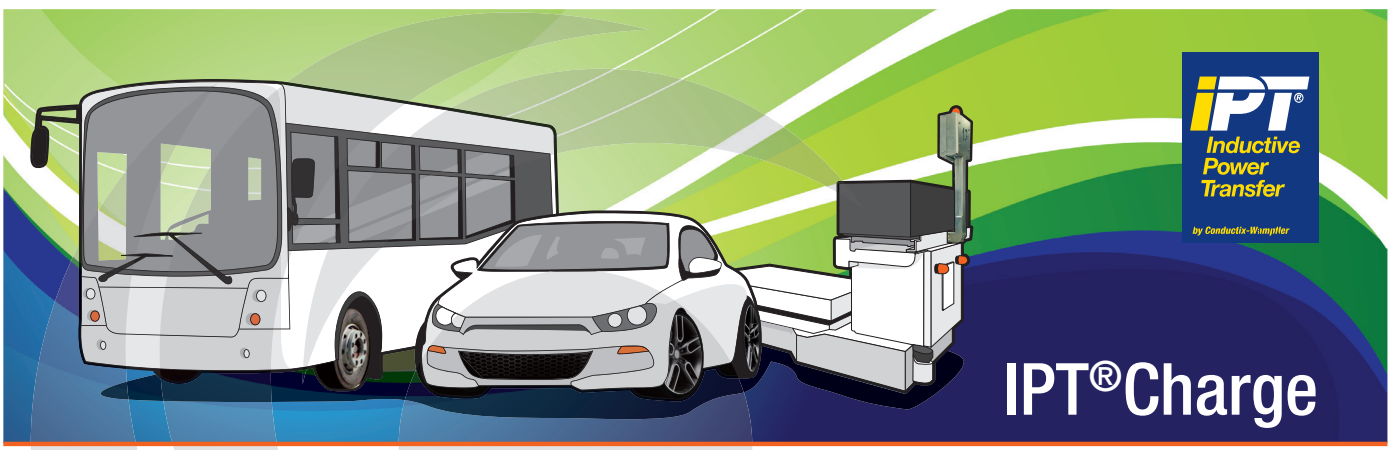
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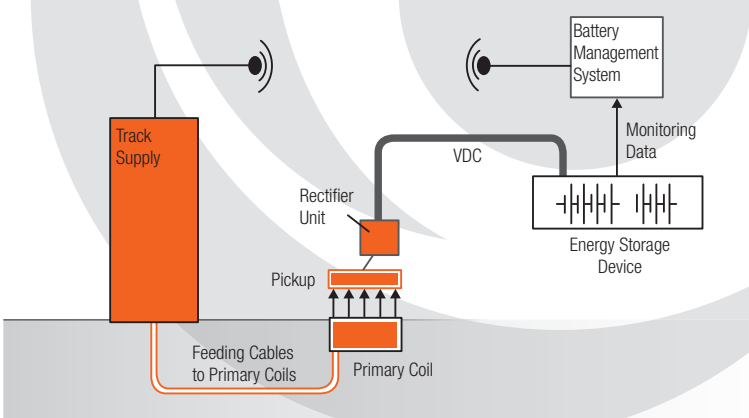
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Digging deep

It's been a busy start to life for Lithium Americas and there's no slowing down as the company looks to expand

WORDS: **DEAN SLAVNICH**



Lithium Americas has covered much ground in the space of only 18 months. Established in April 2009, the Canadian/Argentinean company has already achieved what might take another organization years to do.

"We've advanced our project immensely," says a proud Waldo Perez, CEO of Lithium Americas. "It's been a challenging year, but we successfully went public, found two established strategic investors, and completed the exploration stage on the ground in Argentina. It's put us in a really good position to advance the project further."

Being still in its infancy, you could be forgiven for not knowing much about Lithium Americas. Focusing on lithium and potassium projects in South America, Lithium Americas has five salt lakes in its property portfolio, but it's the two adjacent sites in the Argentinean salt lakes in Cauchari and Olaroz that have got many people talking. Covering 43,627 hectares, the property is said to have the equivalent of 4.9 million tons of lithium carbonate and 7.7 million tons of potassium, making Lithium Americas' principal property one of the largest known lithium brine deposits in the world.

> We have lower magnesium levels than the best mine in the world, and our grade is equivalent to the second largest mine in the world

Having undertaken preliminary exploration, the company is now aiming to complete its production-drilling program by the end of 2010. The objective for Lithium Americas is for the mining to be fully operational by 2014.

"We are taking an aggressive but prudent approach to the development and commercialization of our Cauchari resource," explains Perez. "We will be funded through final feasibility



Mitsubishi Corporation has come on board as an equity investor



Tests have shown that Lithium Americas' lithium concentration is rated at 580mg/liter

and anticipate our timing for the proposed commercial production will meet the demand estimation provided by party experts. We want to establish Lithium Americas as an important participant in the global lithium market."

It's easy to get sucked into a CEO's rhetoric and enthusiasm, but there is real substance to Perez's words. Not only does Lithium Americas have one of the world's largest lithium brine deposits, it also oozes quality.

"The most productive brine mines in the world are located in the Atacama salt lake in Chile; there's no question about that. But our project can easily be compared to the mines located in the Atacama salar in terms of quality," says Perez, who is eager to highlight key points. "The first factors are size and grade and we certainly have the volume to compete with Atacama. Second – and equally important – is the level of contaminants. If you have a high proportion of magnesium, there are extraction issues to overcome. For example, magnesium is not soluble and stays in the solution with lithium, making both elements difficult to separate from each other. Extraction is not cheap, so deposits that have 10 times more magnesium than lithium can only just break even.

"Atacama, for example, has a magnesium/lithium ratio of six, which is high, but because of its grade and the surrounding infrastructure, Atacama is one of the lowest-cost producers. We have a magnesium/lithium ratio of three, which is ideal."

In fact, with a lithium concentration of 580mg/liter, Lithium Americas' brine quality is on a par with world's second best commercial deposit.

And Perez says that Lithium Americas' site is comparable to the Atacama site when it comes to infrastructure: "This is so important. For example, there's a fantastic mine in China. It's everything you could dream of as a geologist, but the problem, from an engineering perspective, is that it's 2,000 miles out into the wilderness. On top of that, there is very little evaporation and high annual rainfall,

FAST FACTS

Puna Plateau is an area that contains 84% of the world's lithium brine and includes two of the world's three commercial lithium brine deposits

Given the extremely dry conditions in the Puna Plateau region, low-cost evaporation technology can be used during lithium brine processing

which means extracting the lithium is a very slow process. If you're working in a place where there's little sunshine, how do you evaporate the brine?"

The best news is that Lithium Americas plans to be one of the lowest-cost producers of lithium in the world.

"Brine with low levels of magnesium naturally leads to lower costs," explains the CEO. "We have lower magnesium levels than the best mine in the world and our grade is equivalent to the second largest mine in the world. On top of all that, our biggest advantages are access and cost: our operation is on a paved road and we have an energy supply; very few other mines in the world can make this boast. This puts us in a very strong position." Aiding Perez's team are their now-completed on-site lab and pilot evaporation facility.

The company has mirrored its progress on the ground with its activity in the boardroom. Magna International and Mitsubishi Corporation have come on board as equity investors, while WorleyParsons has been retained as an engineering partner.

"The agreement we have with Mitsubishi Corporation is very important because it is Japan's largest trading organization," Perez adds. "It is tied to the EV in the sense that Mitsubishi Motors will launch the i-MiEV globally. The batteries that go into the current i-MiEV are produced by Lithium Energy Japan. This company is a joint venture between Mitsubishi Corporation, Mitsubishi Motors, and GS Yuasa. Mitsubishi Corporation is showing an interest in our lithium deposit, which will hopefully flow up to GS Yuasa's batteries and Mitsubishi Motors."

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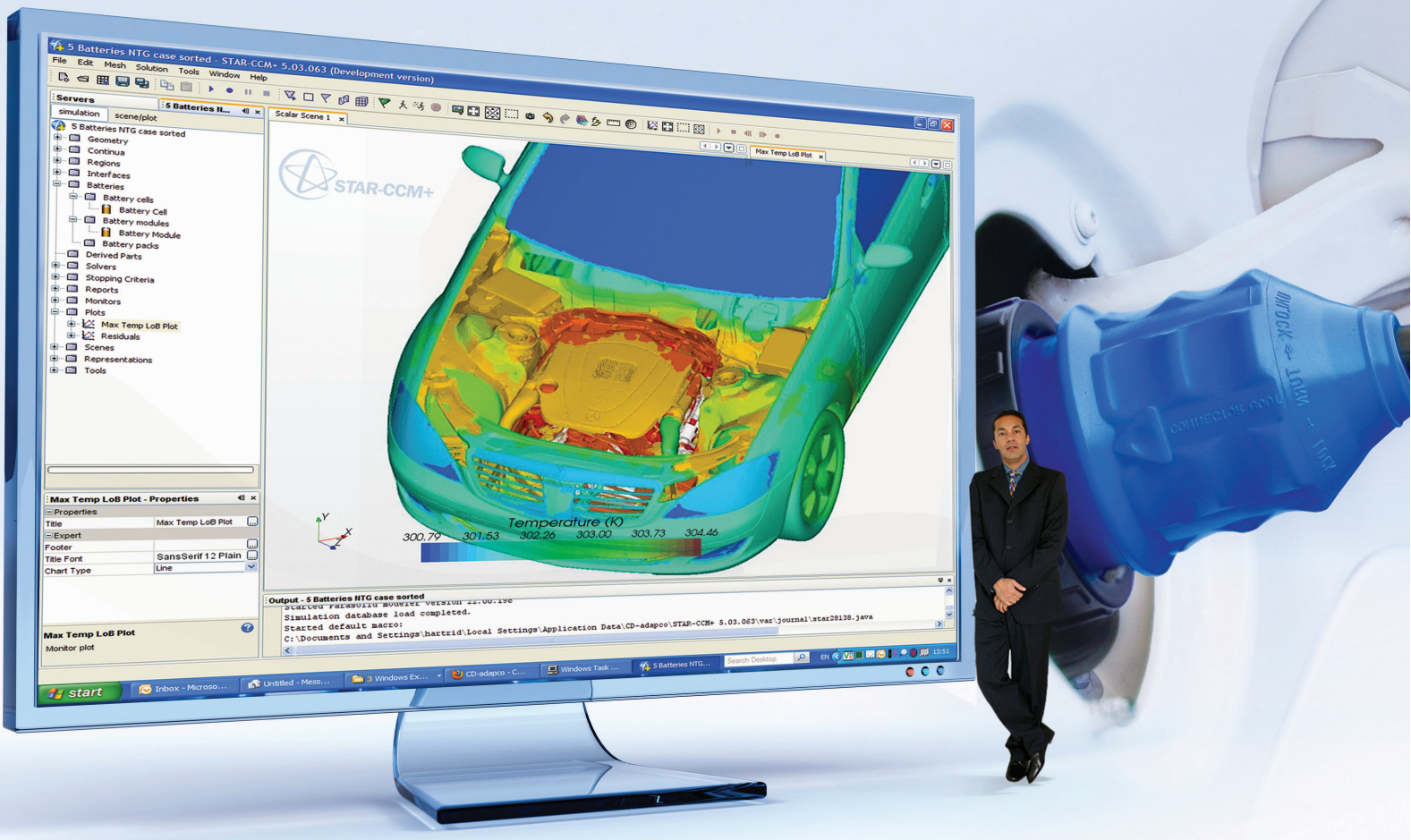
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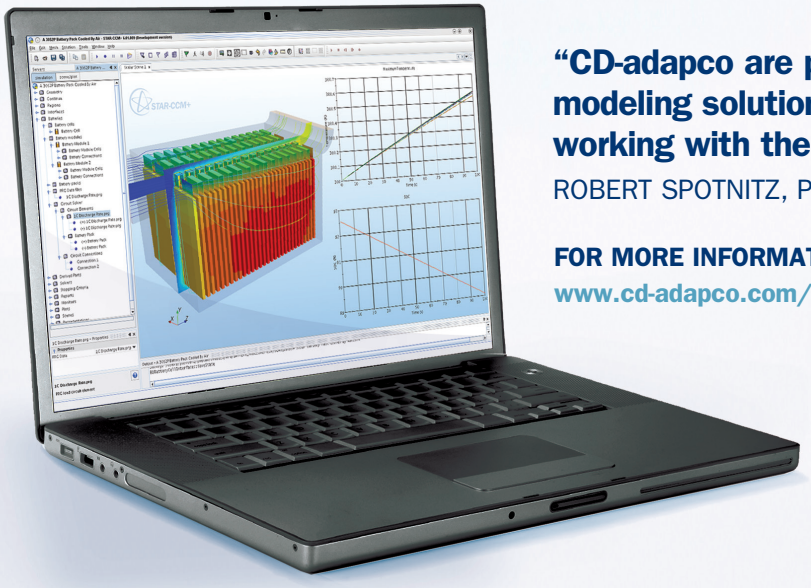
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GREEN **NEWS**

FIAT FLEET CLEANEST IN EUROPE

Fiat Automobiles has again underscored its environmental credentials after registering the lowest average CO_2 emissions for cars sold in Europe for the first half of 2010.

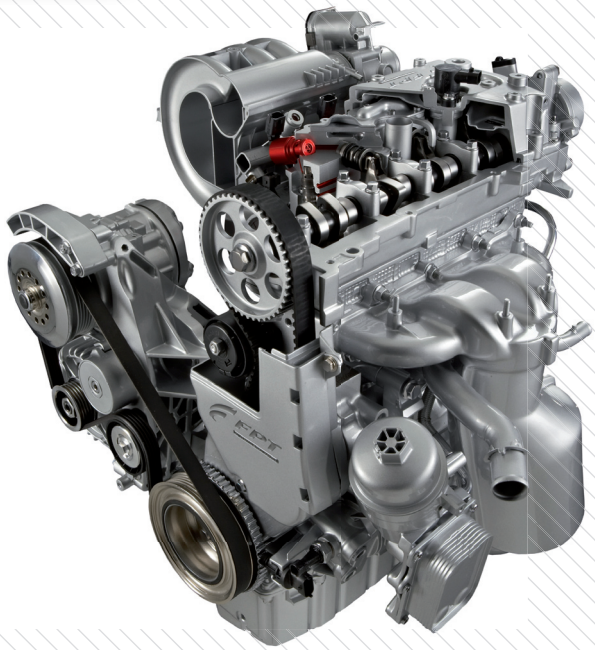
The figure of 123.5g/km was corroborated by leading automotive advisor JATO, and is one of a succession of landmark results dating back to 2007.



Of the top 10 brands, Fiat is ahead of Toyota (128g/km), Peugeot (132.3g/km), Citroën (133.4g/km), Renault (134.6g/km), Ford (137g/km), Opel/Vauxhall (141g/km), Volkswagen (142.2g/km), Audi (154.2g/km) and BMW (154.5g/km).

The outcome is one of three exceptional results recorded in the model and group rankings. Although all the 20 best-selling models in Europe reduced their emissions in the first half of 2010, no fewer than three Fiat vehicles are ranked in high positions: the Fiat 500 is first with 116g/km of CO_2, the Fiat Panda comes second with 118.9g/km and the Fiat Punto is in fourth place with 123.5g/km.

Fiat Group cars was also confirmed first among the automotive groups (126.2g/km), increasing the gap over Toyota (130g/km), PSA (132.8g/km) and Renault (136.7g/km). It means Fiat Group is the only OEM already below the European average goal of 130g/km set for 2015.



AXEON AND RICARDO COLLABORATE ON NEW BATTERY SYSTEM

An unnamed European automotive manufacturer has sought the expertise of UK-based lithium-ion energy systems supplier, Axeon, and automotive technology, innovation, and systems integration provider, Ricardo, to supply and integrate an advanced, lightweight battery pack for a pioneering plug-in hybrid vehicle.

The plug-in hybrid vehicle, from an established European brand, will feature an advanced, bespoke Axeon battery system that leverages nanophosphate lithium-ion cells from A123 Systems. The team is developing a high-tech solution for this application, featuring an ultra-lightweight, liquid-cooled battery pack and a development of Ricardo's BMS incorporating active cell balancing. Ricardo will engineer the pack from all aspects of the mechanical, electrical/electronic hardware and software, including its thermal design considerations and safety. Axeon will assume responsibility for a full test and validation program, production, and supply.

"It's difficult to think of a more demanding application or client for our skills, so we were delighted to be selected to play such a key role in this development program," says Lawrence Berns, CEO of Axeon, adding: "This car will transform thinking about hybrid cars in every area, especially performance. Our technology will play a key role, underlining our prowess in this competitive field and showing that hybrids can offer significant advances to performance as well as environmental benefits."

THINK EXPANDS

With the EV market set to grow in the next three years, THINK has announced it will invest in a new product development facility at its corporate headquarters in Fornebu, Oslo, Norway.

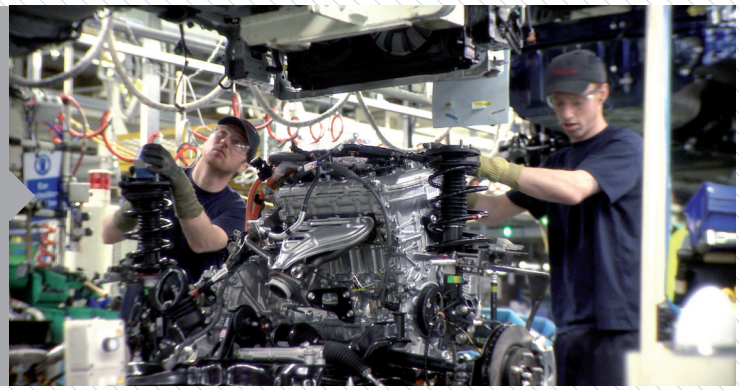
The company's 70-strong team of product development engineers will soon move to the facility, which, when fully integrated, will offer the THINK team facilities such as a dedicated climate chamber, dynamometer, rolling road, clean room, and several prototype laboratories for electrical and hardware development.

THINK CEO Richard Canny says, "The move to our brand new development center builds upon the continued strengthening of the pioneering THINK EV product development team, with new staff being recruited right now to continue and enhance the development of our world-class EV drivetrain systems, vehicle control software, and EV design. We aim to take on 30-50 new staff during the next 12 months to focus on the future development of the THINK City vehicle."



TOYOTA ROLLS OUT FIRST EURO HYBRID

Toyota's Deeside plant in the UK has become the car maker's first manufacturing facility to produce a hybrid vehicle engine outside Japan. The 1.8-liter VVTi drivetrain will be installed in the all-new Auris. The production process for the hybrid powerplant sees raw aluminum being smelted and cast on site prior to machining, with assembly and testing of the completed unit also taking place at Deeside. The finished engines are then shipped to Toyota's second UK plant in Burnaston for installation. Toyota opened its Deeside operation in 1992 and it currently has more than 500 people on site, working two shifts five days a week.



ORIGO CONFIRMS BATTERY INVESTMENT

Origo has announced the acquisition of a 16.5% stake in Unipower Battery for an aggregate amount of US$4.3 million.

Unipower is a new venture established to provide lithium-ion batteries and related materials to China's burgeoning electric vehicle market. The company is in the process of being spun out from the Huanyu Group, one of the largest privately held rechargeable battery manufacturers in China.

Thanks to significant government support, as well as longer term market dynamics supporting growing demand for electric and hybrid vehicles in China and across the world, the market for Unipower's products is expected to grow substantially, which has led to Origo's investment. The Chinese government hopes to achieve production capacity of 500,000 electric and hybrid cars in China by 2011. To this end, the Chinese government has recently drafted the 2011-2020 new energy automobile development plan, which recommends over US$15 billion in subsidies be provided to support the electric vehicle market.

HYBRID BASE FOR ALLISON

In an effort to accelerate its plans to bring commercial-duty truck hybrid products to market by 2013, Allison Transmissions is to open a new hybrid manufacturing plant in Indianapolis. Once fully operational – which should be later this year – nearly a hundred production workers will be capable of producing more than 20,000 commercial-duty hybrid propulsion systems each year.

Allison's new hybrid propulsion system captures kinetic energy that's otherwise wasted as a vehicle decelerates. It later reuses this energy to propel or reaccelerate the vehicle. It's said that fuel economy improvements along with other Allison hybrid products are typically in the range of 20-30%.

The dedication of the facility followed a visit to Allison's existing Indiana base by President Obama in August 2009, who signed a US$62.8 million matching grant by the US DoE to increase the country's capacity to manufacture fuel-efficient commercial-duty hybrid truck propulsion systems. Discussing the new base, Allison CEO, Lawrence Dewey says, "Over US$130 million is being invested in the renovation of this facility and the deployment of our commercial hybrid truck product. We will deliver a new generation of hybrid propulsion system solutions to the transportation industry."

GREENEST RANGE ROVER REVEALED

Land Rover has released official pictures of the smallest, lightest, and most fuel-efficient Range Rover ever, the all-new Evoque, which will make its public debut at the Paris Motor Show.

Due to hit European showrooms in early 2011, the Evoque is a key model for Range Rover according to CEO Dr Ralf Speth. "Not only will the Range Rover Evoque increase our worldwide market share, but it will also help to define a new segment for premium compact SUVs that are more sporty and stylish."

Offering CO_2 emissions below 130g/km and a combined fuel economy of 58mpg, the Evoque showcases how Range Rover is adapting to an industry that's become environmentally conscious. Lightweight construction techniques and the addition of a front-wheel drive variant ensure optimum efficiency is achieved. Meanwhile, state-of-the-art petrol and diesel engines come with direct injection and stop/start systems.

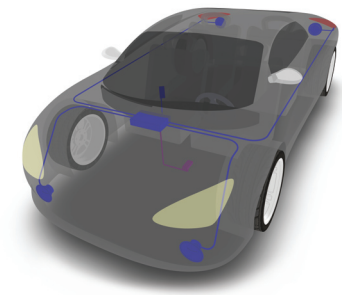
Based directly on the LRX concept, Evoque comes with a turbocharged powertrain that offers smooth and responsive performance, blending four-cylinder efficiency with six-cylinder refinement and power.

Customers can choose between two advanced 2.2-liter turbodiesel derivatives with either 188bhp or 148bhp. The front-wheel drive Range Rover Evoque with the 148bhp 2.2-liter engine achieves 58mpg and CO_2 emissions below 130g/km. The four-wheel drive 2.2-liter 148bhp version delivers 50mpg and 145g/km CO_2.



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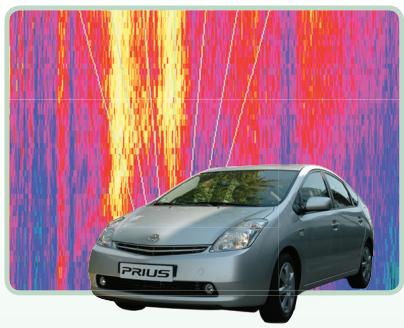
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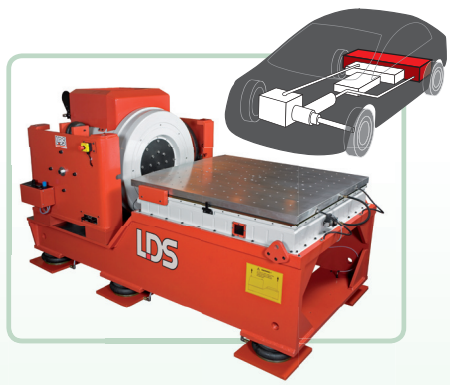
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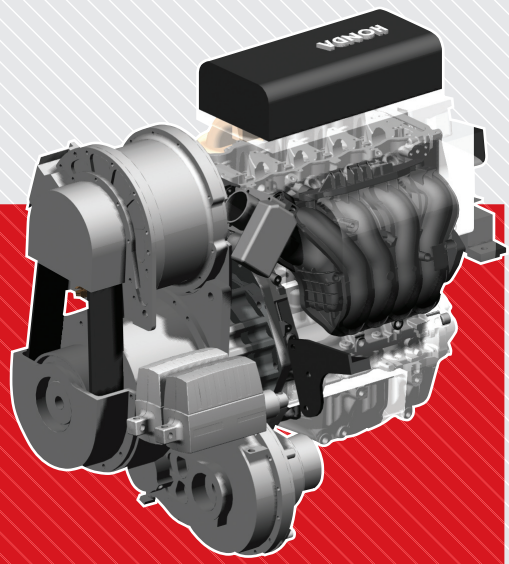
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Trailblazers

Ohio State University is gunning for first place in EcoCar with a high-tech, extended-range electric vehicle





The OSU EcoCAR is an extended-range electric vehicle featuring a 1.8-liter high compression ratio E85 IC engine, coupled to an 82kW front electric machine via a twin-clutch transmission

EcoCAR
The NeXt Challenge

Ohio State University (OSU) is one of sixteen North American universities participating in 'EcoCAR: The Next Challenge', a vehicle-development competition that's sponsored by the United States Department of Energy (DoE) and General Motors. This three-year competition challenges student teams to re-engineer a GM-donated crossover SUV to minimize fuel consumption and emission levels, while maintaining vehicle performance and consumer acceptability. Each team's task is to design and build a new powertrain for their vehicle, resulting in a fully functioning prototype demonstrator at the end of the third year.

The teams follow a real-world engineering development process modeled after GM. The first year focuses on selecting vehicle architecture and using computer-aided design and simulation tools to develop the vehicle design. During the second year, teams receive their GM-donated vehicles, remove the stock powertrain, and integrate their unique powertrain technologies into the vehicle to achieve a driveable mule-level prototype.

In the final year, teams refine their vehicles to improve areas such as driveablility, emissions, and aerodynamics, thus culminating the program with a 99% buy-off prototype vehicle. At the time of writing this case study for *Electric & Hybrid Vehicle Technology International*, the teams are beginning the third and final year of the EcoCAR program.

The current OSU EcoCAR team comprises 35 students. Six team members are graduate students in mechanical and electrical engineering and the majority of the team is undergraduate students across multiple engineering disciplines. This engineering group is supplemented with an outreach group comprised of students in business, marketing, communications, and art/design, and this secondary group works toward promoting the EcoCAR program and OSU team through outreach events, media coverage, and website development.

The know-how

The vehicle architecture, developed by the OSU EcoCAR team, is an extended-range electric vehicle (e-rev). The design features a 1.8-liter high compression ratio E85 IC engine, coupled to an 82kW front electric machine (FEM) via a unique twin-clutch transmission designed to enable greater operating efficiency through limited parallel operation. The twin-clutch arrangement permits coupling the engine and/or the FEM to the front axle through a single gear reduction, enabling the vehicle to operate in a series or parallel hybrid mode and also ensuring front-axle regenerative braking.

A 22kWh lithium-ion battery pack is used for onboard energy storage and is packaged as a split pack with two modules in the center console area and three further modules in the rear of the vehicle. A 103kW rear-electric machine (REM) provides pure electric-vehicle capability and enables rear-axle regenerative braking. In addition, a DC/DC converter and an AC/DC charger are also packaged in the vehicle, enabling the team to charge the vehicle through a 208V outlet.

This vehicle architecture is unique to the OSU EcoCAR team and based on the overall goals of

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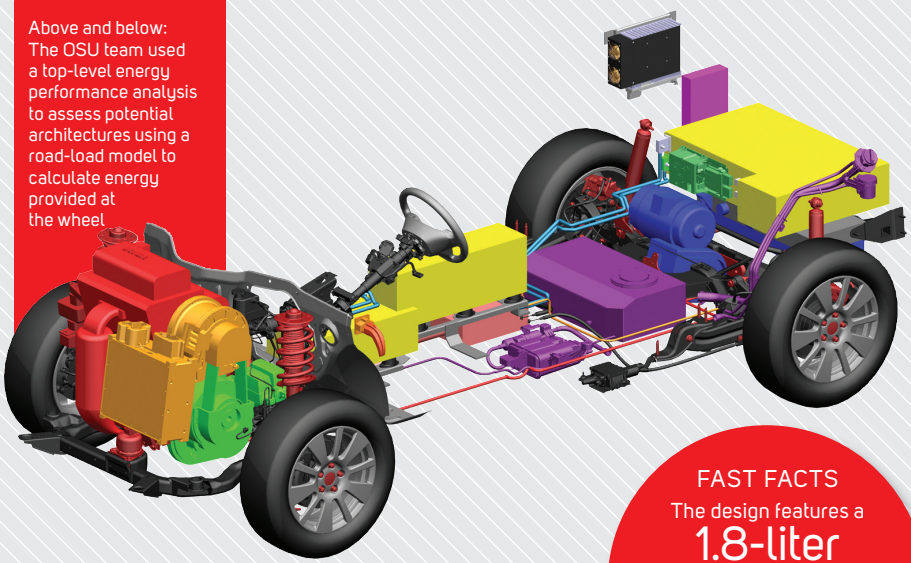
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Above and below: The OSU team used a top-level energy performance analysis to assess potential architectures using a road-load model to calculate energy provided at the wheel

FAST FACTS
The design features a
1.8-liter
high compression ratio
E85 IC engine, coupled to an
82kW
front electric machine

improving fuel economy and emissions levels, while maintaining vehicle performance and consumer acceptability. The EcoCAR competition limits the fuel types that teams could choose from to E10, E85, B20, hydrogen and electricity. The OSU team evaluated these fuel types with the Argonne National Laboratory GREET Model to calculate energy and emission impacts on a full lifecycle basis, assuming a total traveled distance of 200 miles (the minimum range for a production vehicle) with an initial 30-mile, charge-depletion range for PHEV fuel choices. By virtue of superior criteria emissions and reduction in petroleum usage, E85 with electric subsystems, was selected as the best fuel based on the competition metrics as well as the team's specific goals.

In the early stages of the program, the OSU EcoCAR team used a top-level energy performance analysis to assess potential vehicle architectures using a road-load model to calculate the energy provided at the wheel over the UDDS, HWFET, US06, and towing drive cycles. Based on the power and energy demands of the most aggressive drive cycles (US06 and towing), the OSU EcoCAR team determined that a minimum continuous-power rating of 40kW and a minimum peak-power rating of 130kW would be required.

Wealth of information

With this data, the team then performed a second round of simulations to focus on specific components by incorporating component data into Eco-SIM, a quasi-static vehicle simulator developed at the Ohio State University to model the vehicle and control systems. By exploring numerous architectures with preliminary simulation, the team found the twin-clutch architecture design to provide a good compromise of efficiency and complexity as compared to architectures like pure series e-revs and more complicated multimode transmissions.

The twin-clutch E85 e-rev architecture, the OSU vehicle is able to operate in multiple control modes, thereby optimizing vehicle performance under a variety of driving conditions without requiring extra input from the driver. The front powertrain is packaged as an assembly that includes the engine, twin-clutches, gearbox, and front electric machine. The first clutch of the twin-clutch transmission provides a connection between the FEM and the engine. The second clutch provides a connection between the FEM and the single-speed final drive.

In charge depleting mode, the vehicle functions as a pure electric vehicle. Power from the battery can be utilized in two ways.

Firstly, in REM only mode, where the battery provides power to REM for rear wheel drive. The front powertrain is disabled and both clutches are disengaged.

Secondly, power to the battery can be utilized in 4WD EV mode, where the battery provides power to both electric machines. In this instance, the second clutch is engaged, thus enabling the FEM to drive the front axle.

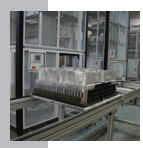
When the battery state-of-charge reaches a defined minimum threshold, the vehicle transitions to charge sustaining mode to utilize the engine for the extended range. The twin-clutch transmission enables the vehicle to have multiple functionalities during the charge sustaining mode, such as series mode, where the first clutch is engaged, thus connecting the engine to the FEM to charge the battery at optimal efficiency. The second clutch at this point is disengaged and the vehicle operates in rear-wheel drive. Another functionality of the vehicle during the charge sustaining mode is parallel mode, where both the first and second clutches are engaged, thus connecting the engine to the wheels through the final drive. The engine speed and FEM speed are matched.

The vehicle is capable of regenerative braking on both the front and rear axles. When braking occurs, the second clutch is engaged and first clutch is disengaged. The FEM and REM are utilized as generators, and energy is transferred to the battery.



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Twin-clutch benefits

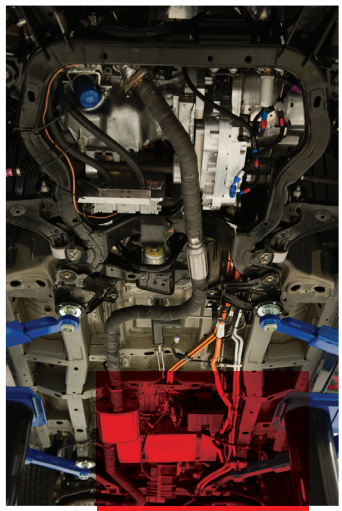
A key attribute of the vehicle that enables these mode transitions is the twin-clutch transmission. This transmission system is comprised of a dry dual-clutch assembly developed by Luk and a custom gearbox, designed by OSU EcoCAR. The transmission is designed to hold stock gears, bearings, and the oil passage system from the original GM vehicle, while meeting the space requirements and mounting needs for the e-rev design.

The clutch actuation system consists of two electric linear actuators connected to concentric throw-out bearings. The actuators were selected for high speed of motion and the ability to provide the amount of force necessary to engage the clutches. Since the actuators require high current but also need to switch direction, H-bridge circuitry from Freescale Semiconductor was used. Positive locks were implemented in the linear actuators so that force is only required to engage the clutches, thereby eliminating the need to supply current to the electric machines to keep the clutches engaged.

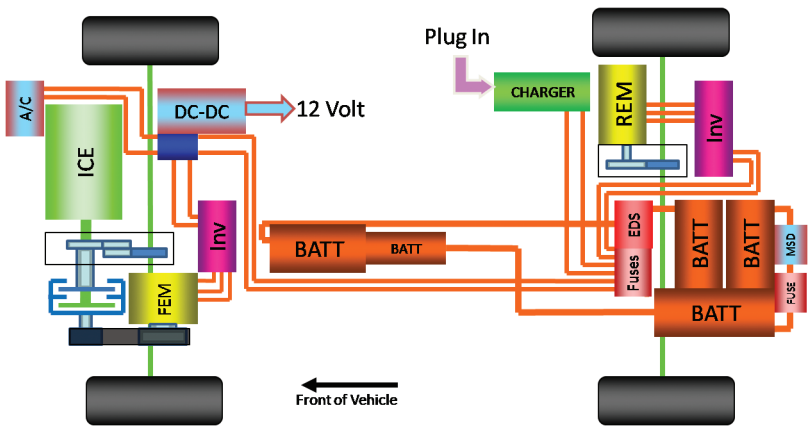
Special concentric shafts were needed to connect the engine output shaft to the first clutch and transmission input to the second clutch. Integration of the flywheel to the pulley system was undertaken by adapting the body of the clutch system to a Goodyear pulley. The unit contains bearings to carry the weight of system tension of the belt and to ensure smooth rotation.

Two key features that make the OSU vehicle a plug-in hybrid are its battery pack and charger. The 22kWh battery pack designed by the OSU team consists of five A123 Systems prismatic cell modules (22S3P) connected in a series configuration. The batteries are controlled by the BMS, which is responsible for providing an estimate of the state of charge, as well as monitoring temperature and cell voltages for safe operation of the pack.

All battery packaging and cooling was designed by the Ohio State team. The team developed a split-pack configuration to reduce the amount of infringement the batteries have on passenger and cargo space. This split-pack design packages the five modules into two smaller battery packs located in such a way that the batteries are not within the crush zones of the vehicle. The front pack houses two of the modules and sits in the center console area between the driver and front passenger seats. The rear pack is located in the vehicle's spare wheel-well area and houses the other three modules. Each pack makes use of aluminum frames with internal plastic insulation plates surrounding all sides of the module. These aluminum frames are mounted to the vehicle on rubber mounts for electrical isolation and vibration damping. Each module has a custom aluminum cooling plate designed by OSU EcoCAR, which provides liquid cooling through an active cooling system (enabling liquid-to-liquid cooling by connecting into the vehicle's air conditioning system) used in series with the existing heater core.



Above: Underbody modifications
Below: OSU's chosen vehicle architecture



HISTORY LESSON

EcoCAR is the latest in the 23-year history of Advanced Vehicle Technology Competitions (AVTC). These competitions represent a unique coalition of government and industry aimed at eliminating technical and institutional barriers to acceptance of advanced vehicle technologies and alternative fuels. Each competition series enables graduate and undergraduate students to gain hands-on experience tackling the challenges associated with building more fuel-efficient vehicles using cutting-edge technologies. Since 1987, over 16,000 students from more than 600 institutions in the USA, Canada, and Mexico have been impacted by the AVTC program. The level of sophistication grows with each successive competition, and the vehicles being developed for EcoCAR are the most complex vehicles yet to be developed in the AVTC program. Ohio State has been a successful contender in these competitions since 1996.



The on-board charger for the vehicle is a Brusa NLG513-Sx 3.3kW charger designed for the A123 battery modules. The charge port is an SAE J1772-compliant Yazaki charge port and can be connected to a wall outlet for 208V charging. It is located in the driver-side fender to be visible to prevent anyone from attempting to operate the vehicle without first unplugging the charge cable. In addition, the supervisory control system stops the vehicle from operating while connected to AC power.

Overcoming range anxiety

To extend the total vehicle range beyond the pure electric range achieved by the large battery capacity, the vehicle uses a Honda R18A4 1.8-liter compressed natural gas engine, recalibrated by the Ohio State team for dedicated E85 usage. This engine's high compression ratio (12.5:1) takes advantage of the E85 high octane rating to achieve a peak dynamometer-measured brake efficiency of 40%. This engine efficiency is competitive with diesel engines, yet maintains the emissions benefits of a spark-ignited engine. The emissions system features a close-coupled, metal-foil monolith, three-way catalytic converter with precious metal group loading of 150g/ft^3 Pd and 10g/ft^3 Rh for high catalytic performance. The catalytic converter includes an Emitec electrically heated catalyst for improved cold-start and hybrid restart performance. This technology is particularly useful for the e-rev architecture because the engine will start cold during mode switches from charge-depleting to charge-sustaining operation.

Calibration of the engine was a considerable task and was conducted in the powertrain labs of the OSU Center for Automotive Research. Several stages of hardware development, control development, and calibration were required to move from a feed-forward control capable of only steady-state operation to a fully transient capable engine. The team developed the required maximum brake-torque spark-timing maps, volumetric-efficiency maps, air and fuel dynamic compensators, and dual-oxygen sensor closed-loop controllers to deliver a clean and efficient engine for the competition vehicle. Additional features include a variable duty-cycle cooling system.

The front electric machine is an 82kW Remy HVH250 permanent magnet machine, driven by a Phoenix FI-9 Inverter. This electric machine was chosen to replace the FEM initially selected by OSU EcoCAR, which was not powerful enough for an optimal e-rev design. Its compact size provides more packaging flexibility, enabling the team to achieve the twin-clutch transmission-packaging configuration. In addition, the Remy electric machine is matched with the Phoenix Inverter, which streamlined the process of integrating these two components.

The rear-powertrain design revolves around the rear electric machine. This electric machine is a 103kW AC induction motor from the GM EV1 electric vehicle. Due to interference between the REM and rear sub-frame, the main cross member was replaced with a reinforcement structure verified with finite element analysis to maintain the original strength of the frame. The three mounts for the electric machine are designed to coincide with the original three mounts used in the GM EV1. The original EV1 inverter was separated from the unit and relocated at the rear of the vehicle. Additionally, minor sheet-metal modifications were required, as the drive extended slightly into the cabin area. Lastly, new shafts were fabricated that matched the splines from the EV1 differential and the rear wheel hubs.



Above: The battery pack at the rear
Inset: Rear subframe modification for REM

Below: Changes aplenty inside the SUV
Bottom: The onboard charger for the vehicle comes from Brusa





The team spent the first year (August 2008 – June 2009) developing their vehicle design, procuring components, and doing advanced controls-development work, using software-in-the-loop and hardware-in-the-loop methodology. Their hard work culminated in an outstanding first placed finish in the first year of the competition.

During year two (June 2009 – May 2010), the team continued to do detailed subsystem development, including engine recalibration, battery pack design and fabrication, and transmission design and fabrication, with initial vehicle modifications starting once they received the stock GM vehicle in October 2009. All sixteen team vehicles were shipped to the General Motors desert proving grounds in Yuma to undergo safety and technical inspections and dynamic vehicle testing. At this point, the team had all powertrain hardware installed and was able to drive the vehicle using all-electric operation of the rear powertrain. With this limited functionality, the OSU vehicle excelled in braking and performed respectably in other events, such as handling and towing, finishing fifth place overall. However, the team expects a large improvement in acceleration with added power from the front powertrain.

Despite not having charge sustaining functionality for the second year, once the team returned from competition it took less than two days to get the engine and front-electric machine running. Work will continue on integration and refinement until June 2011, when team members eagerly anticipate bringing a fully functioning e-rev to the final, third year of the competition.

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Great expectations

Having led the way in DCT development, **Getrag** is now looking further ahead to the electric vehicle revolution as part of its new-found growth plans

WORDS: **DEAN SLAVNICH**



Getrag is preparing itself for the electric vehicle era by ramping up development of several e-transmission technologies



It's been a challenging few years for Getrag, one of the industry's largest transmission suppliers. A quick flick through the company's books shows that it has been hit hard by the global financial crisis: In 2007 turnover hit a record high of US$3.3 billion. Last year that margin shrunk to US$2.6 billion, not a disaster by any means – Getrag is still outperforming many rival suppliers – but this proud German Tier 1 has only ever known growth.

"Getrag has suffered during the financial crisis," admits Rolf Najork, the company's vice president for product development. "So our strategy of late has first been to expand in the DCT area, which was a positive move on the whole, despite some drawbacks, like the failed corporation with Chrysler in the USA. At the moment, we're in recovery mode, which means getting back to financial success. I'm pleased to report we're well on the way to achieving this aim.

"We now have the biggest portfolio of DCTs on the market, so our strategic goal moving forward is to take our existing architectures and proliferate them more into the global markets. This will really harvest the earnings from our investment. As a second step, we will go for the worldwide industrialization of DCTs.

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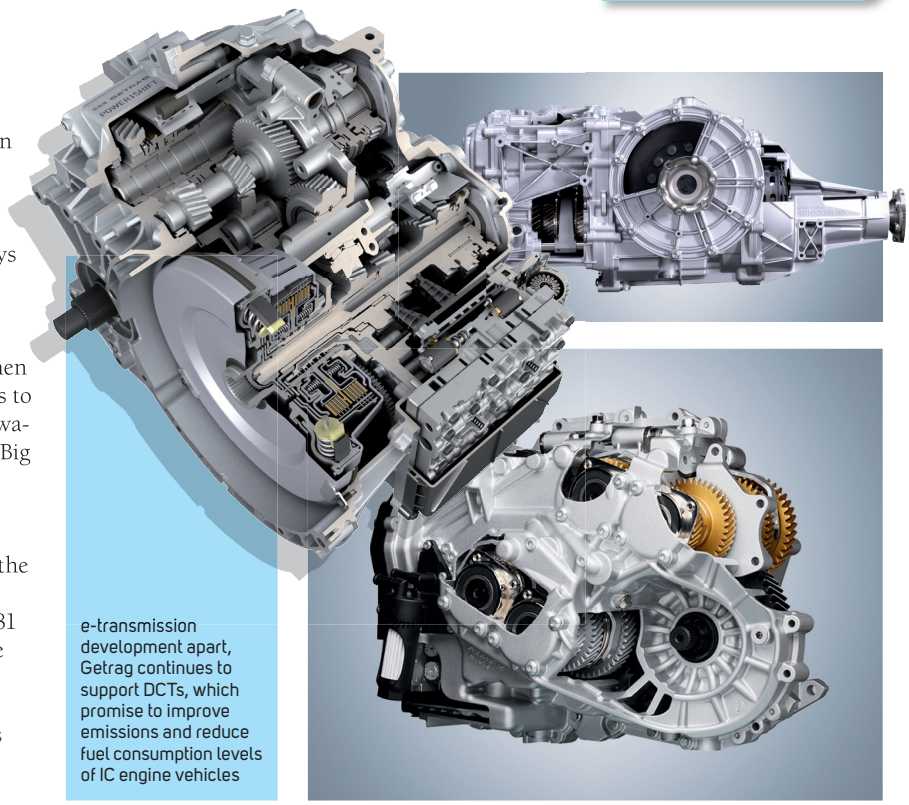
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And looking ahead further still, innovation will be strongly focused in the field of e-drive technologies."

With 24 product development centers and production facilities across Europe, Asia and North America – as well as a rich company history that dates back to 1935 – it's easy to believe that the last two years have simply been a blip for Getrag. And looking forward, Najork says DCTs – a technology that the company has invested in heavily – will help facilitate Getrag's aim to realize financial success. "When you look toward the mass-produced vehicle segments in Europe – particularly when it comes to front-wheel drive applications – there seems to be an across-the-board trend toward DCTs from Volkswagen, Audi and Ford, through to Fiat, Alfa and Renault. Big manufacturers are taking this technology forward and they either have production plans to develop their own DCT or they're planning to buy it from suppliers."

It's a trend that places Getrag in a strong position in the market. The company has DCTs that cover all types of applications, from PS150 five-speed DCT through to 481 seven-speed units for high-end applications such as the Ferrari California and the Mercedes-AMG SLS. And despite the financial downturn – DCTs are inherently more expensive to develop – emissions legislation, says Najork, is helping to offset such cost fears. "One of the easiest ways for automatic transmission powertrains to reduce emissions is to switch from a classical auto to a DCT, which would normally bring about a 10% reduction. It's a significant saving and the technology eventually pays for itself.



e-transmission development apart, Getrag continues to support DCTs, which promise to improve emissions and reduce fuel consumption levels of IC engine vehicles

"There will be a need for transmissions in the future, even in conjunction with full electric driving"

"The other important point in all this is that the price of the DCT is coming down," Najork adds. "The main reason why they're still expensive is because of companies sitting on depreciated automatic transmission capacity. For them it's easier to present a good deal on an existing automatic, or its next-generation, than starting a new investment on a DCT – both in terms of actual development and production. Today, the cost of the DCT – depending upon what segment we're in – is slightly above a new automatic transmission, but there's a real CO_2 benefit and this usually overcompensates for the initial cost advantage of the automotive."

Najork believes the future's bright for DCTs, but the same can't be said for the traditional automatic box: "DCTs will replace automatics on a broad scale, a global basis, particularly in those markets that have not yet gone down the torque converter route. As a country, China, for example, has the option to invest in whatever technology it sees appropriate.

"There's a clear push to go for DCTs in China and we have had a lot of interest and business relationships with Chinese customers. I think the situation in China will become a global trend." Far from wanting basic, low-cost four-speed manuals, the demand in China from the transmission players for high-tech solutions and governmental policies promoting CO_2 reduction is only helping to increase DCT demand further.

But despite Najork's unwavering confidence in DCTs, transmission players are having to adapt further, with governments urging car makers to ramp-up development of pure electric vehicles. It's a phenomenon that has

END GAME

A few years ago everyone but the Japanese was predicating the decline of CVTs, but it would seem this technology – favored by the likes of Nissan, Toyota, Honda and Mitsubishi – is far from finished. "The Japanese are still enthusiastic about CVTs," says Najork. "There are three reasons for this: firstly, they genuinely like the CVT; secondly, they have invested in this technology and have operational facilities that have to be used; and thirdly, the technology one chooses is often dominated by personal experience. Japanese engineers usually operate their vehicles in a slow-speed environment in heavy city traffic. In this environment, the CVT is not a bad solution, which is another key reason why this transmission remains popular in Japan."

It was predicated that the plight of CVTs would be mirrored by AMTs, albeit at an even faster rate. However, as with CVTs, it seems that AMTs are not going down without a fight. Najork explains the theory: "I thought AMTs would eventually die after the introduction of DCTs but AMT has one big advantage: it's far less costly. So I can't rule out that AMT will sustain its presence in cost-conscious automotive markets."

"Energetically, it's accepted that nothing beats an AMT. If efficiency is your only goal, then an AMT can't be beaten, although there is a deficit in shift."



worried some in transmission circles but Getrag is safeguarding its future: "By 2020, Europe will mainly run manuals and DCTs, but we will also be increasingly reliant on hybrid and e-drive applications.

"As a company, we can't rely only on the classical transmission business because it is very hard to predict the migration to electric technologies in the automotive world," Najork adds. "If we were talking about pure electric driving, then yes, we are on the way, but I don't think this will replace much of our business by 2020."

Despite this, Getrag's R&D engineers are busily developing e-drive technologies. Hybrid DCTs and e-drive systems for boosted range extender vehicles and parallel hybrid electric vehicles are all part of the German supplier's plans. "It's important to remember that the technology associated with electric driving will only replace transmissions to a certain degree," Najork says.

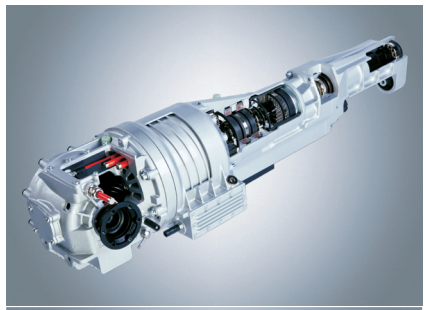
"On the other hand, we will see that the assumption that an electric drive vehicle does not need any transmission is not sustainable. They will need smaller, easier transmissions, but there's also a tendency for e-drive aggregates to go for two or even three gears. There will be a need for transmission technologies in the future in conjunction with electric driving. So, instead of being the rabbit in front of the snake and simply waiting for e-drive to come and eat away at our manual transmission business, we'd rather take a proactive step and put ourselves at the forefront of e-drive and come up with new and interesting technologies. We have a complimentary business that could replace the shrinking classical transmission business."

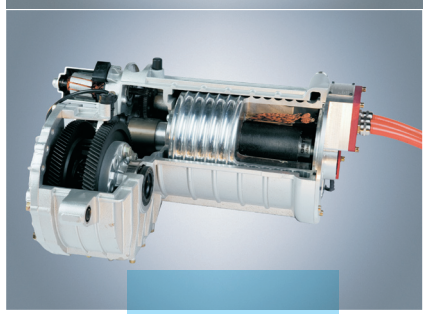
As a result, Getrag has around 15 e-drive transmissions on the boil, varying from a single gear through to more sophisticated high-speed electric machines. The Tier 1 has also won a 50,000-unit e-drive contract to supply Daimler for their 2012 electric Smart.

"We're preparing for the EV future," insists Najork. "We are investing in this technology and also stepping up our efforts with hybrids and range extenders, with the latter field expanding our current content. As a company, we see e-drive technologies as a challenge, not a threat."



Part of Getrag's e-drive focus is with Daimler, working on the further development of the electric Smart





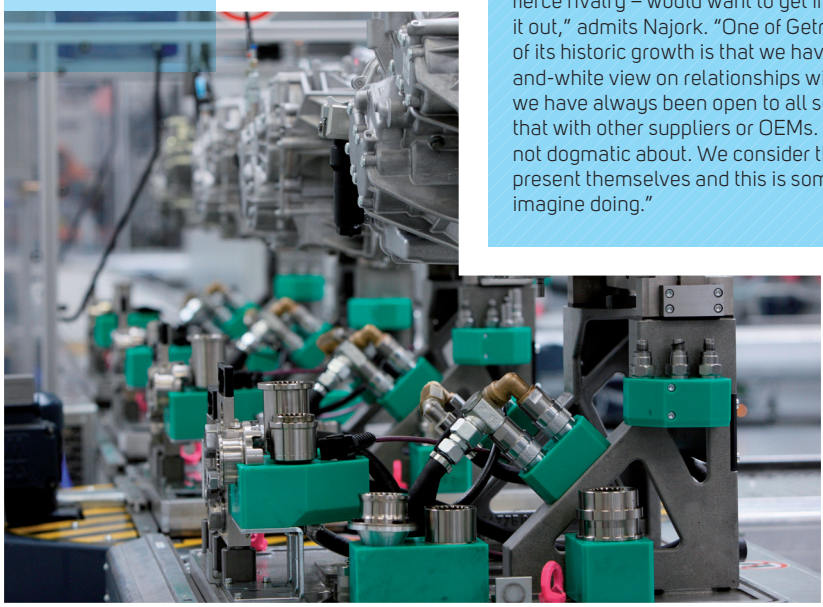
Electric or hybrid drive units with one or two speeds allow new levels of freedom in vehicle integration as well as offering the additional customer benefit of electric all-wheel drive functionality

PERFECT PARTNERS

Car makers in recent years have increasingly embarked on collaborations and joint ventures with other car makers. Supporters of this trend say that such moves enhance efficiency and productivity, and slash costs, but is this something in which transmission suppliers – with their fierce rivalry – would want to get involved? "I wouldn't rule it out," admits Najork. "One of Getrag's strengths in terms of its historic growth is that we have never taken a black-and-white view on relationships with other companies; we have always been open to all sorts of relationships, be that with other suppliers or OEMs. This is something we're not dogmatic about. We consider the opportunities as they present themselves and this is something I can certainly imagine doing."

"As a company, we see e-drive technologies as a challenge, not as a threat"

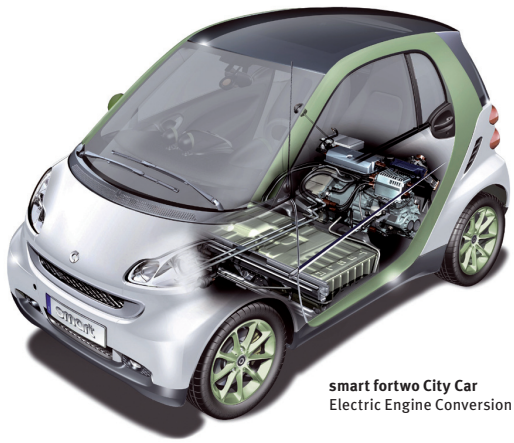
End of line control inspection takes place at Getrag's DCT facility



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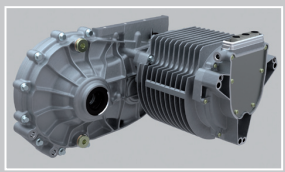


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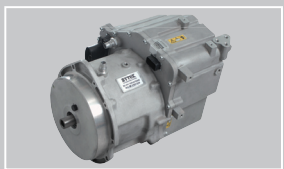
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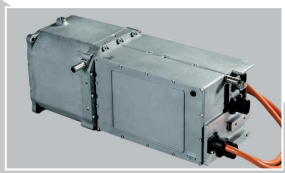
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Integrated processes

How one supplier's innovative integrated solutions has helped to create one of the world's leading battery test and development facilities

From its beginnings in 1957, Bitrode has consistently produced specialized battery formation and lab testing equipment noted for standard-setting excellence in engineering, accuracy, reliability and consistency.

The company's trademark high-performing formation equipment and laboratory test instruments, state-of-the-art software tools, and battery simulation and manufacturing automation tools – appropriate to a broad spectrum of battery chemistries and applications – have been running in plants around the world so long that their durability levels are almost legendary.

One of the first in the industry to anticipate the rapid ascent of the hybrid and electric vehicle market, Bitrode launched the development and production of their first HEV high-power, high-speed equipment and test systems well before OEMs stepped up investment in advanced technology vehicles early in the last decade. Their test equipment – known as the FTF line of machines – performs advanced applications requiring fast switching speeds, extensive data collection, and CAN interface for cell, module and pack level testing, therefore ensuring that ensures EV and HEV batteries can pass the rigorous tests (FUDS, ECE-15, DST) now standard in the industry. The units' regenerative capabilities can also return power back to the power grid, eliminating heat dissipation and recycling discharged energy. Since the release of their first machine in 2003, Bitrode has become widely recognized for complete turn-key solutions for HEV/EV cell, module and pack testing.



Bitrode, A&D and CSZ delivered complete turnkey solutions for cell and module testing

Bitrode Corporation has had a long history of setting new industry benchmarks for collaboration with its partners to pioneer some of the most innovative laboratory testing systems in the world. For example their collaboration with A&D Technology has resulted in a testing system that offers highly flexible software interfaces, state-of-the-art circuitry, and lab tools for data management and safety.

Employing A&D's iTest software, this integrated system provides their customers with the capability to fully automate all levels of battery testing including cells, modules and packs while maintaining a common software interface and data set. It was for these reasons that this high-tech system was implemented in the General Motors Global Battery Systems Laboratory in Warren, Michigan, the largest and most technologically advanced battery lab in the USA. Incorporation of this integrated approach provides the GM lab with significant efficiencies in both manpower and test bench utilization as well as the capability to operate 24 hours a day, seven days a week.

It was late in 2007 when GM formed a team of designers from the powertrain and battery testing communities to redefine the requirements that would ultimately impact all battery testing laboratories of the future. "The design team understood that they would be making decisions no one had ever faced before", says Tony Modafferi, GM GBSL engineering group manager.

"Having built powertrain labs at other GM facilities, I already knew that the right systems integrator, the company that analyzes available equipment and software to determine how they'll work together as one system, would be crucial. The integrator would need to be skilled in working with all the suppliers involved as the project progressed, and I already knew we would be working with Bitrode." In June of 2008 GM selected A&D Technology as the systems integrator for their lab. A&D's thirty-year history of providing advanced powertrain development and testing solutions combined with their willingness to incorporate essential innovative features into their products made them the first-choice partner for GM.

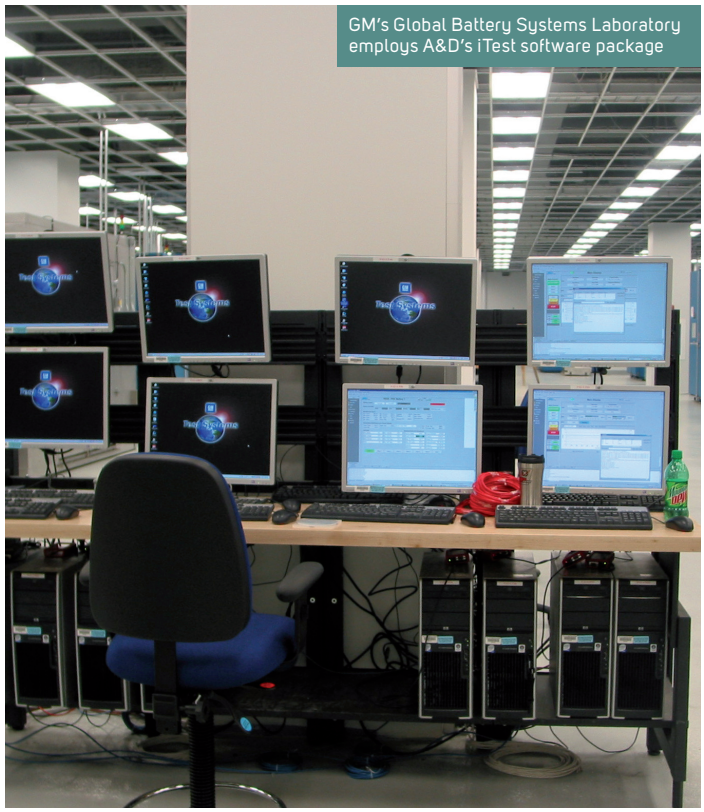
"I told them what we wanted to do, how we wanted to tie all of the pieces together," recalls Modafferi. "Because we wanted to create a test automation system with innovative features that were not available to the battery testing environment, it was critical that we identify suppliers who could offer us a high degree of flexibility as well as state-of-the-art test equipment."

Recognizing the importance of creating a team of highly regarded battery experts, Modafferi knew he wanted to bring in Bitrode, Aerovironment, and Cincinatti Sub Zero to compliment A&D's vast experience in developing test automation systems. All planners agreed that bringing 'the best of

Bitrode's advanced technology has enhanced the General Motors Global Battery Systems Laboratory



GM's Global Battery Systems Laboratory employs A&D's iTest software package



the best' together under a single umbrella would be an important factor in developing the plan for the successful execution of this historic project.

Modafferi selected Bitrode and CSZ based upon his positive past experience with the company. "We already had a lot of equipment from them on the Warren campus and knew that we could depend on its reliability," he says. "I wanted to make the lab as flexible as I could, with a broad range of capacity and Bitrode was one of only a couple of manufacturers that could cover the range of testing we wanted. For example, we needed to be able to test from zero to eighteen volts and up to five-hundred amps; most manufacturers' equipment cannot go down to zero volts.

"In addition to this, Bitrode has always been very responsive to anything we need, and I must say, that's a hugely important component in an effort like this, which basically requires that multiple suppliers work towards a smooth integration." The result of this innovative partnership, including the incorporation of A&D's iTest system, has resulted in one of the most advanced battery testing facility in the world. The iTestEV solution in tandem with Bitrode testing equipment, and complimented with the A&D LabMinder and iCentral systems, not only maximizes productivity while reducing hard costs, but creates a redundant failsafe laboratory with active error tracking and notification functionality that allows operators unprecedented amounts of information and control at any time from any location. The system consistently monitors and interacts with all testing systems, inside and outside the lab, allowing the user to monitor live status of every test for specific data concerning every aspect of testing procedures and protocols. Should an error occur, LabMinder alerts notifies proper facility operators, and then initiates a shut down sequence of the specified battery channel. This process is undertaken by remote control, therefore preventing potential battery failure and thermal runaway.

Because evolving advanced chemistry batteries have yet to achieve lead acid's proven history, new battery test systems must not only provide the efficient automation required by today's methods, but also the flexibility necessary to adapt to the changing needs as in-use experience grows and batteries evolve. The collective team's fully automated system provides flexibility for incrementally changing test procedures, and also enables future methods such as design of experiments, modeling, and real-time simulation as well as hardware-in-the-loop.

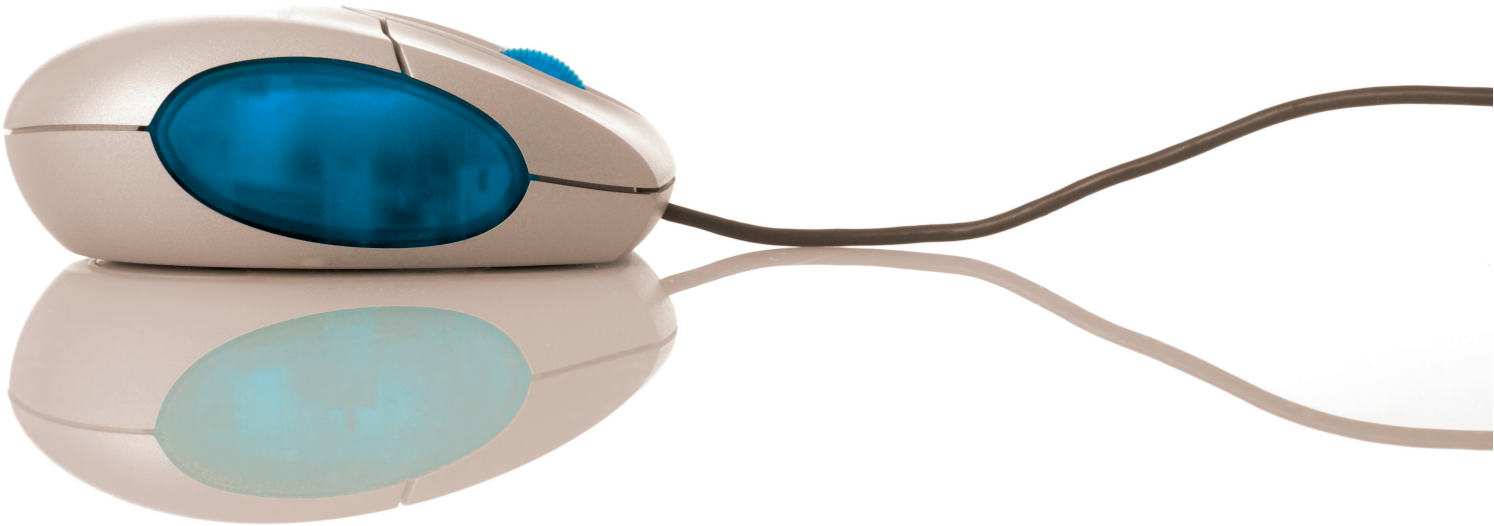
Though automation adds cost, the cost of constructing a lab without it will be higher because reduced efficiency will require more equipment, floor space, people and infrastructure to support the same testing throughput. Other cost savings include the cost of hiring, training, writing standard tests and delays. On top of the initial savings, automation saves operational costs by reducing personnel needs.

"This kind of cutting edge automation and lab management system was an absolute requirement for our new Advanced Battery Lab," recalls Modaferri. That such a system came together so quickly speaks to the quality of what the creative team could assemble, in only a matter of months. "We started in June of 2008, completely gutting an area that had been office space, building the new facility by December of that year, in only six months, and opening the second part of the lab in May of 2009."

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Auxiliary power modules

A look at low-cost, fully automotive graded Easy 1B/2B power modules with a flexible layout for hybrid and electric vehicle applications

The availability of a high voltage battery system in both HEVs and EVs offers the possibility to increase the efficiency and to reduce the cost of some applications that are today supplied by the low voltage board-net (14V) in IC engine vehicles. These systems include air conditioning compressor, oil pump, cooling pump, boosted power steering, and heaters.

The power of these loads ranges from 1kW to 6kW. Driving such applications from a high voltage DC-link allows a system designer to reduce the required current levels, which is a great benefit in terms of cost (as well as realizing a reduction of cable thickness and the amount of copper in the motor).

In HEVs and EVs, new applications are needed that do not exist in today's IC engine vehicles. One of these is the DC/DC converter between high- and low-voltage batteries. The purpose of it is to transfer energy between batteries to optimize the energy efficiency of the car. Another example is the battery charger for plug-in HEV, which enables the battery to charge fully by connecting a plug to the power grid.

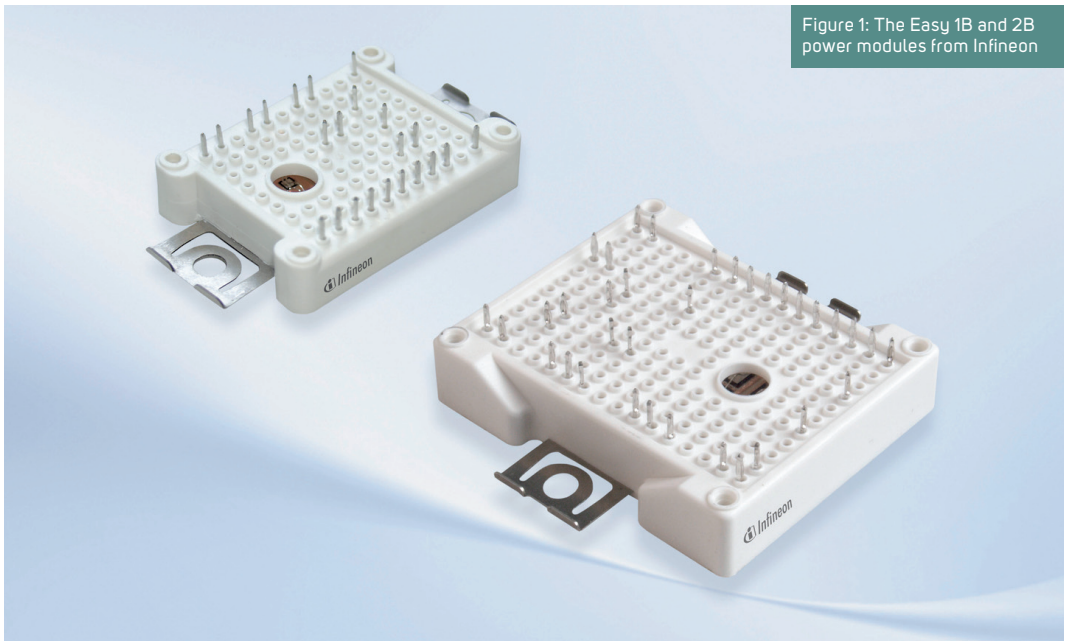


Figure 1: The Easy 1B and 2B power modules from Infineon

All these loads have different requirements. It is a big challenge to provide a solution that will be customizable for the different semiconductor components, such as IGBTs, diodes, HV MOSFETs – CoolMOS, LV MOSFETs – OptiMOS, and DCB and PCB layouts. Additional challenges involve unifying the packaging for the components as well as keeping them low-cost. A specific approach is needed to meet these needs.

Unlike with the traction (motor/generator) inverter, these small loads do not need a base plate. They require the right combination of efficiency, flexibility, and cost. The fully automotive Easy 1B and 2B power modules from Infineon Technologies (Figure 1) target all these new and old applications (Figure 2) and topologies.

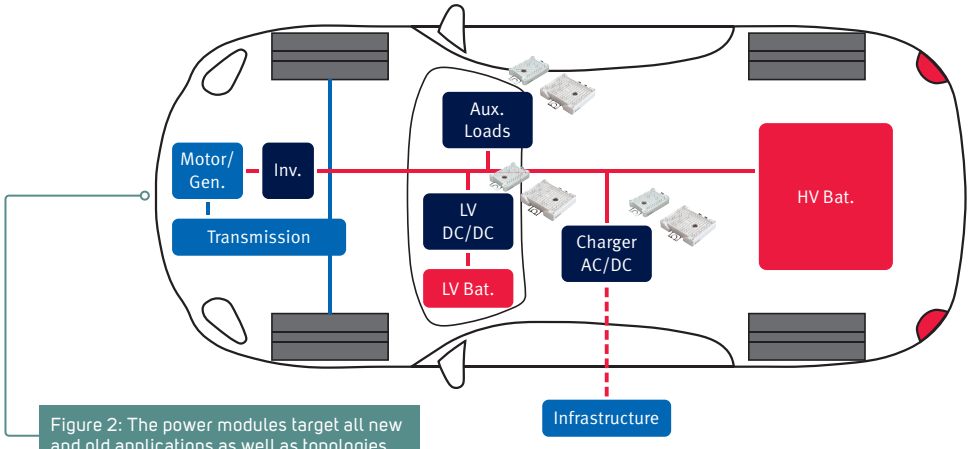


Figure 2: The power modules target all new and old applications as well as topologies

The Easy 1B and 2B power modules are well-known and proven in industrial applications (industrial drives, UPS/power supplies, air conditioning, welding, battery chargers, inductive heating, and solar inverters). These modules were developed to have a cost-effective and compact design as well as offering a simplified and reliable mounting.

The base plate-less modules have injected screw clamps and press-fit pins to provide a new, fast, reliable, and low-cost mounting concept. The main features of Easy 1B/2B modules can be summarized as follows: compact module concept; standardized and well-

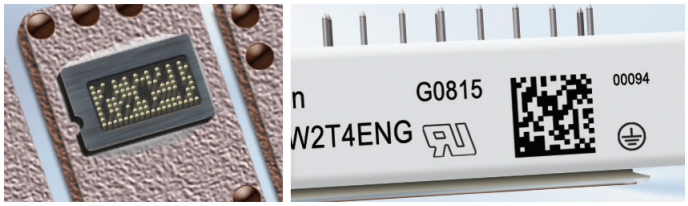


Figure 3: One DMX-chip on the ceramic of the module and one DMX-code on the module housing provide important data

established packages for different applications; application flexibility through customized DCB (direct copper bonding) layout, and pin matrix; optimized development cycle time and cost; high-power density; integrated temperature sensor availability; low-stray inductance module design; and RoHS-compliant modules.

Infineon Technologies has already incorporated these modules into its automotive power modules portfolio. As a result of this, Easy 1B/2B power modules are fully automotive graded.

As with all automotive-qualified power modules, the Easy Modules have to pass strict qualification tests to fulfill the automotive requirements on lifespan and reliability. The automotive qualification includes different chip and package relevant tests. To pass the automotive qualification an improved DCB ceramic is used to reduce copper delamination and DCB cracking.

Low temperature storage (LTS) tests the module at very low temperatures to prove the functionality of the isolation gel. Thermal shock test (TST) is a two-chamber test. The air-to-air thermal shock is an accelerated test to evaluate failure mechanisms driven by mismatches in the coefficients of thermal expansion of the different materials. The modules are kept for one hour at very low temperature and then put into a high temperature chamber for an application-relevant number of cycles. Vibration and mechanical shock tests are conducted, their purpose being to determine if the module meets operational requirements when subjected to mechanical stresses over the lifetime of the vehicle.

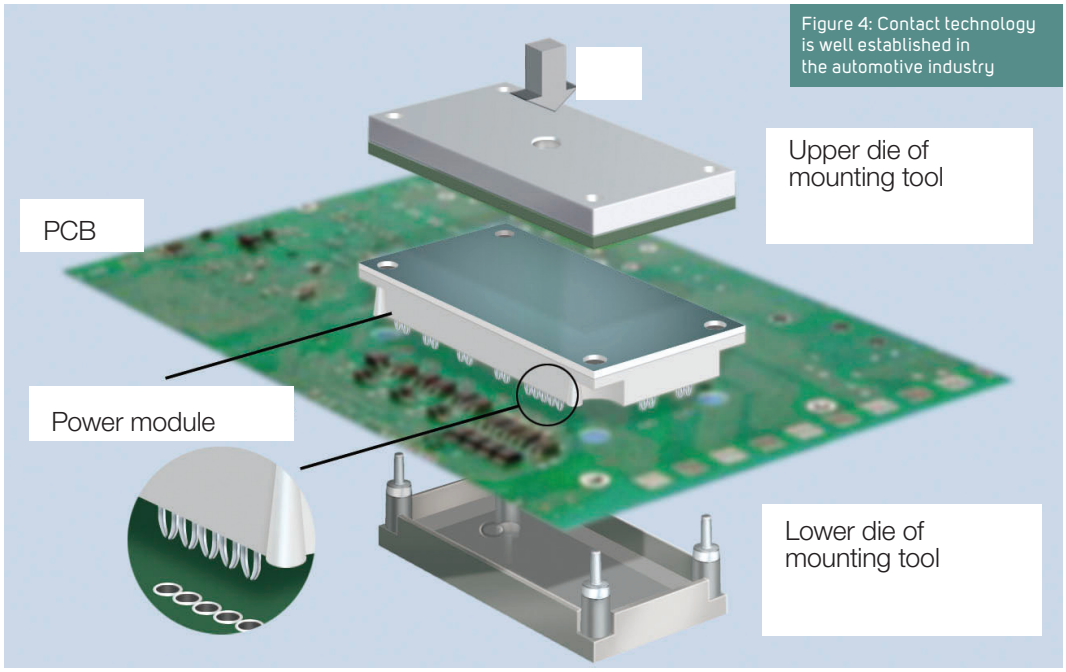


Figure 4: Contact technology is well established in the automotive industry

Besides passing the automotive qualification tests, the Easy 1B/2B modules integrate additional features such as traceability and press-fit connections, all of which are relevant in auto applications.

In terms of traceability, one DMX-chip on the ceramic of the module (DCB) and one DMX-code on the module housing (see Figure 3) provide very important data as the position of the different chips on the wafer of origin, bonder traceability, and 100% interchange protection.

Press-fit is an alternative method for connecting control and power contacts on power modules to a printed circuit board and/or bus bars that complies with the requirements for greater durability levels, the trend toward higher temperatures, RoHS and simple handling. This contact technology has already been employed for years in the automotive sector around the world (Figure 4). Its main advantages are the improved reliability (which is a much better FIT rate than soldering), birth time and cost saving assembly, reduction of PCB sizes, and the possible repairs of system.

The auxiliary drives, DC/DC converter, heaters and battery chargers present a challenge for automotive modules. The high-tech solutions presented in this paper are Infineon's answer to this challenge: new automotive Easy 1B/2B power modules offer a flexible platform for high voltage and low-power applications (up to 6kW), enabling the use of different semiconductor components that realize a reduction of system costs.

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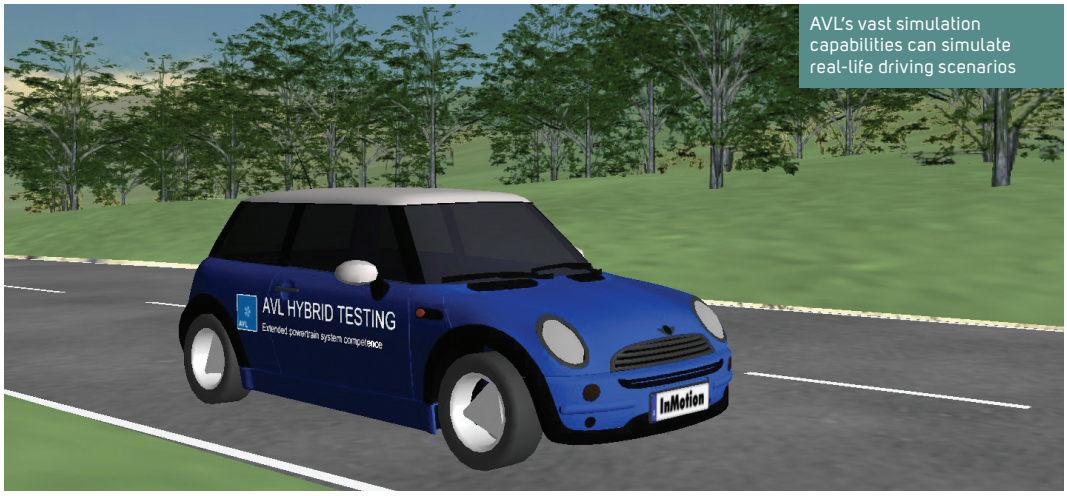
Testing in the real world

How virtual vehicle integration under simulated real-life conditions can improve the development process

The vehicle of the future is driven by strong market demands for minimum energy consumption, as well as maximum driving fun within an increasingly dynamic and complex system and user environment. New hybrid and electric powertrain technologies evolve at a faster pace to tackle these changing market needs and meet new legislative targets.

The variety of solutions for the new electrified powertrain pose extreme challenges with respect to the best integration of the increasing number of hybrid subsystems. How do the electric motor, high-voltage battery, internal combustion engine, and hybrid control strategy interact in the diverse situations of real-life vehicle usage?

These questions cannot be addressed at the end of the vehicle development process, but ideally at early stages to develop each subsystem with its later integrated real-life usage in mind. Therefore anticipating real driving conditions and their immediate impacts on vehicle performance is one of the key factors of success in the development of future drive systems.



AVL's vast simulation capabilities can simulate real-life driving scenarios

The need to pursue developments in all the test environments in a realistic fashion, coupled with the increasing need to cut cost-intensive development times require capturing and mapping of the real environment-system-user interaction and making it continuously available throughout the entire development process. Of the different test environments, the testbed – as the interface between the real and virtual environments – plays a key role in the development process. Simulation data is integrated on the testbed, the testbed results are verified on the road, and real-world results returned to the testbeds.

To seamlessly integrate the varied reality of everyday driving operation into the testbed from the earliest possible phase of the development process, different paths can be taken. On the one hand, the AVL InMotion real-life simulation tool powered by CarMaker enables the representation of complex environmental influences, driving characteristics, and individual driver-behavior patterns. The other option for gaining relevant data is





The uptake of new electric powertrains, such as the Mini E (left and below), are posing fresh challenges with respect to full systems integration



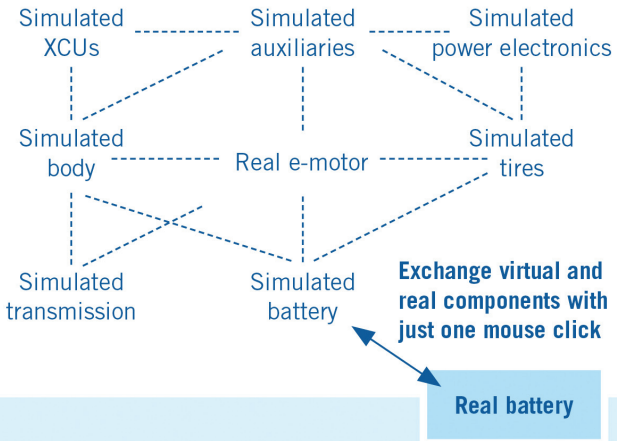
AVL's InMotion system brings together the company's vast system integration know-how

Below: AVL's proven model and approach to using high-tech simulation test systems in order to optimize development of new powertrains early on in the program

Simulated environment and maneuvers

- Real-life driving profiles
- GPS and maps
- Climatic influences
- Road conditions
- Traffic
- Incidental events
- Active and reactive maneuvers
- Different driver types

Simulated system integration



real-life testing with the AVL MOVE onboard measuring equipment. Used complimentarily, both approaches offer the best results in maneuver-based testing.

As OEM product lines keep expanding and the variety of testbed systems for electric and hybrid components on the market increases steadily, development teams rely on simulation-based testing to enhance process efficiency by transferring testing tasks from the expensive physical proving ground to the virtual proving ground. Improved development quality and productivity gains can be realized by utilizing simulation tools that anticipate powertrain system integration under simulated real-life conditions and enable continuous improvement of simulation results throughout the entire development process.

AVL InMotion bundles the vast hybrid system integration know-how of AVL in one integrated real-life simulation platform. It enables the simulation of single hybrid subsystems, including their integrating control strategy, and anticipates how the entire vehicle would behave under typical real-life user conditions and individual driver maneuvers. Real-life driving maneuvers, simulation data and validated testing results are shared in all stages to enable simulation model improvement throughout the development process.

As system integration, optimization and validation can thereby be moved to earlier stages of the development process, and the best real-life calibration results can be achieved faster and with maximum cost efficiency. Test engineers appreciate the efficiency and speed with which concepts can now be evaluated and turned into tangible products, given the capability to perform corporate test procedures in a reliable virtual prototype environment in place of, or prior to, more expensive experimentation on the physical proving ground.

OEMs can now take advantage of AVL's real-life approach and test drive their products on the Nürburgring, France Route, Schwarzwaldrunde or 'auto motor und sport-Vergleichsrunde' upfront – and before the journalists get there – on the testbed. Preconfigured digitized 3D-benchmark roads, tires, and virtual prototype cars enable engineers to hit the ground running. Maneuver-based testing helps to bring new powertrain designs to market faster, manage increased regulatory pressure and maintain cost efficiency through versatile and reliable processes. Easy-to-install upgrade packages with best-in-class features are available for all types of testbeds.

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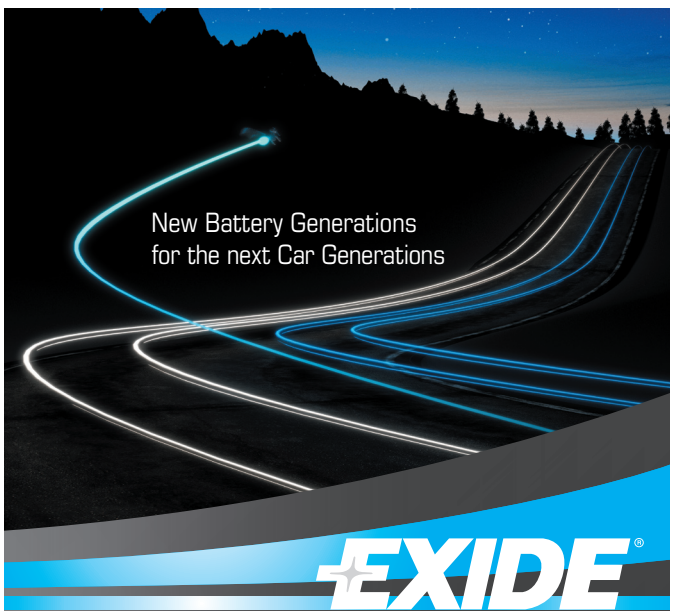
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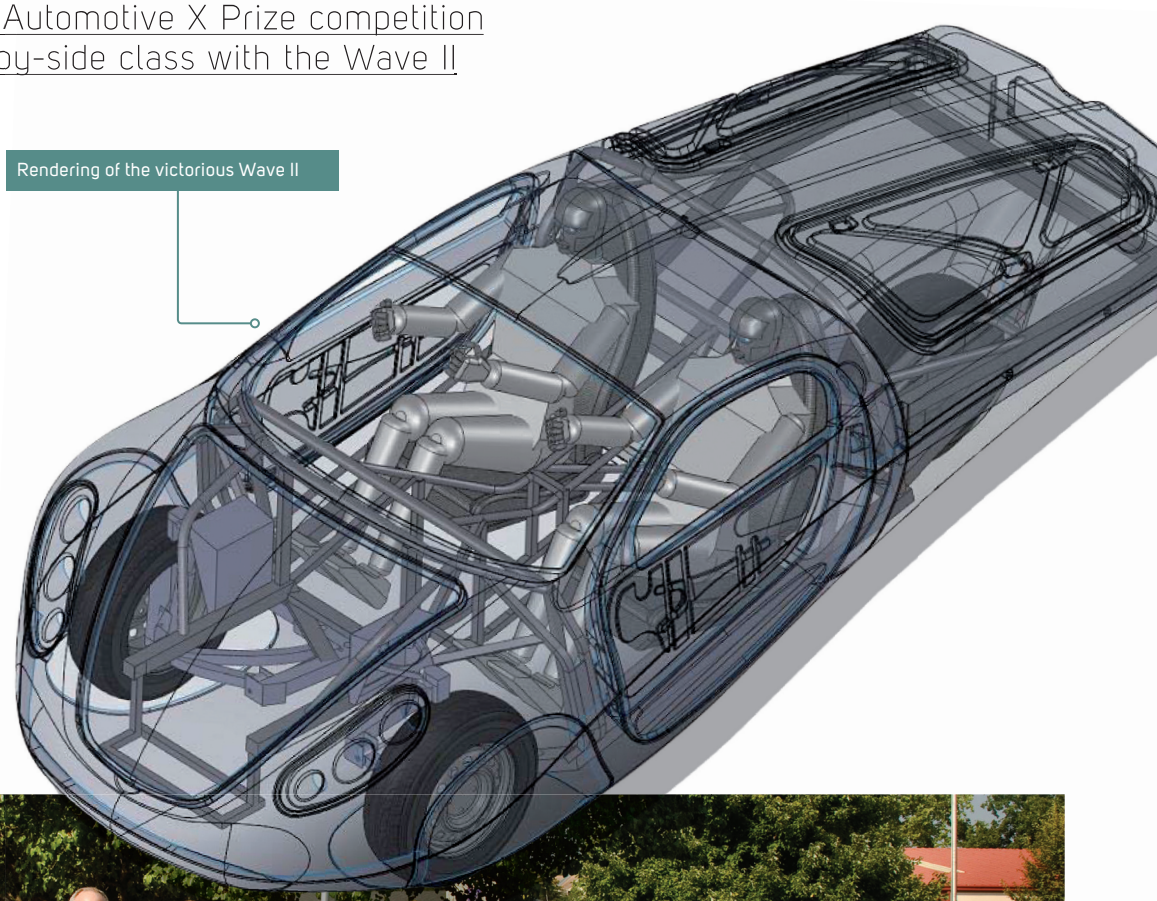
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Li-ion Motors scoops first place in X Prize

Li-ion Motors wins the Automotive X Prize competition in the alternative side-by-side class with the Wave II

Throughout the X Prize competition, Li-ion Motors was able to validate and demonstrate its leading-edge, high-speed, extended range all-electric vehicle technology using lithium batteries. For more than seven years the company has been undertaking research and development to produce and manufacture this state-of-the-art technology. Winning this award gives Li-ion Motors a place in the history books as a pioneer in the evolution of the automobile.

Since 2003, Li-ion Motors has been working diligently to develop its patented battery management system (BMS), and has done so independently without financial assistance from the government, corporate sponsorships, or joint ventures.



Rendering of the victorious Wave II



Li-ion's Wave II achieved an impressive 191mpg on the highway run during the Automotive X Prize knockout stage

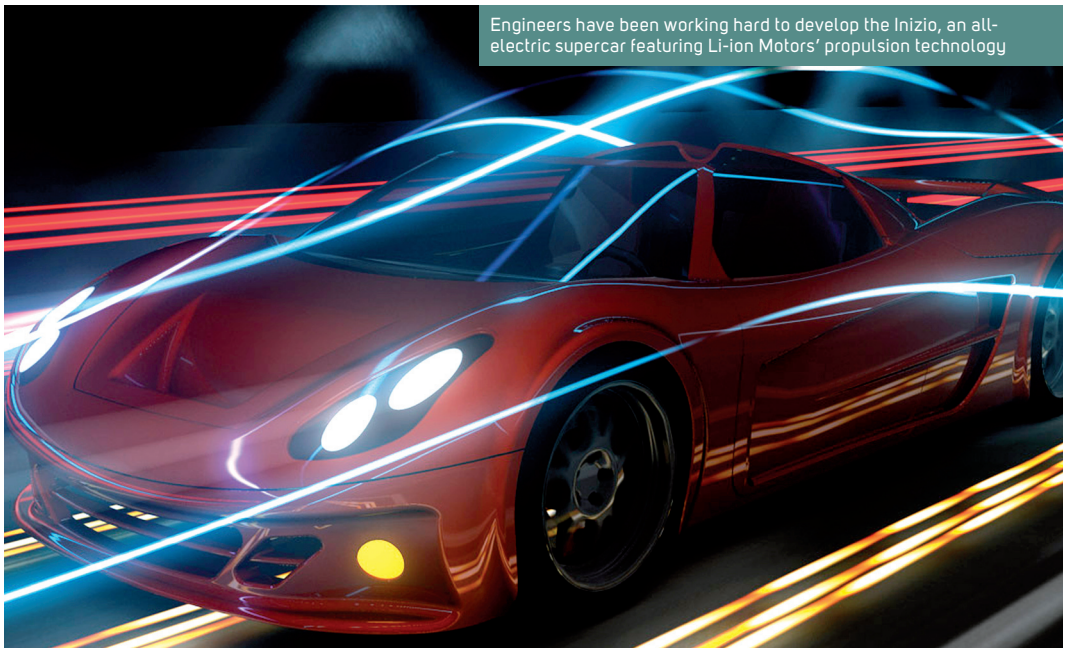
During the progressive Automotive X Prize knockout stage, Li-ion's Wave II achieved an impressive 191mpg on the highway run. The Argonne National Lab (USA) gave Li-ion Motors a 203mpg rating after vigorous testing.

The Wave II was the only North American vehicle to complete the performance and efficiency race in the final stage.

Li-ion Motors continues to improve vehicles' performance with enhancements to its proprietary systems – including the BMS – with the goal being to increase overall efficiency by 10-20%. As its history shows, the company's goal is to remain ahead of the competition for the foreseeable future.

With recent environmental catastrophes in mind, Li-ion Motors intends to manufacture its products in the USA, as well as licensing its technology to automotive manufacturers worldwide. The USA will lead the way in accelerating ecological benefits by sharing this technology, and by licensing the system to other manufacturers will also help to reduce their carbon footprint.

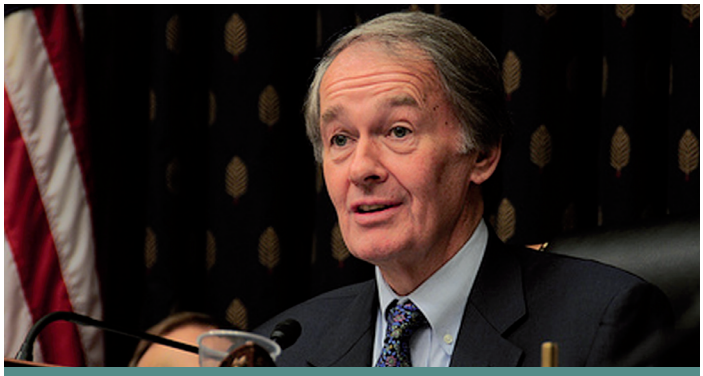
Automotive manufacturing giants such as Nissan and General Motors have spent tens of millions of dollars on electric vehicle innovations and will still have to fine-tune their technology before making it available to the public.



Engineers have been working hard to develop the Inizio, an all-electric supercar featuring Li-ion Motors' propulsion technology



Nancy Pelosi, speaker of the US House of Representatives, is a supporter of the X Prize competition



Edward J Markey, chairman of the House Select Committee on Energy Independence and Global Warming, US House of Representatives, has gone on record to say that Li-ion Motors represents an inspiring example of ingenuity

For other OEMs, licensing Li-ion's technology will save them millions of dollars, eliminate years of research and development, and will result in an advanced, fully functional, tested, and proven prototype within four months.

In 2008, Li-ion Motors started prototyping four-wheel drive vehicles designed around an all-electric propulsion system and aerodynamics to achieve the highest efficiency possible in electric vehicles. This evolution resulted in Li-ion Motors winning the X Prize competition.

In November 2010, Li-ion Motors is expected to unveil its all-electric, 21st-century-designed supercar, the Inizio. This advanced vehicle has been entirely engineered and developed in house by the company, which claims the Inizio electric vehicle will be a leading electric supercar in terms of design, engineering, and performance.

Using Li-ion Motors' propulsion technology, the company's future developments will include a fast charge system using its proprietary BMS, a more efficient two-speed transmission, and an in-house high-performance motor controller system.

After winning the X Prize, staff motivation and confidence have reached a new high. Unlike a typical automotive company, team Li-ion Motors is inspired to take an out-of-the-box approach to business development plans. While the company intends to manufacture in the USA, it will also assist other OEMs to convert their existing models to high-speed, long-range, all-electric vehicles. By licensing its technology and sharing its design and engineering specifications, Li-ion Motors will help other countries to manufacture electric vehicles. This package will greatly reduce the automotive industry's carbon footprint.

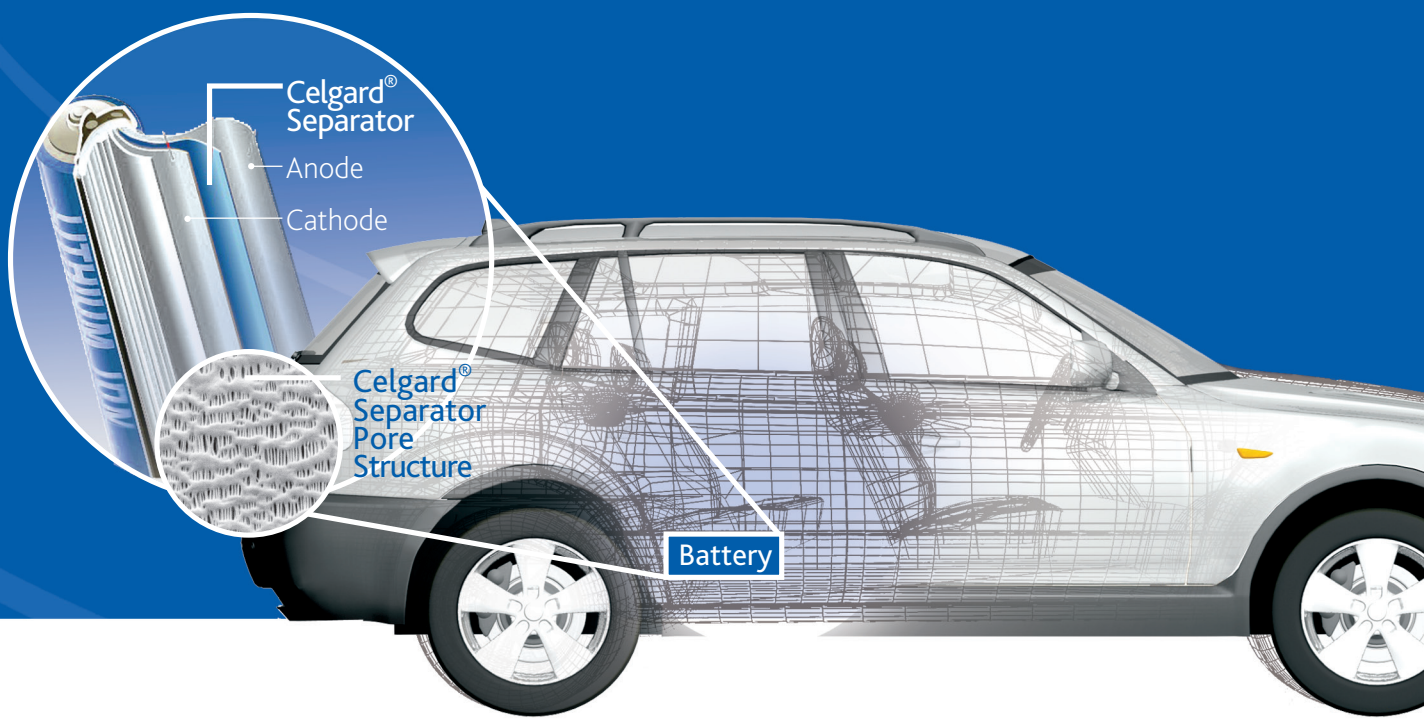
The decision to license its technology will benefit the environment, further reduce oil dependency in the future, and create renewal technology jobs around the world.

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Surging forward

Next year will mark 25 years since Maccor was formed, and in a short period of time the battery development supplier has come a long way



Maccor designs all of its own hardware and software systems

A pioneer of the modern battery test industry, Maccor started operations in Tulsa, Oklahoma, in 1986, as a company dedicated to the development of high-performance battery test systems. With a nucleus of engineers experienced in emerging battery technologies and computer control systems, Maccor has experienced continued growth. As a result, the company has come a long way in a short time.

In the past, the only commercial products capable of evaluating battery performance were designed and built specifically for lead-acid vehicle battery applications. These were high power units without a great deal of accuracy. They had limited test programming capabilities and collected data slowly. In the mid-1980s, when there was resurgence in new battery systems, it became obvious that the then battery test systems were inadequate.

The founders of Maccor conceived an entirely different design for a battery test system. The result was a system that provided extremely accurate results, collected test data at high speed, and would test large numbers of batteries at the same time. The system could also be programmed to perform virtually any test sequence required.

Over the last twenty-two years, Maccor's innovative technology has enabled the supplier to become the standard for most of the companies involved in the research, development, and quality control of cells and batteries for a wide range of products and cell chemistries. This solid foundation provides Maccor engineers with the knowledge, experience, and resources for the future.

Today, Maccor has earned a greater than 80% share of US business in its product area, and the organization has a growing share of both the European and Asian markets.

With nearly 1,500 systems in regular operation in over 40 countries (which includes the first system ever built), there is no doubt that Maccor is a leader in the battery test industry.

Maccor designs all of its own hardware and software – and this is an ongoing process. Most systems are customized to meet a client's specific requirements, and from time-to-time customers also request specific features in the software. Over the years, this has provided Maccor engineers with a wealth of knowledge and experience in the design and performance of these systems.

This experience is being used to develop systems for the future with even higher levels of performance, and additional features and capabilities that utilize new computer technology. For this type of equipment, Maccor is confident that it offers the widest range of features and capabilities of any manufacturer. And, if the company's standard equipment does not meet the customer's exact needs, then Maccor engineers will customize the equipment to specific requirements.

In 2009 Maccor moved to a newer and larger facility due to increased demand. This new facility is capable of handling the present manufacturing demand as well as having room to expand should it need to handle any increase in demand in the future.

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Le Mans flywheel showcase

The 2011 Le Mans 24-Hour race will feature its first flywheel hybrid vehicle, and the system integration gives a glimpse of the future for road cars

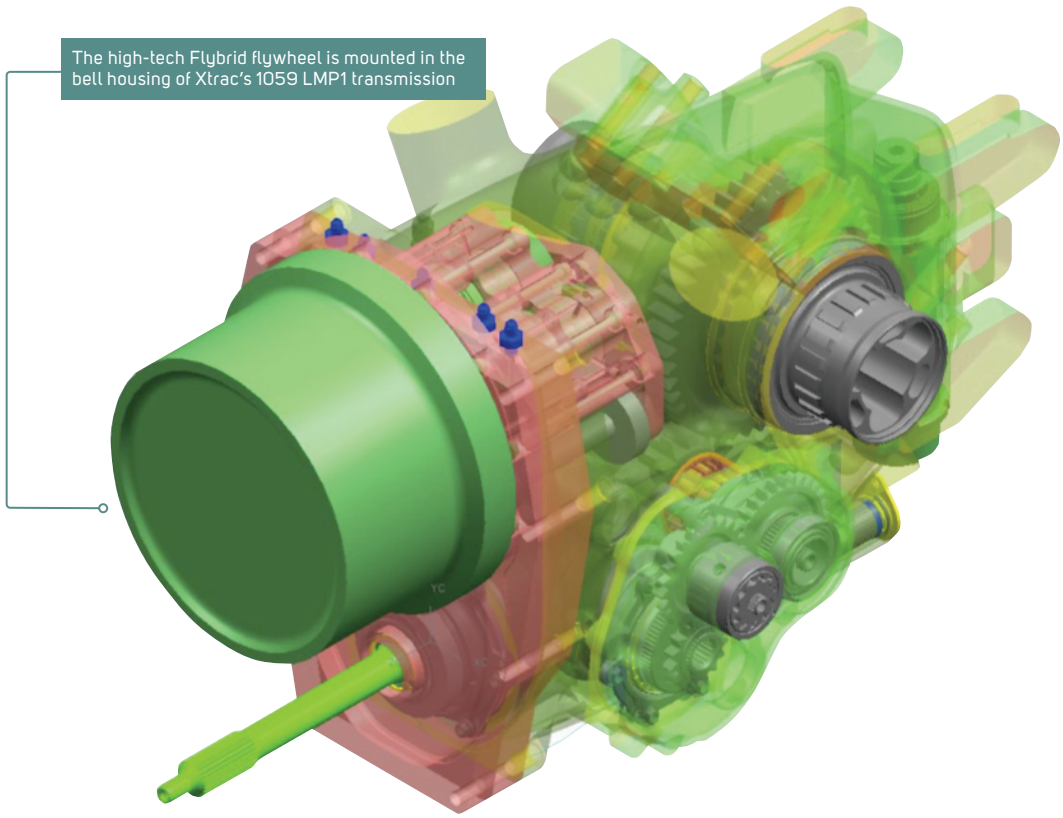
Le Mans is renowned the world over as a testing ground for the latest automotive ideas. Covering well over 5,000km with no rest, the top class LMP1 cars showcase the highest level of sports car technology that will soon be filtering down to road cars. This will be particularly true in 2011 as race organizers allow flywheel hybrid cars entry for the first time.

To take up this challenge, flywheel hybrid specialists, Flybrid Systems, will be developing an all-new hybrid unit that has been specially designed to fit inside the bell-housing of the new Xtrac 1059 gearbox, which will be used by the team. Xtrac have specifically developed this gearbox to enable customers to benefit from the latest Le Mans rules, as Xtrac's technical director Adrian Moore explains:

"We have been supplying gearboxes to Le Mans competitors for almost 20 years, and with the latest regulations and our close relationship with Flybrid Systems, we are really excited about this new project as a way of demonstrating innovation in a truly grueling but very public environment."

Le Mans regulations call for the car to be a full hybrid with storage and release of power from the system automatically controlled by an onboard computer. The car must also demonstrate the capability to drive the length of the Le Mans pit lane under stored energy alone with the engine turned off.

The system specification is 100kW maximum power in either storage or release and 600kJ of stored energy. The energy will be stored in a high-speed flywheel spinning at up to 60,000rpm and the energy store will be cycled from high to low charge five times each lap. The whole system – including the associated hydraulics and control unit – weighs just 25 kg.



The high-tech Flybrid flywheel is mounted in the bell housing of Xtrac's 1059 LMP1 transmission

The location of the system with its drive connection on the input shaft of the gearbox gives the best combination of hybrid functionality and small packaging space. With this connection, it is possible to charge the flywheel from the vehicle's kinetic energy when it is braking; to charge the flywheel from the engine when the car is driving or stationary; to drive the vehicle from the flywheel with the engine running or turned off; and to restart the engine using energy from the flywheel. The connection to an engine speed shaft also minimizes the number of additional gears needed between the flywheel and the wheels of the car, thereby reducing size, weight, and cost.

According to Jon Hilton, managing partner at Flybrid Systems, the integration of the hybrid unit within the gearbox of the LMP1 car is something that Flybrid Systems see as a longer-term direction for road cars. "Many OEMs are looking for an easy-to-fit hybrid solution that can be applied to existing model cars with minimum disruption to expensive tooled components. This often rules out the gearbox-connected option for flywheel hybrid systems in the short term, but we think this will change as they decide to include the technology on every car they make and really start pushing for lower costs."

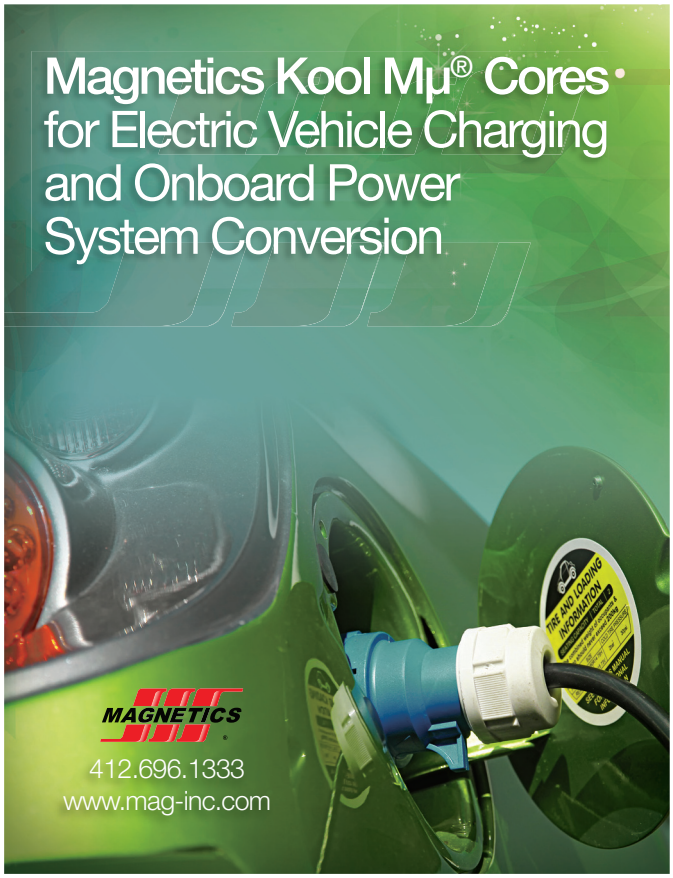
The gearbox-integrated solution promises to be around 70% of the cost of a rear differential-mounted Flybrid solution and would be a great compliment to a heavily downsized engine given the high power capability of the system.

CONTACT

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Heavy-load booster

A booster support technology promises to cut the main battery capacity level of next-generation electric vehicles by 50%

A new heavy-load booster support function for the engine-generator set has been developed and it will make a large reduction in battery capacity. In addition, the booster support function increases fuel economy of a vehicle, reduces battery pack size, and extends the utilization lifespan of the battery pack. As a result of all this, the long-term utilization cost of the electric vehicle will be reduced.

An important benefit for the booster-support function is that it could be integrated into many different types of powertrains, as illustrated in Figure 1. The other important feature of the booster-support system is the battery preventive operation, which, under highly demanding driving such as acceleration or climbing, enables the system controller to detect the output current of the motor and to kick-in the heavy-load support system. Such a setup enables the system to relay the power from the engine-generator set and to the motor directly, reducing the loading current of the battery. Integration of the heavy-load booster support capability into current PHEV/REEV and SHEV powertrains could further reduce battery capacity by 50%. This would lower the total vehicle cost and battery-replacement cost in the future.

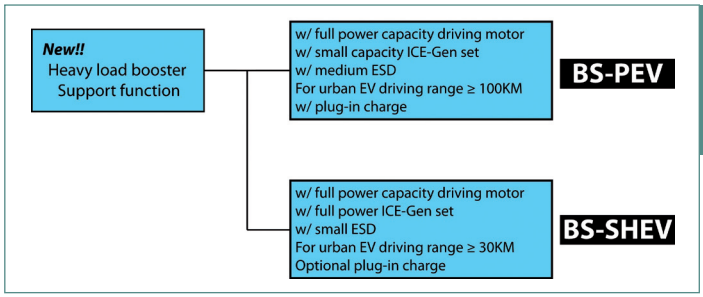


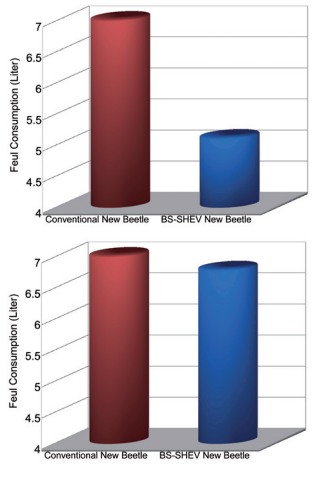
Figure 1 (left): The many varied applications of BS-xxEV technology

In addition, the heavy-load booster support system also has the capacity to regulate the engine and generator so it operates within its optimal efficiency region. Furthermore, the controller continuously monitors the output current and SOC value of the battery pack after the vehicle has started. By integrating these extensive technologies, the fuel economy/cost ratio of booster-support systems will be superior to conventional IC engine vehicle, PHEVM/REEV, and SHEV.

Figure 5 and Figure 6 illustrate the evaluation of fuel economy, with the booster-support system being simulated on a new Beetle platform. As part of this trial, the vehicle starts the 100km driving range (FTP75*6) with a fully-charged (90% start SOC) and half-charged (50% start SOC) battery.

Under the fully charged starting scenario, the system achieved 27% fuel economy, as shown in Figure 5. With the half-charged battery, the vehicle achieved 3% fuel economy, but with the battery fully charged more than 90% was achieved, as illustrated in Figure 4.

Figures 5 and 6 (below): BS-SHEV has improved fuel economy levels



The advantage of the booster-support system is highlighted in Figure 3 and Figure 4, which show that the operating window of SOC is 15% of battery capacity, which suggests the battery is operational in a region that prolongs its life with further possibilities for overall capacity reduction.

Figure 2: Such is its design, that the BS-xxEV improves fuel economy

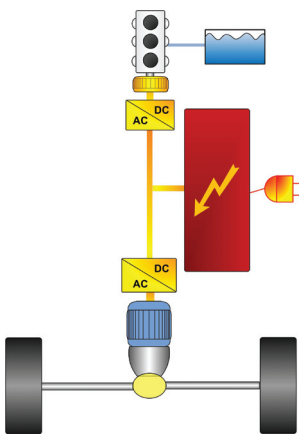


Figure 3

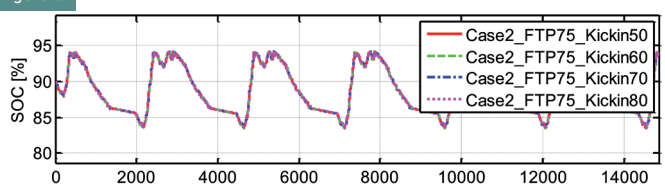


Figure 4

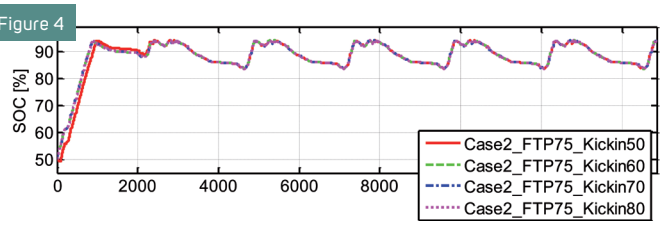


Figure 3: The SOC time chart during validation highlights another benefit
Figure 4: With a SOC window of 15%, the BS-xxEV reduces battery size

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Overcoming range anxiety

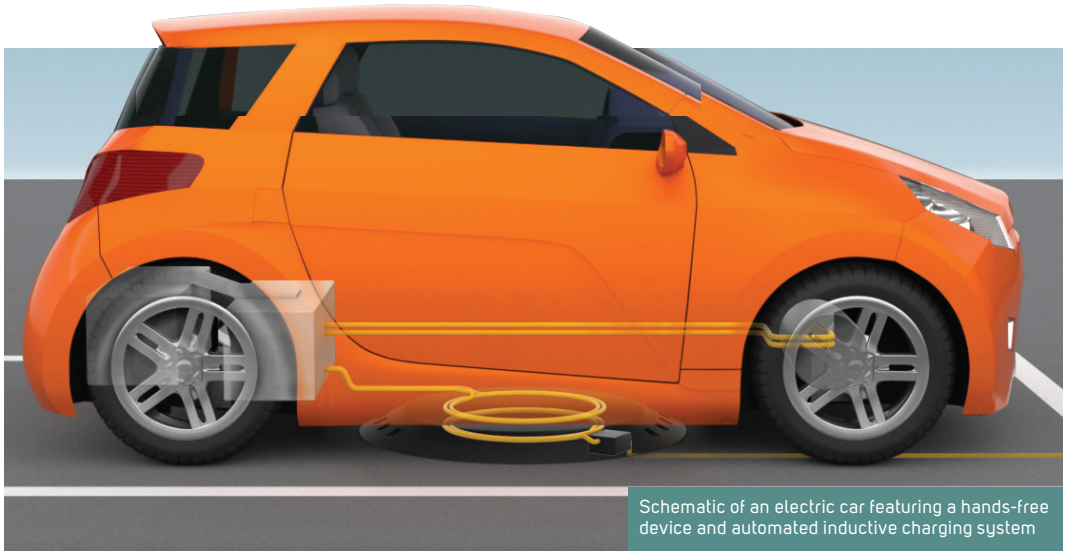
An innovative wireless recharging system is making major inroads in the EV sector by claiming to be better than plug-in solutions

One of the big concerns regarding electric mobility is the driving range of electric vehicles. In fact, such range requirements will be a key driver for the overall efficiency and weight optimization of electric vehicles. Today, hybrids are seen as an option to overcome range limits. But that is only possible at the cost of having two technologies on board: an IC engine and an electric motor. As a result, the full extent of the benefits of hybrid vehicles is arguable.

First, vehicle manufacturers are speaking about efficiency improvements of up to 30%. However, in real life conditions the energy saving is likely to be less than 30%, depending on the operation mode and the driver. Second, the efficiency of a diesel vehicle is quite low to start with, somewhere slightly more than 30% efficiency in best cases. A maximum efficiency improvement of 30% on a vehicle only 30% efficient is not as meaningful as it seems. Finally, local emissions are still an issue.



A bus stop in Turin, Italy, with IPT Charge



Schematic of an electric car featuring a hands-free device and automated inductive charging system

The growth of the world population and the increasing trend toward urbanization will make clean, efficient, and affordable urban transportation a must. As a result, hybrids seem to be a logical technology, but for the price of a complex drive system that emits emissions, one has to ask why not go straight to fully electric drive?

Batteries and capacitors are the technologies discussed today, and flywheels are seen as a third alternative. Yet even with the huge progressive steps that battery technology has made in recent years, aspects such as charging time, energy storage capability, and cost reduction remain an issue.

In 2002, Conductix-Wampfler enhanced a range of electric buses in Italy by adding inductive power transfer (IPT) to the bus fleet operations. IPT enables recharging power on a wireless basis in the vehicles, safely and automatically, without any intervention of personnel. The driving range is more than doubled and therefore the number of vehicles limited; and no battery swapping, or other similar measures, are necessary to keep the buses in operation throughout a full day of operation. Conductix-Wampfler engineers declare that a plugging solution is not feasible, as plugging needs active manipulation of a plug, requiring time and also bringing up safety concerns.

IPT achieves automatic charging and is invisible to the public. Driving the bus over charging coils that are integrated in the road surface is the main requirement to charge the application. The rest is done by IPT transferring power wirelessly into the vehicle. The localized magnetic field responsible for the power transfer is canalized so that no unwished stray field is emitted.

A bus in service runs over 90% of the time, cars are immobile roughly during the same amount of time. So, why is IPT also an ideal solution here? Trials of the Mini E have shown that a plug connection is made on average every 2.8 days. Engineers can assume that batteries are re-charged most of the time when they are in a low state of charge. Each of these batteries face a full charging cycle, and because full charging cycles decrease the lifetime of most batteries, only a very limited number of re-charging cycles is possible with most battery types.

IPT eliminates these problems and other issues surrounding energy grip capacity, cable handling and charging stations. Conductix-Wampfler and Daimler are conducting a pilot trial, initiated by the German Federal Ministry of Environment, as a first step in proving the suitability of IPT for personal transportation. The public transportation systems running in Italy, Japan and the USA are examples of IPT milestones already used in transportation.

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Salt battery upgrade

Introducing a new joint venture between two leading companies that will bring to market new and innovative battery systems

In just a short space of time, FZ SoNick has established itself as a leader in the production of salt batteries, an advanced technology for electric motors that not only provides back-up of energy to the system, but also offers the maximum amount of performance when it comes to extracting real energy from renewable sources.

FZ SoNick recently signed a strategic partnership that focuses on clean energy development with the FIAMM Group and MES-DEA, a Swiss-based company that specializes in the production of sodium-nickel-chloride batteries for electric vehicles.

The agreement, which will lead to the formation of a new joint-venture company, has become active in February 2010. The company's headquarters are in Stabio, Switzerland, where MES-DEA operated a factory that housed 190 employees. The new company's production capacity from next year will be 90MWh per year, but this figure will increase to 170MWh per year in the next five years, with the turnover being around US$120 million during the same period.

In conjunction with this, a production operation will also commence in Italy for assembling and charging the battery systems developed in Switzerland, which have been assigned to the Telecom and UPS sector.

The new joint-venture company brings together expertise from FIAMM Group and MES-DEA, all of which results in realizing many advantages, especially when it comes to the further development of ZEBRA battery technology, a sustainable solution that will help power tomorrow's environmentally friendly vehicles.



The salt-based ZEBRA batteries are currently used in European electric buses

FZ SoNick is helping to marry the important technical inroads achieved by MES-DEA with the strong penetration of FIAMM in the energy storage markets. As a result, FZ SoNick estimates that significant results will be achieved in terms of product quality and profitability in only a short time.

Through innovation, experience, and knowledge of the market's requirements, FZ SoNick is confident that the new joint venture will be an absolute success. The industrial plan of FZ SoNick has been structured so that it offers optimum technical solutions in the generation and distribution of energy produced from renewable sources to a variety of sectors.

The salt-based batteries made in Switzerland, and sold with the ZEBRA SoNick brand, are currently used in electric buses operating in several cities across Europe and the USA. There's also a growing need for this ZEBRA technology to be applied to the automotive industry to power vehicles. For example, the first European fleet of electric vehicles assigned to the postal service in France will be equipped with ZEBRA-Sonick batteries. In addition, the ZEBRA technology can also be applied to the aviation and railway industries.

FZ SoNick is confident the five-year project has great potential, especially as salt batteries are a technology that offers considerable benefits in ecological terms, including very low environmental impact, zero emissions, high efficiency, a long service life, high specific energy levels, and low cost of the raw materials.

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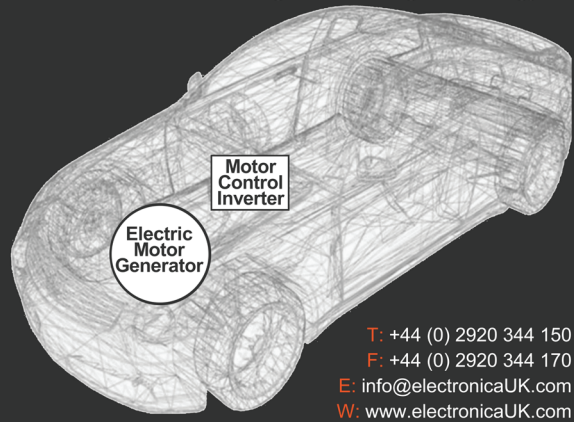
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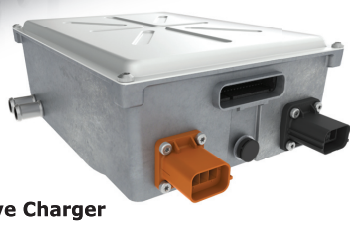
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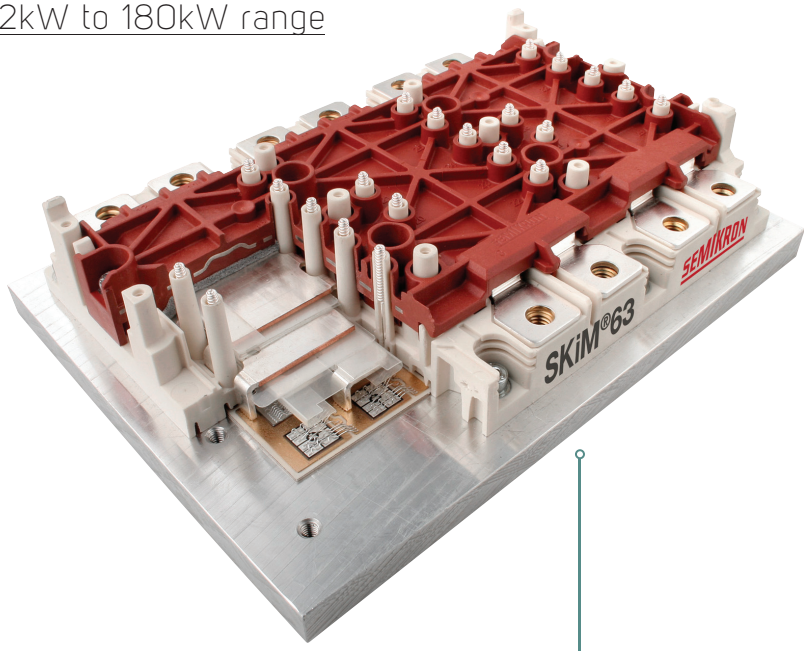


Figure 1: The solder-free SKiM module without base plate. The removal of solder joints eliminates solder fatigue, a common failure mechanism in power modules. In addition to this, the removal of the base plate also eliminates a large proportion of the thermal stresses, thus improving efficiency levels

In hybrid and electric vehicle powertrains, power inverters are exposed to considerable temperature swings that are caused by ambient conditions (passive temperature cycle) and by temperature due to the operation of the module (active temperature cycles). The operation temperatures limit the output power and reduce the service life of the power converter.

As a result, steps must be taken to ensure that power modules used in hybrid and electric vehicles are able to meet typical application requirements, such as being able to withstand more than three million active thermal cycles. Regarding the future development of hybrid and electric vehicles, semiconductor technology reliability is a key quality factor.

Sintered modules with no base plate offer a series of possibilities for boosting the temperature cycling reliability of inverters in hybrid and electric vehicles. The disadvantages of solder connections and expansion caused by the base plate are eliminated. The optimized chip layout ensures lower and more homogenous operating temperatures of the semiconductors inside the power module. This means in service life calculations, all three phases can be considered to have equal operating temperatures, facilitating more reliable life time predictions.

The reliability of the inverter, even under considerable active and passive temperature swings, is clearly improved. Testimony to this are the many different applications for sintered modules without a base plate, such as in electric powertrains in certain vehicles, as well as for harsher applications like racing cars.

SKiM, the three-phase IGBT module for DC/AC and AC/DC inverters in electric and hybrid vehicles, has a passive temperature cycling capability fifteen times higher than standard soldered modules. These modules have also been tested at levels beyond industrial test conditions and the results have shown that they are highly resistant to ambient temperature changes, cooling changes, and operational effects.

Figure 2: SKiM, the three-phase IGBT module for DC/AC and AC/DC inverters in electric and hybrid vehicles, has a passive temperature cycling capability that's fifteen times higher than standard soldered modules



Sinter interconnects and the solder-free pressure contact technology ensures a 100% solder-free module, eliminating the solder failures that can occur at high temperatures. In addition, the pressure contact technology allows for low-inductance design of the internal bus bars, providing a 50% lower stray inductance compared with other six-pack devices. The inductivity of the DC-buses in the inverter leads to a reduction of voltage overshoots during switching operation. The safe operation area is expanded, and by exploiting higher DC-voltages, the customer can increase the power output of his system by up to 30%.

SKiM modules are characterized by proven mechanical stability at levels above standard industrial test conditions, reaching 10*g* compared with the industrial standard of 5*g* in the vibration test, and 100*g* compared with the industrial standard of 50*g* in the shock test. The total resistance is 0.3 milliohms compared with a typical industrial level of 1.1 milliohms. SKiM withstands stringent requirements for endurance during high acceleration and vibration stress.

SKiM modules are assembled quickly and easily onto the heat sink using screws. The modules are supplied with pre-applied thermal paste to ensure homogenous thickness of the paste. Power boards are assembled without any solder steps using spring contact technology. The combination of these packaging and connection technologies results in a cost-efficient and time-saving inverter assembly process.

SKiM 63 and SKiM 93 modules are available with blocking voltages of 600V, 1,200V and 1,700V and currents from 300A to 900A. Two case sizes are available: SKiM 63 measuring 120 x 160mm² and SKiM 93 measuring 150 x 160mm².

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Advanced Li-ion batteries

The Ford Transit Connect Electric, featuring battery packs from Johnson Controls-Saft, is due to be launched in the USA and Europe



The Johnson Controls-Saft battery consists of 192 high-power 41Ah cells. The 28kWh system provides the Ford Transic Connect Electric with a 130km range

In the future, vehicles must use less fuel, and indeed one day manage completely without fuels based on petroleum, to minimize CO_2 emissions and protect the climate. Together with US-based Azure Dynamics, Ford will launch the Ford Transit Connect Electric, powered by Johnson Controls-Saft's high-tech lithium-ion batteries.

"Key characteristics of this energy-storage solution are driving pleasure in electric mode for 130km, a design life of more than ten years, and a special safety design," explains hybrid sales director at Johnson Controls-Saft, Stefan Suckow.

The Ford Transit Connect Electric is scheduled to be launched in the USA later in 2010. The light commercial electric vehicle will also come on the road in Europe in 2011.

The battery comes from Johnson Controls-Saft, one of the first companies in the world to produce lithium-ion batteries for mass-production hybrid vehicles. Engineers at integration centers in Milwaukee, USA, and Hanover, Germany, have jointly developed and tested the battery system, which is being produced and assembled in Holland, Michigan.

The actual battery is under the floor of the vehicle and consists of 192 high-power 41Ah cells. The 28kWh battery system provides the Ford Transit Connect Electric energy to travel up to 130km on a single charge.

The battery system can be easily recharged overnight using traditional household power outlets. The battery has been designed to deliver more than 3,000 charge/discharge cycles (equivalent to more than 300,000km). A liquid cooling system keeps the cells at an operating temperature to ensure a 10-year design life.

To enable safe vehicle operation, designers have provided redundant safety features from software control to the design of the cell. The battery management system connects to the vehicle safety management system. In the event of a vehicle accident, the battery is immediately switched off and isolated from the vehicle.

Recognition of this advanced technology came recently when Johnson Controls-Saft was awarded second place in the 'supplier innovation' category for this energy storage solution in the ÖkoGlobe awards, an international environmental prize for the global automotive industry.

"This recognition illustrates our commitment to sustainable products that allow us to use less fuel, minimize CO_2 emissions and protect the climate," states Suckow.

The judges cited driving pleasure in electric mode for 130km, a design life of more than ten years, and a special safety design.



Ford's light commercial electric vehicle will be launched next year

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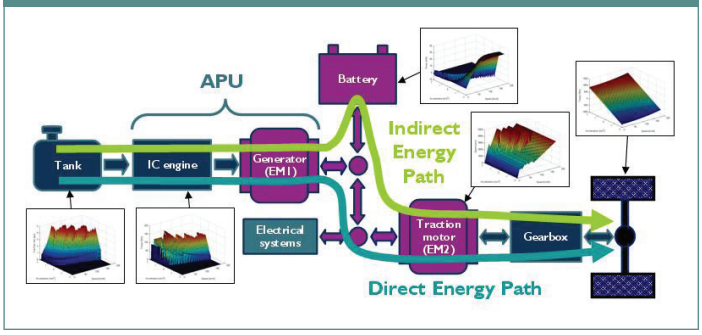
Range extender evolution

Defining the most efficient control for range extender hybrid vehicles has now been made much clearer

Range extender hybrid vehicles (REHVs) show real potential as the next-generation of HEVs, bridging the gap between existing conventional hybrids and pure EVs and offering an excellent combination of economy and range. To be successful, the auxiliary power unit (APU) sizing and its control are fundamental to the final efficiency of the vehicle. There are a high number of variables that must be considered in the APU integration, such as the matching of the engine and generator to ensure best total APU efficiency; ensuring sustained high-speed cruising ability; and tailoring the APU control strategy for efficiency, drivability, and battery durability.

Romax Technology in the UK has developed an advanced optimization technique for REHV APUs using its RomaxEVision simulation suite. RomaxEVision has been developed by Romax since 2006 to address the complexity of hybrid vehicle design, providing more insight into energy flow, and allowing optimization for efficiency. RomaxEVision incorporates Romax Optimizer for rapid optimization of driveline layout, component design and control strategy, as well as energy flow analysis, which offers maximum insight and understanding into the detailed operation and loss mechanisms within a hybrid driveline.

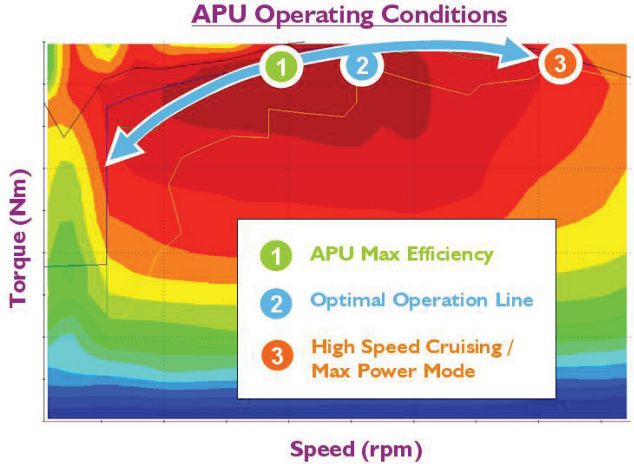
Romax has developed an advanced optimization technique for REHV APUs



The conventional approach for REHVs is to run the vehicle as a pure EV initially and then activate the APU at a specified battery SOC level. When analyzing APU control there are two aspects to the problem: from the perspective of the APU, the engineer needs to decide whether to operate at peak APU efficiency (which is defined as APU-MAX) and increase to higher power when required; or to operate continuously along the optimal operation line.

There is also the choice of which route the energy should take to the wheels, either directly from the APU generator to the E-Machine, or via the battery. For example, at low-speed cruise the APU may be at APU-MAX so it's powering the vehicle and recharging the battery.

In the case of a transient power demand greater than that produced at APU-MAX, the choice is either to increase APU power and reduce generation efficiency, or supplement the APU with battery power and reduce propulsion path efficiency (bearing in mind that the APU will need to recharge the battery later). The Romax Optimizer software can calculate the most efficient combination of these two variables for any vehicle condition on an instant basis.



Romax Optimizer software can calculate the most efficient energy combination

The next stage is to define additional time-based parameters, such as acceptable APU start/stop hysteresis, battery charge/discharge rate, and maximum SOC under range-extender driving conditions. By overlaying rule-based control to the optimized strategy, the result is a highly efficient, robust and driveable hybrid vehicle application. As a company, Romax will also consider including additional energy storage devices – such as super-capacitors – in the process and will compare driveline performance levels of the total combined APU and battery system with a real-world mix of drive cycles to ensure complete system optimization in terms of both the hardware selection and the control strategy.

Romax has already applied this process to customer projects, and, as well as yielding excellent technical results, customers have also been impressed by the time required to perform the analysis. As a result, Romax will be able to solve such problems far more quickly than a conventional time-based vehicle simulation approach would allow. Romax's hybrid and electric vehicle design expertise, in conjunction with its leading design tools and processes, means that Romax can support hybrid vehicle designers in achieving the best possible efficiency.

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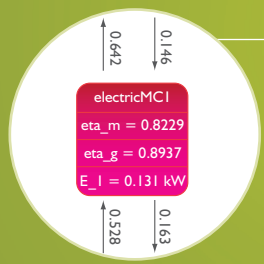
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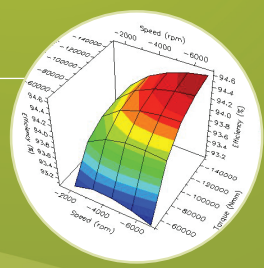


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Integrated BLDC motor with electrical control system, interface: CAN

New thermal systems

A high-tech supplier has developed and integrated thermal-management systems for a new generation of environmentally-friendly powertrains

The next generation of advanced powertrains – IC engines, EVs and HEVs – requires greater thermal-management flow control and efficiencies than previous generations.

Thermal management systems and components, such as pumps, valves and connectors, have the potential to dramatically influence vehicle performance.

These components enable car makers to more easily design fuel-efficient vehicles, without them many of the requirements and benefits of these eco-friendly vehicles could not be fully realized.

As one of the world's largest full-service suppliers of thermal-management components and systems, Cooper Standard develops and manufactures complete customer-specific solutions for today's complex automotive powertrain and performance requirements.

Cooper Standard provides heating and cooling management systems and components for IC engines, EVs, and HEVs and offers a unique expertise in its ability to both design and manufacture key components, including pumps, valves, battery manifolds, thermostats, and connectors to create integrated solutions that improve vehicle performance and occupant comfort levels.



The Quick Connect unit from Cooper Standard with integrated sensor technology

Cooper Standard has developed a variety of new products and systems to address the technology needs that result from advanced propulsion vehicles. This includes a family of brushless pumps with varying levels of flow, low current draw, and a communication method to best manage modern vehicle architectures from battery-cooling loop through to passenger-cabin comfort.

In addition, Cooper Standard has developed three-way and four-way valves, and electronic thermostats to help divert coolant to maximize thermal efficiencies within a vehicle system. This includes (but is not limited to) coolant diversion for engine warm-up, as well as fluid management for battery cooling and hybrid systems.

Furthermore, Cooper Standard specializes in joint technologies to ensure leak-free connections. One prime example of the company operating in this area is its innovative connection technology is the company's Quick Connect with sensor technology. This next-generation connector integrates proven sensor technology into the body of a patented connector to monitor temperature and/or pressure, eliminating the need for secondary components and processes to the systems, which helps reduce complexity, leak paths and weight.

Finally, Cooper Standard's battery cooling manifolds enable the latest battery innovations to perform at the highest level of efficiency by controlling the ambient temperature.

Cooper Standard can provide several components for advanced propulsion vehicles, however the greatest benefit is the company's ability to integrate thermal-management components into functioning systems for both traditional and new propulsion systems. Cooper Standard offers the ability to integrate traditional thermal management systems with newer, complex systems, which will be critical as these systems evolve to become part of mainstream production vehicles.

As a solutions provider, Cooper Standard's focus is on integrating current products and systems with innovations that are often unseen, but critical for next-generation vehicle development. Its ability to design, manufacture, assemble and test – using structured engineering disciplines, such as DFSS and Taguchi – is why customers look to Cooper Standard for advanced thermal management solutions.

Cooper Standard's four-way valve





The new family of brushless pumps feature varying levels of flow, low current draw and an advanced communication method to best manage modern vehicle architectures

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Cell manufacturing safety

A look at one leading supplier's launch of a new and high-tech formation process that optimizes large format lithium cell manufacturing

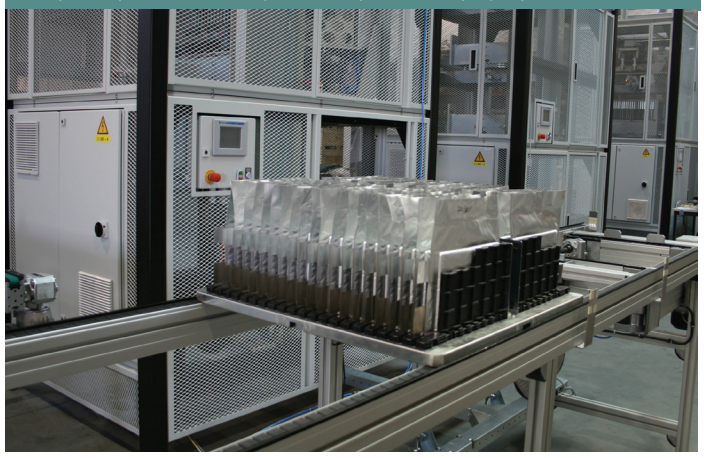
PEC delivers the key building blocks for the development and manufacturing of advanced energy and power cells. This includes cell and battery test equipment, automated cell finishing lines, and in-line test equipment.

For its cell finishing lines, PEC covers all technologies in-house, from right after electrolyte filling to assembly as well as aspects such as final testing of the battery pack.

Cell handling, initial testing, formation, degassing, aging, grading, and sorting are all integrated into one turnkey production system using an automated storage and retrieval system (ASRS) for material handling. Such impressive capacity means that PEC offers well-known formation and grading electronics at the heart of the process.

The system is managed by a manufacturing execution system that routes the cells through the line, controls the material handling equipment, guarantees individual cell traceability, and presents management with accurate, real-time reports.

Typical systems will hold thousands of cells at various steps in the process and at different states of charge. Therefore safety is an important factor when considering the automation of these lines, with many of the lithium chemistries posing a considerable risk to factories, equipment, and operators in case of thermal runaways or electrolyte leakage.



An input/output machine swings into full operation, helping to produce new cells



PEC Formation Towers enhance safety levels when it comes to cell manufacturing

PEC has designed its new 2011 formation towers to deal with these hazards. The formation stations are equipped with several features to withstand catastrophic and non-catastrophic cell failures, all without requiring additional fire suppression or flushing gasses, such as Argonite or CO_2.

Each formation station has a sectional door at the front side. The door is opened by the onboard controls for loading and unloading the cells by the ASRS. During normal operation mode, the doors remain closed to prevent propagation of fire and smoke outside the formation station in case of a cell failure.

All new formation towers come equipped with this technology, as well as integrating several other features: accurate temperature conditioning (cooling and heating); accurate cell grading; automated cell connection; individual channel control; individual cell monitoring; and early warning systems for cell failure detection.

The PEC cell finishing lines are designed to full building height by installing the formation towers on different mezzanine levels accessible by the ASRS.

The advantage of this approach is to create a compact footprint for the complete cell finishing area, but without compromising on safety.

PEC offers these cell finishing lines for different cell types such as pouch, cylindrical, and prismatic.

PEC designs, manufactures, and supports its solutions from several locations across the globe, including Belgium, Hungary, the USA, China and Japan.

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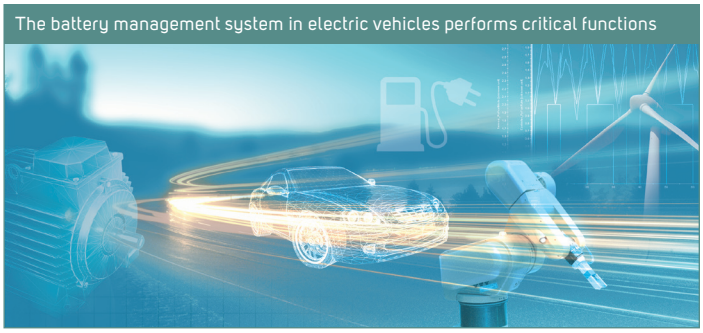
Intertek

Developing a BMS

Advanced battery management systems continue to play a critical role in the development of next-generation electric vehicles

Battery performance is the core metric of success for a new breed of automotive products that includes EVs, HEVs and PHEVs. This demand on battery performance is stimulating the R&D of complex battery management systems (BMS) and driving strategies to deliver on the goals of range, battery life, efficiency and safety levels.

BMS, in these vehicles, performs a critical function of managing battery performance, maintaining health of the individual cells and the pack, providing onboard diagnostic information, interfacing with the vehicle drivetrain system, monitoring and ensuring safety aspects and overall power flow through the battery. Developing such complex functionality requires sophisticated tools to provide realistic real-time simulation of desired and undesired behaviors of the battery cells, modules and the pack. To make this development process faster, an easy programmable real-time platform emulating a battery, vehicle electrical and mechanical systems, environment and a battery controller is necessary.



The battery management system in electric vehicles performs critical functions

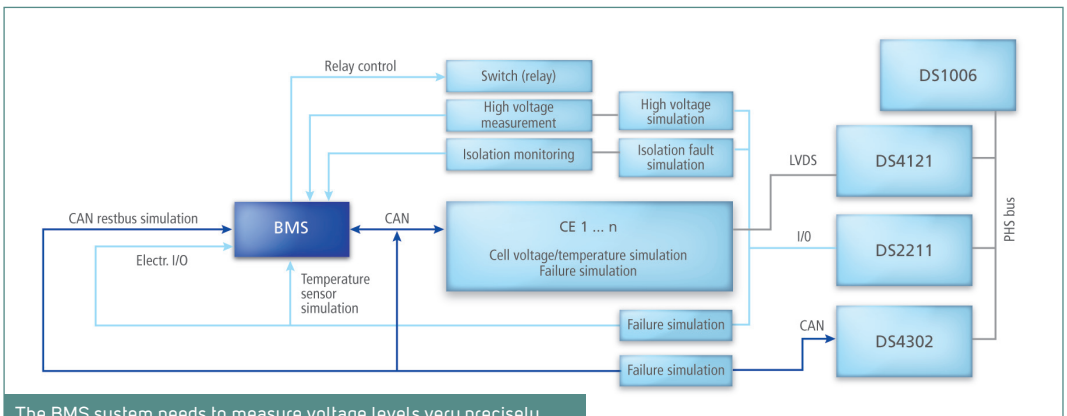
The core of the BMS system development solution is real-time battery cell simulation model and electronics hardware to emulate electrical behavior. It is known that at nearly any state of charge (SOC) the battery cell voltage varies within a narrow range. The BMS system is therefore required to measure this voltage very precisely to determine the SOC of independent cells. In the development process of the BMS, it is necessary to have capability to simulate these voltages with even more precision and accuracy. Without such capability, engineers have to rely on actual components that limit the ability to control them precisely, and to test and validate control strategies in an effective manner, passing over the entire expected working range and error conditions. A precision, calibrated, digitally-controlled voltage source that replaces the physical lithium-ion battery cell is required to meet such needs.

In the early development stages, engineers require rapid prototyping controllers that are easily programmable in environments such as Simulink and provide necessary IO and communication channels such as CAN. Flexibility to use systems in vehicles and in the lab helps quickly engineers to take their algorithms to the vehicle validation.

As the BMS algorithm matures, engineers can rely on the industry standard technology for auto code generation to translate the graphically represented algorithms to a target deployable c-code. Automotive industry accepted solutions would be IEC61508 and ISO26262 certified and will provide both consistent and high-quality production code.

As a further step in BMS development, testing of BMS controller performance, and diagnostic algorithms is critical for production release. This testing involves testing for normal and abnormal conditions that the battery system will be likely to face in the real environment. Hardware-in-the-Loop (HIL) systems are the leading solution used for validation of individual vehicle controllers for drivetrain, safety, electrical components, and integration testing of vehicle platforms.

The software components for the HIL systems include plant models, virtual instrumentation, and experimental software. It is necessary to have real-time capable models for various electric components such as the battery, inverters and motors to validate BMS performance. Additionally, entire vehicle model with drivetrain components, driver and environmental conditions is required. The HIL test platform also supports testing for fault conditions in the simluated environment for onboard diagnostic (OBD) software validation and verification.



The BMS system needs to measure voltage levels very precisely

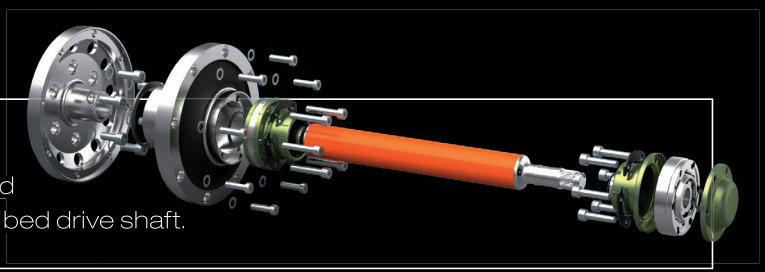
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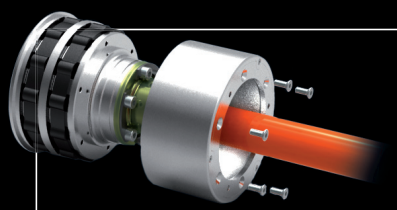
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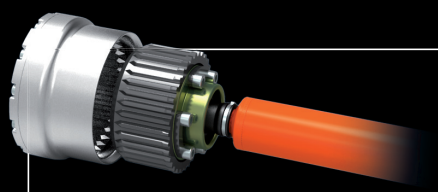
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Axial advancements

Participating in a ground breaking new project, Evo Electric is working on a new design of Axial Flux motor/generator technology

Evo Electric, along with partners Jaguar Land Rover, Lotus Engineering, Nissan, Think, Axeon, and Xtrac recently announced their participation in a US$32 million project to develop and implement advanced electric powertrains for range-extended vehicles (REEVs). The project, codenamed REEVolution, is part funded by the Technology Strategy Board, the Department of Business Innovation and Skills, and the Office of Low Emissions Vehicles in the UK. Among other things, the project will deliver new Jaguar, Lotus, and Nissan technology demonstrators with sub-50g/km CO_2 emissions. This feat represents a 75% reduction over a similar vehicle with a conventional powertrain.

Evo Electric's role in the consortium is to supply advanced electric motors and generators, thereby tapping into the company's expertise in Axial Flux machines. Discussing the joint venture, Dr Michael Lamperth, Evo Electric's CTO, says: "We need to deliver a small and light, yet extremely powerful, motor/generator in such a way that can be mass-produced reliably and at a cost."



From left to right: Tim O'Brien, low carbon vehicles innovation platform leader at TSB; the Rt Hon Philip Hammond MP and British Secretary of State for Transport; David Latimer, CEO of Evo Electric; and Michael Howell, non-exec chairman at Evo Electric

The new Lotus City Car concept with Evo range extender, drive motor and power electronics

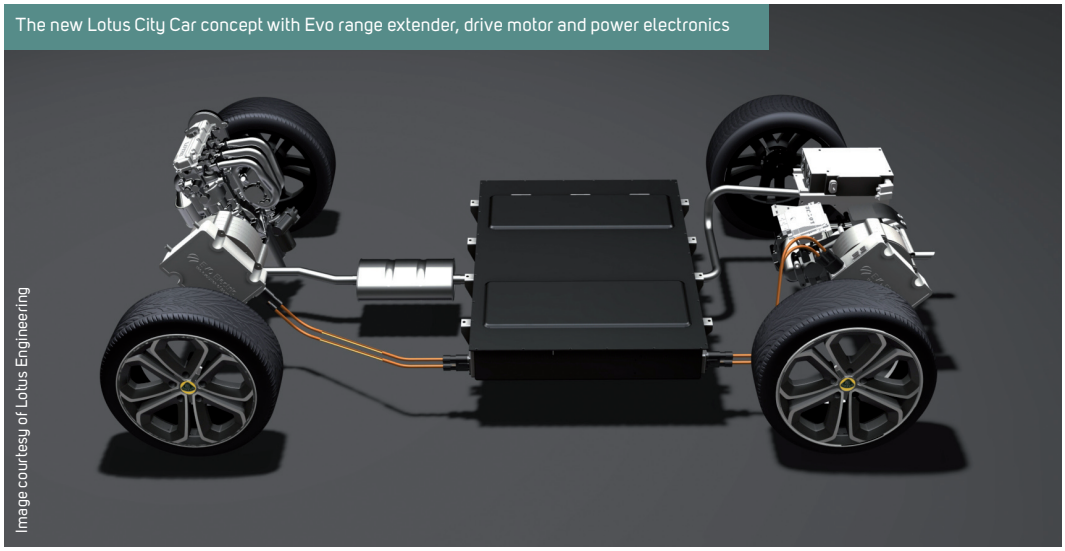


Image courtesy of Lotus Engineering

Evo Electric's Axial Flux motor/generator technology is already known to the industry. The company has demonstrated machines with leading power densities of 2.5kW/kg (5kW/kg peak) and torque densities of 6Nm/kg (16.5Nm/kg peak). When only active materials are measured, the machine's design can release upward of 3.9kW/kg (7.8kW/kg peak) and 9.4Nm/kg (25.8Nm/kg peak). What this means is that Evo Electric is able to pack more power and torque in a smaller and lighter envelope, which in turn facilitates innovative, highly efficient, and cost-effective approaches to vehicle electrification and hybridization. The very high power density also results in lower material usage, which in turn reduces the cost of the product to the end user. Another benefit is that, with a nominal speed of 4,000rpm and top speed of 8,000rpm, the range of the motor means it does not need a complex gearbox. Last but not least, the state-of-the-art permanent magnet technology offers efficiency exceeding 94% at nominal power.

Evo Electric will develop a new design for the REEVolution project, seeking to offer an ideal balance of performance and cost. The new model is basically a smaller version of Evo's flagship AFM-140 model – a 200kW machine that has already been deployed in a range of hybrid and electric vehicles. The smaller REEVolution motor will produce 50kW (100kW peak) and a peak torque of 320Nm in a compact volume of around 8 liters and weighing only 29kg (18kg for the active materials only). Its short length (110mm) and diameter (300mm) as well as its disc shape offer many advantages in terms of powertrain integration; the design is especially appropriate for building range extenders and extended electric drivetrains, such as the system developed by Lotus for its Evora 414E Hybrid; or compact powertrains, such as the one developed for Lotus's new City Car concept.

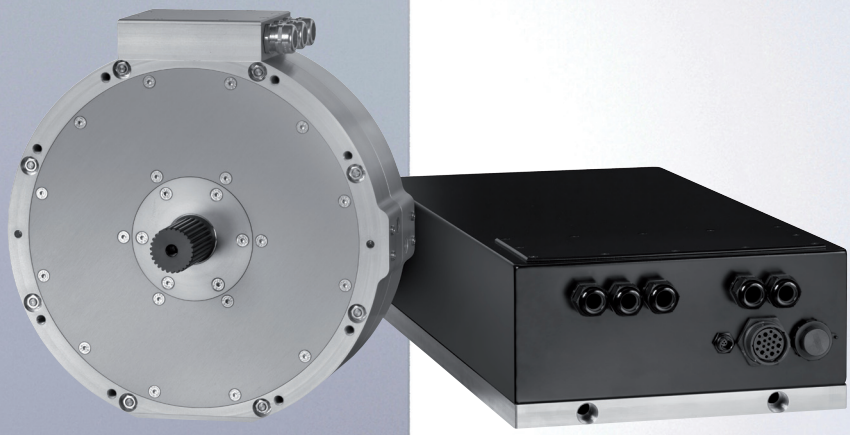
Lamperth concludes: "The REEVolution project is a highly strategic initiative for us. By working with leading automotive OEMs to develop advanced powertrain architectures, we'll gain invaluable experience and ensure that our technology meets our partners' specifications and the high quality and performance standards of the automotive industry."

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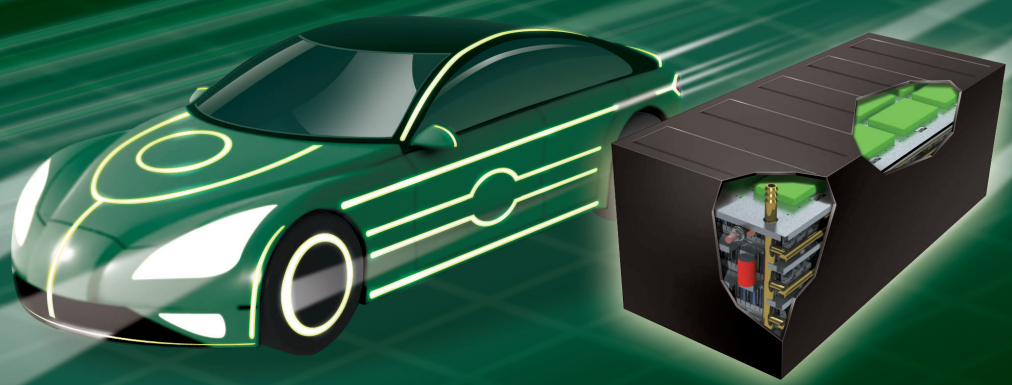
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Innovative batteries

In creating its next-generation vehicle, Microcab identified a need to change to Li-ion technology, and one leading supplier was on hand to deliver a breakthrough system



Above are the Mark 1 Microcabs at Birmingham University. LiFeBATT will be providing LiFePO4 technology and a CANbus Battery Integration System for the Mark 2 vehicles

As part of a study in 2008 by Birmingham University's School of Chemical Engineering into the viability of hydrogen in transport applications, Microcab Industries unveiled their Mark 1 fleet of hydrogen-powered Microcab vehicles. Powered by a hydrogen fuel cell, the vehicles were pollution free and were virtually silent.

Although still in their experimental phase, the vehicles were used to carry out real utility duties. This gave engineers a large amount of information on their operational efficiency and performance compared with that of the campus fleet of petrol, diesel, and pure electric vehicles. This helped establish how they could be adapted to make hydrogen a more attractive and cost-effective fuel for the future.

As part of the 2008 study, and in collaboration with the Royal Mail, one of the vehicles used for delivering post within the university was branded in Royal Mail colors.

Each vehicle was powered by a 1.2kW hydrogen fuel cell, which provided enough power for the low-speed and the intermittent drive cycle.

Although unsuitable for sustained use in hybrid configurations, the hybrid powertrain used standard lead-acid batteries providing adequate peak power for the electric drive motor and sufficient durability for the two-year project.

As a result of these studies, the next generation of Microcabs – the Mark 2 fleet – has been completely re-engineered to achieve higher levels of robustness, and performance.

Battery selection for the Mark 2 Microcabs included a need for greater energy storage than would be normal for a hybrid system. This gives the vehicle limited-duration high-speed capabilities during the relatively long start-up time of the 3kW high-temperature PEM fuel cell. This, together with such factors as weight and durability considerations, dictated a change to lithium-ion technology to provide 4kWh of stored energy.

With the critical battery parameter in the hybrid configuration being power density rather than energy density levels, LiFeBATT's LiFePO4 technology was the ideal choice to provide the necessary performance. It offers discharge rates up to 10C, peak power of 38kW for 10 seconds, 4kWh of usable energy to 100% depth of discharge, and up to 15kW of regenerative power.

Key factors in LiFeBATT's selection as supplier of the battery system included the company's ability to provide a complete battery pack and the availability of LiFeBATT's new CANbus Battery Integration System (CANBIS). The sophisticated J1939 (CANOpen) system enables full integration between fuel cell and vehicle ECU to maximize vehicle performance and efficiency. It's also designed to provide full cell management, including balancing and battery state of health, as well as state of charge functions over the CAN network. With a host of safety-critical functions looked after by the CANBIS, battery integration within the vehicle is made easy.

With the benefits of efficiency, safety, and UK-based technical support for system integration, LiFeBATT secured their valuable contribution to the newly improved Microcab.

In 2011, aided by LiFeBATT's technology and in collaboration with Coventry University, the Microcab Mark 2 fleet of vehicles will participate in a 12-month real-world trial on public roads as part of the Coventry & Birmingham Low Emission Demonstrator Project.

Commenting on such developments, LiFeBATT's CEO, Ian Goodman, says: "We are proud to be supplying such an innovative British company with the latest LiFePO4 battery technology. The CANBIS product offers adaptable solutions to the demands of meeting the duty cycles of an urban fuel cell hybrid."

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- Session 2: Verification of Safety, Life, and Reliability of Automotive Lithium-Ion Batteries
- Session 3: Large Lithium-Ion Batteries in Stationary and Specialty Applications

AABTAM SYMPOSIUM Advanced Automotive Battery Technology, Application and Market

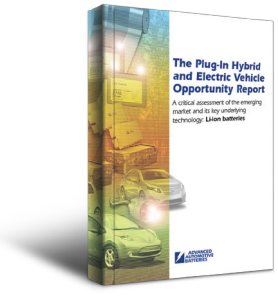
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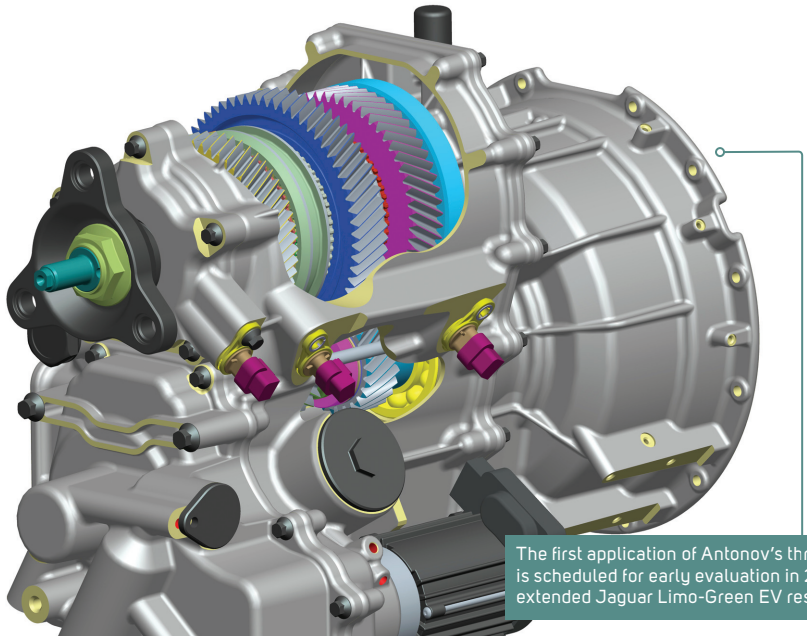
Gearing up for EVs

UK automatic transmission specialist Antonov has designed a high-efficiency powershift gearbox for improved range and performance in electric vehicles

With the trend toward the increased electrification of vehicles and the need for as much driveline efficiency as possible, UK-based automatic transmission specialist Antonov has designed an all new three-speed, powershift gearbox to improve range and performance in electric and hybrid vehicles. The high-efficiency transmission is scalable for virtually any torque application and is therefore suitable for a wide range of passenger cars and commercial vehicles. A number of bus and coach manufacturers have already expressed an interest.

The first application of Antonov's three-speed transmission is scheduled for early evaluation in 2011 in the range-extended Jaguar Limo-Green electric vehicle research project, which is part funded by the UK's Technology Strategy Board (TSB). The transmission could be developed as a four-speed gearbox with virtually the same packaging for further driveline efficiency. In developing an EV transmission for maximum efficiency, Antonov has adopted a layshaft design, featuring two clutches for zero torque interrupt and the continuous transmission of power.

Antonov's proprietary control system enables the transmission to be tailored to different vehicle duty cycles; the software provides full control of the gearchange strategy, enabling accurate energy management of the battery. For increased comfort, particularly in buses, the transmission can be programmed to remain in second gear for smoother deceleration when the vehicle is stopping. First gear is then selected once the vehicle and motor are stationery.



The first application of Antonov's three-speed unit is scheduled for early evaluation in 2011 in the range-extended Jaguar Limo-Green EV research project

"We are particularly pleased with the seamless powershift system," says Antonov's chief operating officer, Simon Roberts. "It not only meets the high level of refinement necessary for passenger cars, but also relates to passenger comfort on public transport buses, particularly if they are standing. Other applications include delivery vans and all-electric taxis."

A particular innovation of Antonov's EV transmission is a novel hydraulic circuit, which has the potential to be integrated with an oil-cooled traction motor. Electric motors can generate a lot of heat, and this provides an effective means of cooling the motor whenever it and the vehicle are stationary.

"The virtues of downsizing in pursuit of increased mechanical efficiency apply equally to electrical machines and combustion engines," says Roberts. "Reducing size and mass are of paramount importance in vehicle design; smaller and lighter electrical machines use less material and are easier to package."

Conventional thinking dictates that because of the flat torque curve of an electric motor, a single reduction gearset is all that's required. The availability of three or four gear ratios, however, enables the electric motor to operate at its most efficient rotational speeds, increasing the overall performance and range of the vehicle, while maintaining optimum tractive effort. It's the efficiency curve that matters, not the flat torque curve.

The same basic principle applies to Antonov's compact epicyclic gearbox intended for more efficient ancillary motors and generators, including a two-speed, 24-volt alternator being developed under an engineering contract awarded by the UK's Ministry of Defence. In its low-speed range, Antonov's two-speed alternator can match the electrical output of a much larger and more expensive single-speed alternator.

It has the potential therefore to replace the multiple alternators that are often required for heavy-duty military and commercial vehicle applications. Increased electrical power on demand at low engine speeds ensures optimal battery charging and permits additional electrical equipment to be specified on the vehicle. Full electronic control of the speed change is via an active clutch mechanism.

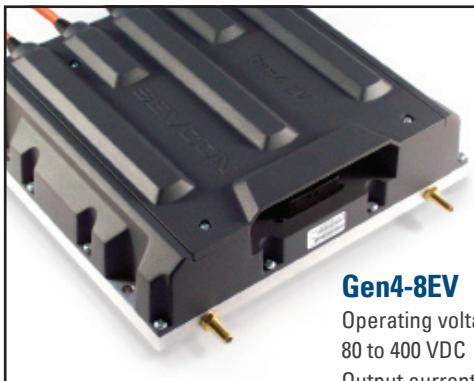
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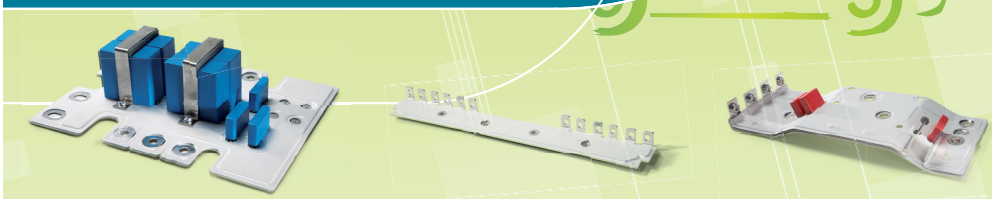
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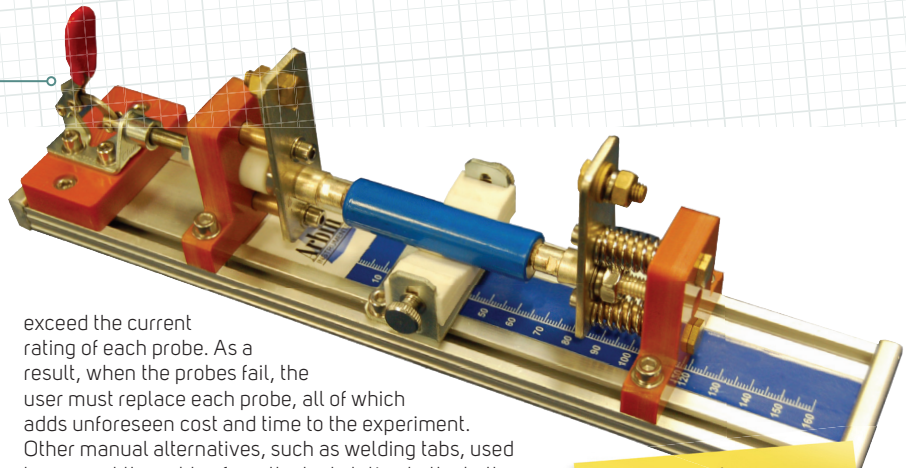


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High current battery holder



Arbin Instruments' engineers have developed a high current (HC) battery holder to add to the existing accessory line of battery holders. This exclusive holder features an innovative patented contact terminal with self-adjusting contact surface (number 7,614,907). Arbin saw the need for a simple, robust, and effective contact to minimize the electrical resistance at the point of contact with a battery terminal. The HC battery holder offers a single probe solution for testing high current devices.

The contact probes, along with the single, spring-lever mechanism, provide secure contact to the battery, thus resulting in very low contact resistance and no damage to the device being tested. By having low contact resistance, the end user does not have to worry about the destructive high temperatures that usually develop in conjunction with high resistance to the current flow.

Previously, users have relied on multiple contact probes to achieve high currents for testing. These multiple contact probes are designed to carry an equal amount of current. However, when one probe fails to make a good connection, other probes will carry current that may exceed the current rating of each probe. As a result, when the probes fail, the user must replace each probe, all of which adds unforeseen cost and time to the experiment. Other manual alternatives, such as welding tabs, used to connect the cables from the test station to the battery, are often time consuming, costly, and make the battery unusable for future applications.

Arbin's HC battery holder enables the user to quickly connect and disconnect the device to test, eliminating the downtime associated with other methods. This specialized holder accommodates testing applications with a maximum current of 200A, lengths ranging from 10-120mm, and a diameter of 10-35mm. The patented single-probe design would be a valuable resource to any user striving for a simplified way to achieve accurate results.

Arbin Instruments
W: www.arbin.com

ONLINE READER ENQUIRY NO. 519

Extended range

As the industry strives to reduce emissions to comply with current EU emissions targets, the expertise of Active Technologies has been called upon a number of times by sportscar manufacturers.

Over the past few years, AT's team of highly skilled engineers have worked in collaboration on the development of numerous prototype hybrid and electric vehicles. Staffed by mainly ex-Lotus powertrain and chassis engineers, Active's ever-increasing knowledge of the hybrid and electric vehicle market enables the company to provide complete prototype vehicle-design packages.

With many OEMs turning to mild hybrids through the use of integrated starter generators and KERS, Active Technologies has built up expertise within these areas. It is currently working to reduce the cost of KERS to make the components economically viable for everyday use.

Active Technologies acknowledges the concern that many consumers have flagged up when discussing pure EVs that when driving these vehicles, they will run out of battery power before reaching their destination. This is particularly specific for the rural community, away from urban environments.

Active Technologies' solution is for vehicles to have range-extender engine/generators to give supplementary battery charging capacity, thereby ensuring that the power system never runs dry. The engine would be a small but high-efficiency, low-friction power unit running at a single speed to minimize fuel consumption. The ability to charge the power unit from external sources will be maintained to take advantage of off-peak electricity.

Active Technologies
T: +44 1953 859133

ONLINE READER ENQUIRY NO. 520

Emission mission

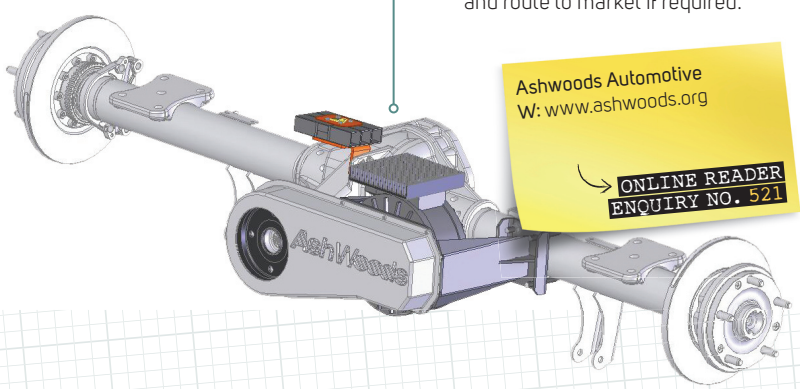
Ashwoods Automotive is one of Europe's largest suppliers of hybrid light-commercial vehicles and advanced low-emission vehicle technologies. Currently, vehicles fitted with the Ashwoods hybrid drive system have covered more than half a million miles. The award-winning Ashwoods hybrid drive system is now in full production.

As well as undertaking all its R&D in house at its ISO 9001-certified facility in Exeter, UK, Ashwoods also undertakes bespoke R&D projects for OEMs and other prominent international automotive clients. The company was recently awarded a Technology Strategy Board (TSB) grant to create hybrid and electric drive systems for a mainstream OEM. TSB grants are awarded only to businesses with a history of R&D achievements and who have effective planning, development, and management systems in place.

Ashwoods also has a number of client development projects underway. The company's innovative development philosophy has enabled it to maintain its track record of delivering projects on time and on budget. All developments have a strict focus on target price and performance from the outset to ensure they achieve the maximum market acceptance and ROI for the customer.

Furthermore, Ashwoods will develop only technologies that have a place in the market and can generate substantial sales revenue for the client.

Working with the leading component suppliers in the sector and benefiting from effective purchasing due to volume sales and existing relationships, Ashwoods can keep project costs down at the early stages of development and then assist the client with production and route to market if required.



Ashwoods Automotive
W: www.ashwoods.org

ONLINE READER ENQUIRY NO. 521

Next-generation lithium batteries

The next generation of automotive lithium-ion battery from Axeon – a lithium nickel cobalt manganese (NCM) oxide system – is currently undergoing evaluation in a trial vehicle. Batteries that use NCM cells provide a combination of superior performance and relatively low cost. Compared with lithium iron phosphate – arguably the most prevalent battery chemistry currently on offer in today's electric vehicles – lithium NCM batteries offer energy density of 155-190Wh/kg or 330-365Wh/liter, whereas lithium iron phosphate provides levels of 90-125Wh/kg or 130-300Wh/liter for electric and plug-in hybrid applications.

Axeon has designed and engineered a preproduction battery system that combines an advanced battery with increased energy density levels and innovative mechanical design.

The new battery system has an energy density of 230Wh/kg, as well as having smaller and lighter packaging, which has enabled Axeon to improve the battery efficiency and increase the range of the vehicle from about 60 miles to more than 100 miles.



Axeon
W: www.axeon.com

ONLINE READER ENQUIRY NO. 522

Advanced material matters

The key to getting the economic benefits from electric and hybrid vehicles is being able to design a bespoke vehicle body structure to maximize the potential of new drivetrain architectures.

Axontex lightweight beam material in carbon fiber can meet many of the requirements to produce variants for different vehicle architectures off a common platform. A typical variant could be providing the structure to add a trunk onto a hatchback vehicle. Whatever the variant, the added mass of batteries and electric or hybrid drivetrain-related components can create added crash loads that need to be dissipated.

"We are working with one electric-vehicle company that wishes to extend its range and battery size without compromising safety. It is examining an additional Axontex crash structure to meet legislation," says Axon's CEO, Dr Steve Cousins.

The Axontex material has many component applications, such as for crash beams, giving a 20% improvement over aluminum in energy/kg, or making additional components such as battery tray supports or cross-car beams.

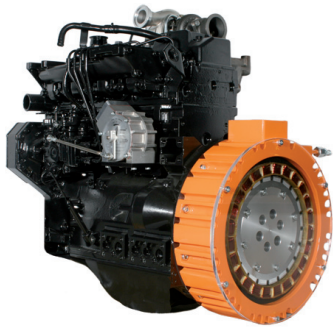
As markets continue to fragment, so the major OEMs, component suppliers and contract engineering companies face the challenge of producing niche vehicles and special editions. Moreover, as platform and architecture strategies continue to encompass world markets, the need for niche customization is likely to proliferate. Axontex carbon fiber beams are there to meet this demand.

Axon Automotive
W: www.axonautomotive.com

ONLINE READER ENQUIRY NO. 523

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Technical recruitment services

Consilium Group (UK) provides an innovative recruitment service to HEV and EV organizations and professionals, both in the UK and internationally.

Launched in 2001, Consilium Group has close to 10 years' dedicated HEV and EV experience and as a result, the company is now established as a leader on a global scale. Consilium Group's enviable database and network of vacancies and candidates provide an innovative ability to match the technical roles with industry specialists.

Consilium Group was built by degree qualified engineers with real-world industry experience. So whether the client is looking to fill a new role or find a new job, Consilium Group recruiters can talk technically, whatever the discipline.

Consilium Group services cover the full range of technologies from OEM to electric motors, from batteries to power electronics. This is all supported, with a long and successful record of building complete teams of engineers for major international clients, through to one-off placements at small design consultancies.

Put simply, if an organization is looking to recruit or a person is looking for a new career, then Consilium Group is the company to contact.

Consilium Group
E: sdoyle@cgl.eu.com

ONLINE READER ENQUIRY NO. 524

Deep down and electric

As part of a comprehensive redevelopment of the Harrison's Cave tourist attraction in Barbados, DCA and Severn Lamb were commissioned to design and deliver the four-wheel drive electric vehicle sets used to carry visitors deep into the 2.3km cave system. Each vehicle set consists of a lead vehicle for the driver and guide and two trailer cars, each with a capacity for 16 passengers. A wheelchair-accessible trailer and a maintenance vehicle were also designed as part of the fleet.

DCA used traditional theory and 3D CAD modeling in conjunction with a full-sized configurable mock-up to optimize the ergonomics of the vehicle set. The company assessed passenger embarking and alighting for the full range of potential user groups and ensured that all visitors have excellent visibility of their guide.

The vehicles follow a challenging route, so the driver is seated in a central elevated position to take advantage of the excellent viewing angles afforded by minimum vehicle overhangs. If accidental damage does occur to the vehicle, the panels most prone to impact – the front wings and front panel – are designed for easy removal and replacement.

To provide rigidity and make the vehicles easy to clean, the main bodies of the lead vehicle and the trailer are designed as single GRP moldings, supported by a welded steel substructure. Tooling for all body panels was CNC machined directly from the 3D CAD data.

As well as the overall aesthetic and engineering design of the bodywork, DCA also focused on the details that give the vehicles their distinctive look, such as a bespoke design and construction for the LED headlight units.

The vehicles have now become an iconic part of the Harrison's Cave brand and an important element of the visitor experience, so much so that visitors can purchase scale models of the vehicle sets as a souvenir of their day out.



DCA Design International
W: www.dca-design.com

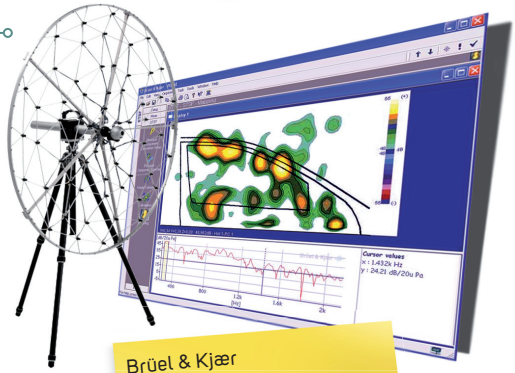
ONLINE READER ENQUIRY NO. 526

Sound advice

Hybrid and electric vehicles pose a new set of challenges for NVH engineering teams. The inherent noise made by IC engine vehicles masks high-frequency and low-level noise, so these have been of lesser concern when designing their cabin acoustics and exterior sound profiles. But for hybrid and electric vehicles, the sounds from the switch gear and motors become prominent inside the cabin, and the exterior noise is much lower than we are used to.

Fortunately, even though NVH engineering for electric and hybrid vehicles is a relatively new discipline, the need to investigate high-frequency noise at low levels is not. Brüel & Kjær has long been a pioneer in the field of sound and vibration measurement and already has a portfolio of proven tools for exploring higher frequencies at lower levels. A good example is the Pulse Array Acoustics Suite, a post-processing environment for array acoustics across all methods and applications currently available, that is, beamforming, spherical beamforming, and acoustical holography.

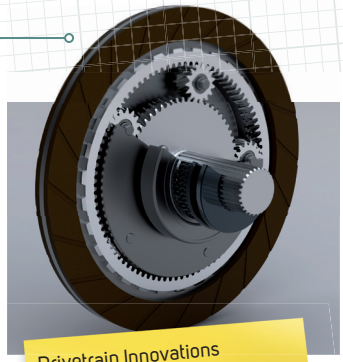
The Pulse Array Acoustics Suite is a single platform that ensures full interoperability between methods. This means that data from one method can be accessed from a database for display and comparison with any other method. Combining acoustical holography techniques with phased-array methods gives accurate, high-resolution maps in the full audible frequency range; ideal for investigating, designing, and optimizing the sound quality of tomorrow's vehicles.



Brüel & Kjær
W: www.bksv.com

ONLINE READER ENQUIRY NO. 525

Powershift transmissions



Drivetrain Innovations
W: www.dtinnovations.nl

ONLINE READER ENQUIRY NO. 527

The optimal blend of using planetary gears and normal gear stages enables a new family of compact, two-speed electric vehicle transmissions (EVTs). Electric vehicles usually have to install large electric motors that should combine good vehicle launch with an acceptable top speed.

The vehicle's overall performance – particularly its launching capabilities and top speed – are improved tremendously when a second-gear transmission is installed. It also realizes an electric driving range improvement of up to 10% dependent on circumstances and vehicle characteristics.

The gearshift between the two-gears should not be felt by the driver as they assume continuous drive power by virtue of the electric drive. For this purpose, Drivetrain Innovations is developing a number of powershift twin-speed gearboxes that have applications for low to high-speed electric machines, light vehicles up to heavy-duty trucks and buses, and in-wheel or differential-based drives.

Three-speed powershift systems are available, which could be useful for enhancing the performance of small, high-speed electric motors.

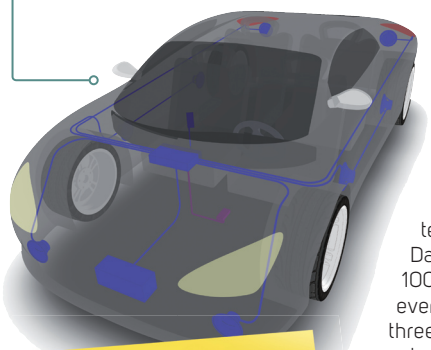
Finally, dry and wet friction-based four-speed powershift transmissions are under development. This constitutes a very compact and efficient DCT-like transmission of less than 300mm length for 400Nm total input torque. This transmission is particularly interesting for parallel PHEV drivetrains.

Sound approach to safety

There is more to electric vehicle sounds than engine noise and horns. ECTunes introduces a new technology that brings intelligent sound to electric and hybrid vehicles. The system maintains the noiseless aspect to the vehicle, but at the same time improves safety levels with specific directional sound.

The technology is innovative in the way that sound is composed and designed to obviate the need for variation. When the electric vehicle moves forward, the sound is audible only in front of the vehicle, as a warning to vulnerable road users that a vehicle is approaching and at the same time minimizing unnecessary noise on the sidewalk. The sound emitted from the vehicle depends on its direction, speed, and acceleration.

ECTunes' concept is partly based on sound simulation software developed by its UK partner NoViSim. Several car manufacturers are already using this sound simulation software in the Brüel & Kjær NVH Vehicle Simulator to style the sounds for their current range of vehicles.



ECTunes
W: www.ectunes.com

ONLINE READER ENQUIRY NO. 528

ECTunes is the first company in the world to use the technology in this innovative way. ECTunes' system interprets input from the EV and translates it into intelligent sound, as opposed to non-intelligent sound from, for example, car horns.

The technology is also being tested as part of a substantial Danish living lab project, in which 100 Danish families are testing everyday use of EVs for a period of three months each. ECTunes is also part of the Elvin EV project at Warwick University, UK.

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Electronic magnetic gearing technology

Electronica Products is well known for its innovative design solutions. Several projects have already been completed, including a magnetic levitation system, which won several awards worldwide, motorized flight-control valve actuators for Airbus aircraft, and a magnetic actuator design for the Rolls-Royce Trent 900 engine.

The company's new major project has attracted keen interest: Electronica has patented electronic magnetic gearing technology for permanent magnet brushless motors that does away with a mechanical gearbox. Removal of the gearbox makes the drivetrain simpler, more efficient, and cheaper.

The prototype system comprises an electric motor and an inverter drive with electronic magnetic-gearing capability. Such an innovative design has received worldwide interest. Electronica is now developing a range of eight electric motor/generator systems, from 500W to 150kW.

With the company's impressive manufacturing partners, Electronica is working on new production techniques to reduce manufacturing costs. The aim is to provide the highest torque to weight ratio in the industry at a competitive price. Electronica believes these criteria are very important in commercializing electric motors for the automotive market.

The main benefit of Electronica's technology is that it gives a very high starting torque with high efficiency, so reducing the power consumption from the battery. The efficiency of the motor is also kept high by using the electronic magnetic-gearing technique in each of the gear stages. This technology can also be used in the design of generators.

Electronica believes the increase in efficiency will extend driving range from 20-80% when compared with an ordinary permanent magnet synchronous motor.

Electronica also makes custom-designed electric motors, actuators, and generators.

Electronica Products
W: www.electronicaproducts.co.uk

ONLINE READER ENQUIRY NO. 529

Low-cost energy packs

During the past two decades, the EV market has had a tumultuous ride from being the next big thing to moving toward obscurity and then back into its current limelight. One of the biggest issues has been the price of the vehicles and their core component, the battery pack.

Central to the philosophy of EVida, a company that is working toward the EV-enabling goal, is the idea that EVs will only take off when their price is realistically suited to the market. EVida designs and delivers bespoke plug-and-play energy packs at low cost. While there is consensus that the price of battery packs will come down in the future, EVida is managing to create a quality product today at a price point that will enable its customers to sell their vehicles in volume. EVida does this by taking a leaf out of the Tesla book, and sourcing cells that are already a mass-produced commodity (EVida's head of engineering was the vehicle integration manager at Tesla for several years).

Unlike Tesla, which uses high energy-density, combustible lithium-cobalt technology, which requires expensive and complex engineering, EVida relies on the more stable lithium iron-phosphate chemistry. With an innovative combination of Chinese low-cost production techniques and Western management and quality processes, EVida is able to profitably deliver safe, reliable and high-powered packs at a significantly lower cost than its competitors. As EVida battery packs proliferate, it intends to use the benefits of this key component as a springboard to launching its fleet enabling system.

EVida Power
W: www.evida.com

ONLINE READER ENQUIRY NO. 531

Wireless charging systems

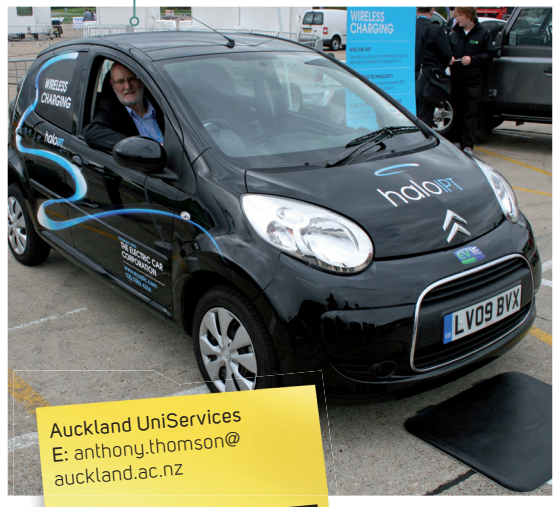
Plugs were a great invention. However, they can rapidly lose their appeal when you forget to plug them in or the power cord gets tangled. Combine plugs with electric vehicles and the result has distinct limitations. HaloIPT believes the future of EVs lies with wireless charging. It has the potential to liberate the EV and, crucially, to address many other issues facing drivers, such as inconvenience, range restrictions, and high cost, that currently prevent mass-market take-up.

HaloIPT's wireless charging technology uses inductive power transfer (IPT) where two pads – one fitted to the car and one on the ground – use a magnetic field to transfer power to car batteries. Cars charge automatically when parked over a transmitter pad. The technology does not need precise alignment to work, can be embedded into asphalt, thereby reducing street clutter, and will still function under water or when covered in snow and ice.

The really exciting thing about wireless charging is that it can work on moving as well as stationary cars. A motorway lane upgraded with transmitter pads (almost like a line of cat's eye road-markers) would enable EVs to drive and charge at the same time.

This solves the range problem associated with EVs and will eventually reduce battery requirements. By reducing the battery size, it is also possible to reduce the weight and cost of the vehicle, thereby improving handling and accessibility.

HaloIPT is working on a number of pilot projects, with the aim of building a commercial prototype by 2012. The end result will be an intelligent EV that works with the customer.



Auckland UniServices
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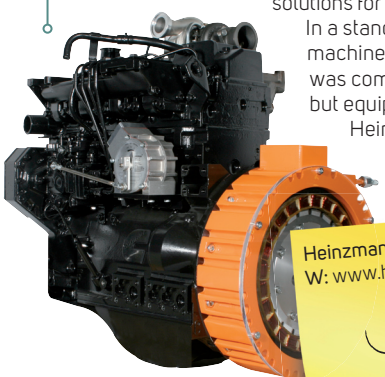
Second-generation electric motors

Heinzmann is collaborating with manufacturers of combustion engines and mobile machinery to develop innovative hybrid drives for off-road applications. This includes wheel loaders, hydraulic excavators, forklift trucks, and aerial work platforms, as well as serial hybrids.

Heinzmann's first generation of electric machines had a classical distributed winding design for the electric motor and the housing was produced as a one-off customer-specific item. The total length of the electric motor was 150mm/20kW.

Now Heinzmann presents the second generation of an integrated motor generator for different IC engines with a concentrated single-tooth winding. The compact and cost-effective design of the electric motor enables both low-volume manual production as well as high-volume fully automated serial production. In addition, the overall length of the electric motor could be reduced to 80mm/20kW. The cast aluminum housing with an integrated cooling channel enables very efficient heat transfer.

The Heinzmann electric motor can be combined with diesel, gaseous fueled and gasoline engines and is available as mild, full, or serial hybrid and as an integrated generator for power networks. Heinzmann supplies hybrid solutions for the full line of industrial applications.



In a standardised test, a wheel loader construction machine equipped with a standard diesel engine was compared directly with an identical machine, but equipped with a downsized diesel engine plus a Heinzmann hybrid drive. Tests carried out by the manufacturer showed that in actual operation, fuel consumption savings of more than 20% can be achieved with the hybrid machine.

Heinzmann
W: www.heinzmann.de

ONLINE READER ENQUIRY NO. 532

NiMH and Li-ion battery solutions

EVB Technology is a fully owned subsidiary of renowned GP Batteries International, which specializes in manufacturing high-capacity heavy-duty battery systems. The company has been supplying batteries for electric vehicles, hybrid EVs, industrial, and energy storage systems since 1993, and is one of the earliest NiMH licensees from the Ovonic Battery Company.

Growing concerns about the environment mean demand for electric-propelled vehicles and energy-storage systems is set to increase tremendously. EVB's focus is to offer reliable solutions to satisfy these market demands. While having extensive experience in NiMH systems, EVB has also developed lithium-based battery solutions with cells developed in house.

EVB's NiMH batteries have successfully hybridized rubber-tire gantry cranes and this solution has outperformed other alternatives. The NiMH solution from EVB is on course to capture the majority market share of the container-terminals sector in South China. EVB also supplies high-capacity battery systems (14kW) with its 100Ah NiMH cell to a battery EV manufacturer in the Nordic region. This makes for a remarkable success story, with the replacement of old technology – in this case lead-acid batteries – with the robust and reliable NiMH system. EVB has been the official battery supplier for the Vectrix electric scooter, and by the end of this year, new lithium-powered scooter models will be launched.

EVB Technology
W: www.evbtech.com

ONLINE READER ENQUIRY NO. 534

Sustainable transport portal

EVtransPortal.org is a non-profit, tax-exempt organization helping sustainable transport to succeed by connecting people with the information and resources they need. EVtransPortal's business-to-business and business-to-consumer website provides market research, consulting, information, and referral services to companies within the EV, HEV, and fuel-cell industries, as well as to individuals, organizations, and government groups.

EVtransPortal provides EV companies with direct access to global customers, suppliers, and industry resources, including sources for cutting-edge battery technologies, EV and HEV product development, marketing, and venture capital.

EVtransPortal is the information resource of choice for a growing number of automotive engineers, manufacturers, suppliers, and government groups developing electric drive technologies.

EVtransPortal
E: mail@evtransportal.org

ONLINE READER ENQUIRY NO. 533

Stop/start battery separators

New vehicle designs that necessitate frequent engine stop/start functions present tremendous challenges for battery makers. Their products must deal with extreme cycling requirements and function to an unprecedented degree under partial state of charge (PSoC) conditions. Traditional battery designs using ordinary parts cannot meet today's SLI stop/start demands.

The new CycleGuard battery separators from Hollingsworth & Vose (H&V) are the first products in their class expressly designed for PSoC applications. Patented synthetic glass fiber technology offers a vital advantage for stop/start battery performance: high-charge acceptance. Tests show that CycleGuard's charge acceptance significantly exceeds that of conventional AGM separators.

Another element is cycling capacity. Being able to cycle repeatedly without full recharging every time defines good PSoC. The CycleGuard separator excels at this critical task.

"Depending on how you design your battery, CycleGuard can dramatically increase cycling capacity," says Bob Cullen, H&V sales and marketing VP. "Our customers may see up to 20% longer cycle life under partial state of charge. So you get more charge cycles over an extended battery life, plus an increased ability to cycle the battery without charging. You can see why we say this separator is not evolutionary, it's revolutionary!"



Hollingsworth & Vose
W: www.hollingsworth-vose.com

ONLINE READER ENQUIRY NO. 535



Great minds think electric.

Join us for the 26th International Electric Vehicle Symposium and Exposition. Hosted by the Electric Drive Transportation Association (EDTA). EVS is the largest electric drive exhibition in the world. Highlights include:

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Join the industry's leading thinkers, movers and shakers at EVS 26 in Los Angeles, California, USA, May 6-9, 2012.

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EDTA®
Electric Drive Transportation Association

www.electricdrive.org

Innovative battery solutions

With EU legislation limiting vehicle fuel consumption and CO_2 emissions, car manufacturers in Europe are developing innovative equipment and alternative means of electric propulsion. These design changes bring a new range of technologically advanced HEVs, ranging from micro- to full-hybrids. Micro-hybrids are expected to dominate the fleets with a share of at least 60% within the immediate future.

Exide Technologies offers products segmented into two ranges, absorbed glass mat (AGM) and micro-hybrid-flooded (MHF) batteries, meeting the energy needs of today's micro-hybrids. The company supplies both technologies to European OEMs and the aftermarket.

The stop/start design and regenerative braking of micro-hybrids require an advanced energy source, and Exide's AGM and MHF battery designs meet the challenges. AGM incorporates one of the most advanced OE technologies available, and MHF is the choice for micro-hybrid systems in the cost-sensitive small car segments.

Exide's products feature high-charge acceptance, partial state-of-charge operations, and an enhanced cycle life, when compared to standard batteries. In 2005, Exide was the first supplier of an AGM battery used in a stop/start system for Citroën. Today, the company provides micro-hybrid batteries to major European automobile industry customers, including BMW, Citroën, Fiat, Peugeot, Suzuki, Toyota, the VW Group and others.

Exide is ahead of the R&D curve as the first manufacturer of MHF technology used for stop/start applications in Europe. Its products, designed in conjunction with the major European car manufacturers, incorporate MHF technology optimized for micro-hybrid cycling resistance at high temperatures. Superior heat resistance has resulted in Exide products being recommended for vehicles such as the Fiat 500, with its downsized two-cylinder engine and battery in the engine compartment.

Exide Technologies
W: www.exide.com

ONLINE READER ENQUIRY NO. 536



Engineering and business consulting service

Hybrid Design Services (HDS) was established in 2004 by James Pinon to provide engineering and business consulting services to the developing alternative energy market. Since then, President and CEO James Pinon and his team have successfully leveraged their expertise to work on many high-profile hybrid and electric vehicle projects, battery pack and inverter designs, stationary power back-up systems, and robotic applications. In transportation, the HDS team has a cross-industry experience ranging from recreational and passenger vehicles, through to special military.

Besides reaching into hybrid and electric vehicle technology including lithium, NiMH, and ultracapacitor energy storage systems, inverters and fuel cells, HDS is building partnerships with global suppliers of alternative energy products such as wind turbine systems. Since last year, the company has combined its technical competence with its clear understanding of the alternative energy market to add technical business consulting and training services to its repertoire.

The HDS team's automotive and renewable energy knowledge helps bring its customers' technologies from the drawing board to the production floor in record time. The experienced simulation team at HDS uses industry-leading tools for CAE, CFD and powertrain analysis to develop high-quality and reliable simulations that aid the rapid and low cost development of complex systems.

Hybrid Design Services
W: www.hybriddesignservices.com

ONLINE READER ENQUIRY NO. 537

Advanced hydrogen solutions

Hydrogenics is helping to deliver clean, sustainable and efficient hydrogen solutions across many different industries. Applications vary from operating on the surface of oceans and the ocean bed to on land and in most modes of stop/start and long-range public transportation.

Hydrogenics power architecture presents economically attractive fuel-cell solutions for all manner of hybrid electric-mobility configurations. Combined with hydrogenics ability to deliver end-to-end solutions including fueling stations and advanced energy storage, it is also a one-stop shop.

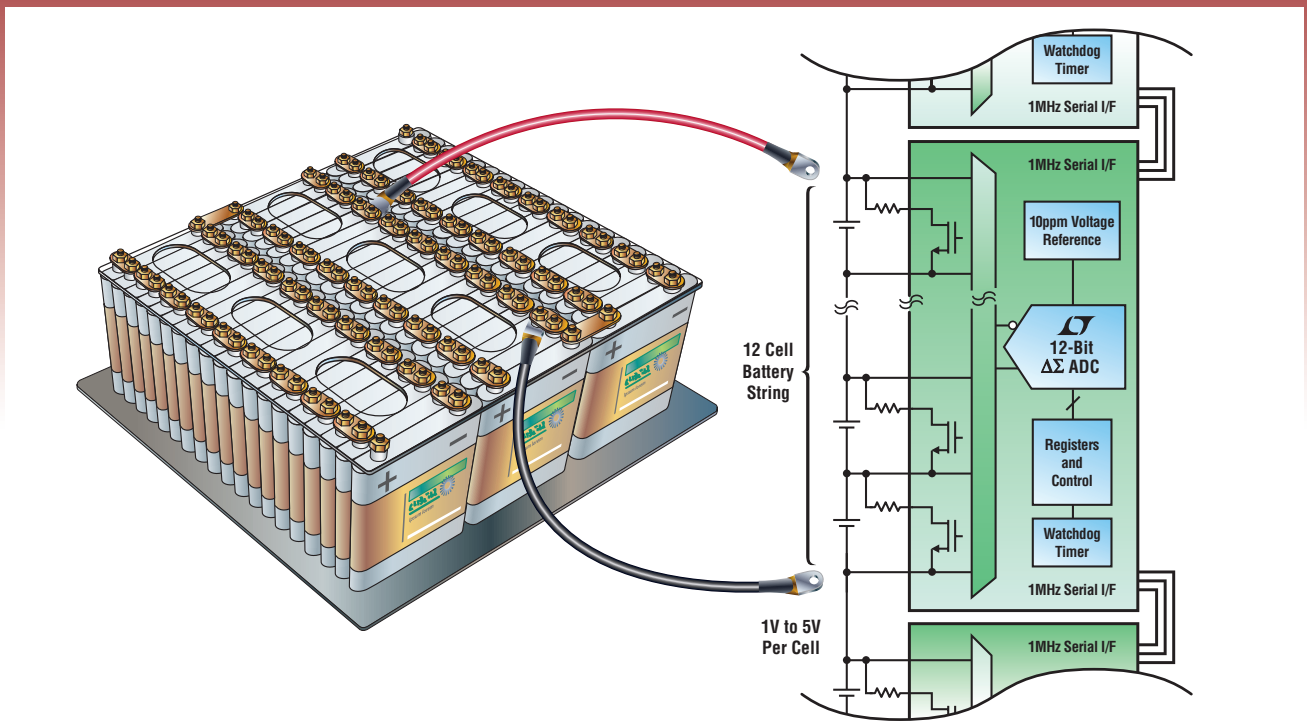
So, what else attracts EV operators and OEM integrators to this single point of hydrogen-based capability and supply? The answer is durability. Hydrogenics has proven durability with world-leading results in the longest running non-humidified low-pressure stack now running almost 13,000 hours in a rugged test environment.

Battery-only-powered vehicles can serve the typical family car duties of less than 50km a day and less than one hour per day in neighborhood drive cycles. However, commercial vehicles have duty hours of anything between four and 24 hours per day. Battery change-out requirements are labor, space, manpower and commensurately cost-intensive. For the best of both batteries and engine hybrids – without the drawbacks – Hydrogenics' demonstrations with commercial fleet clients are proving that fuel cells, hybridized with batteries and/or super-capacitors, achieve the range, maintain optimal performance, enable rapid fueling, provide better efficiency, and are full-cycle zero-emission sustainable with hydrogen from renewable-sourced electrolysis.

Hydrogenics
W: www.hydrogenics.com

ONLINE READER ENQUIRY NO. 538

High Voltage, Precision, Battery Stack Monitor



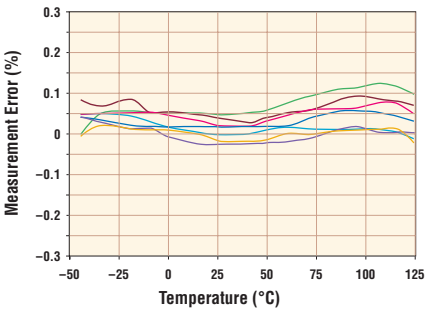
Rugged IC for Hybrid/Electric Vehicles & Battery Backup Systems

The LTC®6802 is a highly integrated multicell battery monitoring IC, capable of measuring up to 12 individual battery cell voltages. Using a novel serial data communication technique, multiple LTC6802s can be stacked in series without optocouplers or isolators, allowing precision voltage monitoring of every cell for 1000V+ systems. With high ESD, EMI and noise immunity, the LTC6802 stands up to real world conditions in a range of automotive and industrial applications.

Features

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- Fully Specified for –40°C to 85°C

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LINEAR TECHNOLOGY

Technologies and infrastructures for efficient vehicles

To create most favorable synergies, the International Advanced Mobility Forum (IAMF) will take place for the fourth time on March 8 and 9, 2011, alongside the Geneva International Motor Show. The forum was created in 2008 with the aim of bringing together scientists and key players from the motor industry to discuss mobility today and tomorrow. In 2010, over 230 participants got together. Among the 35 speakers, outstanding experts and renowned opinion leaders shared their visions.

The 2011 edition will focus on: advanced powertrain and vehicle technologies, onboard energy storage (batteries, compressed gases and liquid fuels), supply infrastructures (CNG, LPG, ethanol, electricity, H2), and marketing aspects of new technologies and consequences of new powertrain solutions.

IAMF is organized by PALEXPO in partnership with the e'mobile association, the Competence Center for Energy and Mobility (CCEM) of the Paul Scherrer Institute, Gasmobil AG and Euresearch. The forum is also supported by the International Energy Agency, the Swiss Energy Council, auto-schweiz, FISITA, the Union Pétrolière and the Geneva International Motor Show.

IAMF 2011 - International Advanced Mobility Forum
E: iamf@geneva-palexpo.ch

ONLINE READER ENQUIRY NO. 539

Lightweight windows

More and more manufacturers of top range cars are using polycarbonate windows for weight saving. Although not certified yet by the authorities for windshields, top car brands have introduced polycarbonates in side and rear windows and in elegant engine covers. A leader in this field, with 30 years experience in manufacture and service of polycarbonate windows, is KRD Sicherheitsdienst, in Germany.

This supplier started out supplying polycarbonate windows for emergency vehicles. The reason for use was the extremely high toughness of such windows, with this technology being 100 times tougher than glass. Although this market continues to grow, KRD has seen a steep growth in uptake in the performance cars. In this sector, it is not the toughness of the glass that is key, but the lower weight. A polycarbonate window weighs just half of an equivalent glass window and so offers all the benefits of better performance, lower fuel burn, and lower emissions.



Picture courtesy of Rinspeed

KRD Sicherheitstechnik
E: info@krd-gruppe.de

ONLINE READER ENQUIRY NO. 541

Global battery and energy-storage testing laboratories

Intertek, a global leader in testing, inspection and certification, has expanded its battery and energy-storage test facilities in North America, Europe and Asia in an effort to support testing capacity needs in the hybrid electric and electric vehicle industries.

The economic and regulatory drivers, and technological advantages of hybrid electric, plug-in hybrid electric, and electric vehicles will drive sector growth and product adoption through 2020. Although lithium-ion is poised to be the battery technology of choice, issues of battery size and performance (reliability, durability, longevity and temperature management) continue to fuel R&D testing, and pre-market testing of batteries for the auto market.

Addressing this rapidly evolving market, Intertek's Detroit, Michigan, lab recently purchased five moderate- and large-format battery cycling systems. In addition to over 500 small-format battery test stations, the new systems offer the ability to test up to 30 mid-size and large-format battery packs, for electric vehicle, military, and backup power/UPS applications.

"With rapid advancements in battery and power source technologies, Intertek is responding to the needs of the market by investing in state-of-the-art test equipment around the world," says Tim Hubbard, director of operations. "Combined with our energy-storage advisory services, existing simulated durability and environmental test capabilities, Intertek is the only global, full-service provider that enables manufacturers to rapidly develop and launch safer, more reliable products that are dependant on power sources."



Intertek
W: www.intertek.com/energy-storage

ONLINE READER ENQUIRY NO. 540

New heating and cooling module

Located in Germany, high-tech company ixetic has developed a new heating/cooling module for electric and hybrid vehicles. The modular system is extremely economical and efficient due to a closed cooling circuit driven by carbon dioxide (R744). With its water interface, the system can be connected in any vehicle.



The new module takes care of an electric vehicle's entire thermo-management, from cooling vehicle components such as electric motors and lithium-ion batteries, to internal cooling and heating. The company's innovative concept is impressive in every way. The heart of the system is the heating/cooling module, which runs using the environmentally friendly refrigerant R744. Although conventional heating technologies almost halve the range of an EV in winter months, this concept enables the remaining range to be 85-90%. The concept's interface for connection with standard vehicle components such as heaters and coolers is both ingenious and straightforward. Furthermore, the heating/cooling module can be integrated in an electric vehicle without substantial modification to existing systems.

ixetic
W: www.ixetic.com

ONLINE READER ENQUIRY NO. 542

EDN GROUP

THE ART OF CHARGING

EDN GROUP has continually made
significant contributions to the art of battery charging
since its founding in 1993.
Its battery charging products range from the
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to the newest generation of CMP series currently
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In-hub motor to revolutionize hybrid drive

For the last 30 years, L-3 Magnet-Motor has been developing innovative hybrid electric-drive systems and has become a leading supplier of compact electric motors for the automotive industry.

L-3's M70 electric integrated wheel motor is the company's latest advancement in hybrid electric vehicle propulsion, offering unmatched performance in both power and torque. The M70 motor is a completely maintenance-free permanent magnet, inner-rotor machine, featuring a highly efficient water cooling system. It provides precise mechanical control via electronic inverters, aided by a high accuracy resolver system.

Designed for propulsion systems requiring high torque and high power, the M70 supports endless possibilities in new vehicle design.

With a large central bore, the M70's in-hub wheel motor provides enough room for a conventional disk brake or a planetary gear, set to support extra-high torque applications. It can also be installed as an add-on hybridization of an existing mechanical drivetrain. Two M70 motors in a vehicle will deliver full traction, and four will ensure optimal performance for the most extreme environmental or terrain conditions.

L-3 Magnet-Motor
W: www.L-3com.com/mm

ONLINE READER ENQUIRY NO. 543



Turkish battery pack design

As an engineering solutions company, Litech is participating in high-technology projects in cooperation with Altinay Robotics, an automation and alternative-energy company. Litech's core business is battery-pack design, while Altinay is more focused on investment and production. Focusing firstly on battery pack design and production, Litech designs a drivetrain according to the vehicle type requested by the customer. While being the producer of its own battery packs, Litech also installs the drivetrain and assembles the associated components, therefore showcasing the company's in-house capabilities.

Litech is now in the module-development stage, making use of high-density energy cells based on Li-cobalt chemistry with density increasing additions. Base modules consist of 1,8650 type cells. They are arranged in wide variety of serial and parallel configurations to get the desired energy density and voltage level.

As a nation, Turkey has very high fuel prices and that's in addition to double-tax legislation on commercial vehicle prices. Therefore the EV is a very important product for Turkey's economic conditions. In this area, Litech battery packs offer very favorable solutions.

It is estimated that the electric vehicles segment in Turkey will grow by 12% in the coming years. In the short term, Litech will continue to concentrate on EV fleet projects and tender business. The aim is to come up with a commercial solution by the first quarter of 2011.

Litech's head office is based within Altinay's facilities, located at the Tuzla Free Trade Zone in Istanbul. All development and production activities are undertaken in these premises.



Altinay Robotic Technologies and Litech
W: www.altinay.com.tr
W: www.litechindustry.com

ONLINE READER ENQUIRY NO. 544

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Looking forward to lower CO_2 emissions
We all know that car emissions are not good for the environment. In the near future, automotive manufacturers are measured by CO_2 emissions and there will be additional costs if they do not comply with emission legislation.
SKF can now present a complete portfolio of products and services that range from single bearings and seals to complete powertrain solutions that help reduce grams CO_2. As an example, for a final drive application we can reduce CO_2 emissions by up to 4 grams, compared to existing solutions. We also offer software which can calculate savings using our products and solutions in today's and future powertrain concepts.
All in all, these SKF solutions can translate into more than 10 grams CO2 less per km.
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Range complexity

In the hybrid and electric vehicle sector, range anxiety among consumers is one of the main obstacles to potentially higher volumes of vehicle sales. However, range itself is a complicated issue; just how is it measured and calculated? And is this an accurate calculation, and is it consistent across all vehicles?

"Measuring the range and CO_2 emissions of a hybrid vehicle is an extremely complicated issue and requires a fundamental understanding of the individual vehicle's system configuration to produce an accurate result," explains Millbrook's Andy Eastlake defining some of the challenges faced in range testing of new-technology vehicles. "Hybrid systems come in many forms, with charge sustaining or depleting modes and everything needs to be tested appropriately to the power source to produce a fair set of comparable results. Additionally, in hybrid and electric testing, frequently the energy balance on board the vehicle may require specialist equipment to monitor battery current and voltage under highly transient conditions - which needs extremely high levels of electrical safety consideration. Also, the range test may continue for a considerable amount of time, which in itself adds both additional cost and complexity for the test house.

"Within ECE regulation 101, hybrid vehicles with an electric-only operating mode have an assumed 25km distance between charges, therefore the published CO_2 figure covers this assumption. However, as yet the CO_2 produced from the manufacturing of the electricity is excluded from the reported number.

"Hybrid and electric vehicles have multiple modes of operation, including eco modes with more aggressive regeneration strategies, which enhance the electric range over the test cycle. Other areas to consider in the testing process are charging strategies for hybrid and range extenders, and the fact that new technology testing is conducted over the NEDC cycle that may not be achievable by some city vehicles.

"This clearly shows how the close coordination of vehicle design, integration, measurement and operation is critical to the success of the new automotive technologies. The team at Millbrook has researched the challenges faced and offers a bespoke service, working closely with clients to optimize the technology, design and integration to achieve the optimum solution for hybrid performance development."



Millbrook
W: www.millbrook.co.uk

ONLINE READER ENQUIRY NO. 545

Sustainable solutions for an evolving planet

The electric vehicle is no longer considered a passing fancy. As nearly every automotive manufacturer designs and produces electric or hybrid models, companies, investors and consumers are buying into the progressive notion that these vehicles represent a viable and effective alternative means of transportation. Next Alternative (NAI), an Ontario-based, company, has been promoting the EV, as well as pioneering a host of additional products and initiatives that provide eco-friendly energy solutions.

As an innovator in the field, NAI is championing the use of the Carbon Nanotube (CNT) battery. The potential of this type of battery is vast, as is the scope of its reach and positive impact on the automotive/transportation industry and the environment as a whole. CNT battery technology enables rapid recharging in less than one hour and provides increased reserve capacity of at least four times that of an unmodified battery. The batteries, which deliver 300 miles between charges and life expectancy, will be extended by a minimum of four times the current output. This far exceeds anything previously available. In addition to this, the batteries lead to reduced emissions, which is one of NAI's primary goals.

NAI has already garnered large contracts for the manufacture and deployment of its CNT batteries. These sizable orders reflect a major surge in popularity and constitute a genuine belief in the battery's capabilities.

Next Alternative
W: www.next-alternative.com

ONLINE READER ENQUIRY NO. 546



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www.ev-battery-technology.com

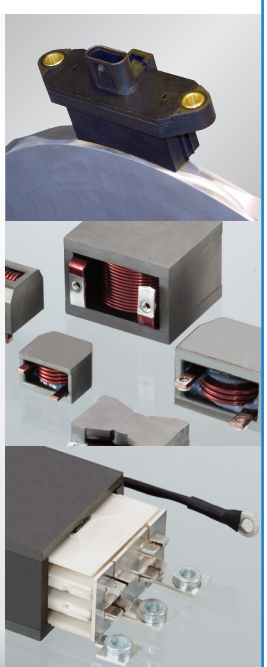
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partners

Opal-RT and ETAS team up to streamline automotive power electronic design processes

Hardware-in-the-Loop (HIL) testing of electric motor controllers that are used in electric powertrains requires simulation of electric signals and mathematical models at substantially higher rates compared with traditional powertrains with IC engines only. To meet these requirements, ETAS and Opal-RT Technologies have joined forces to integrate components of Opal-RT's eDRIVEsim simulation platform with the ETAS LABCAR product line.

eDRIVEsim is an advanced real-time, HIL simulator and control prototyping platform that is excellent for designing advanced control systems or for performing HIL testing of controllers used in high-speed electric motors, power electronics, and other electromechanical systems. Fully integrated with MATLAB/Simulink from MathWorks, eDRIVEsim also includes a number of specialized modeling libraries developed by Opal-RT, which enable real-time simulation of even the fastest power electronic systems with a sub-microsecond time step.

The technology partnership will result in the launch of a new product, xEV-LABCAR, an open-architecture, PC-based LABCAR HIL system that includes Opal-RT developed libraries and Simulink-based models with advanced power electronic capabilities, for testing complete hybrid-electric powertrains, including engine controllers, multiple electric-motor controllers, transmission controllers and battery controllers.

"Continued pressure from government authorities to promote electric vehicles as an environmentally-friendly alternative to traditional IC engines is driving investment in new high-fidelity engineering tools," says Carl Squire, president, ETAS. "Opal-RT has an excellent reputation as a leading developer of real-time simulators for fast-switching power electronic automotive applications. By partnering with Opal-RT, ETAS can now provide users with an integrated solution combining powerful HIL tools, and management of ECU calibration with superior, high-fidelity power electronics simulation."

Jean Belanger, CEO of Opal-RT Technologies, adds, "ETAS is a trusted brand of HIL test systems for automotive ECU development, used by thousands of automotive engineers around the globe. As a result of this partnership, these engineers will now have access to the industry's best platform for electric powertrain ECU development, calibration and simulation, ensuring that the growing demand for high-quality electric vehicles will be met on time and within budget."



Opal-RT Technologies
W: www.opal-rt.com

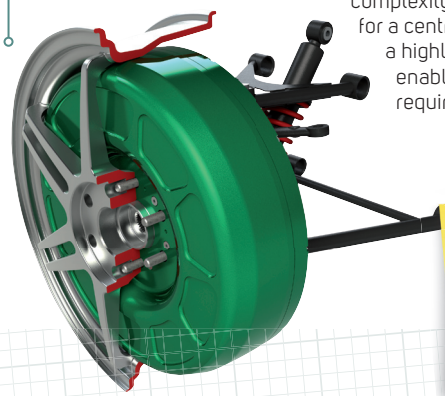
ONLINE READER ENQUIRY NO. 547

The joint development of the xEV-LABCAR platform by both the ETAS and Opal-RT R&D teams is now underway. General availability of xEV-LABCAR is expected in the second half of 2010.

Protean drive developments

The best ideas are usually the ones that first come to mind. At the 1900 Paris World Fair, Ferdinand Porsche debuted the System Lohner-Porsche, and this vehicle was driven by two electric in-wheel motors and set several Austrian speed records. Over the last 100 years several false starts have occurred within the electric vehicle market, with both market demand and technology maturity being cited as root problems. Now though, the electric vehicle market and technology developments are at a crossroads. Consumers want vehicles that offer the same size, performance, range, reliability and cost as their current petrol and diesel equivalents. The Protean Electric PD series in-wheel motor technology offers a solution to these problems that provides power and torque equivalent to IC engine/transmission alternatives in a package that does not invade chassis, passenger and cargo space. This will give OEMs the ability to develop new space efficient vehicles in which being green does not mean being small.

At the same time the PD series in-wheel motors reduce vehicle part count, complexity and cost. A key feature is the integrated power electronics that give complete design freedom and the potential for increased regenerative braking. Based on a novel patented distributed submotor/micro-inverter architecture, the power electronics is miniaturized, integrated and compatible with automated mass-production processes, eliminating cost, complexity and packaging space required for a centralized inverter. It also provides a highly redundant architecture that enables stringent functional safety requirements to be achieved.



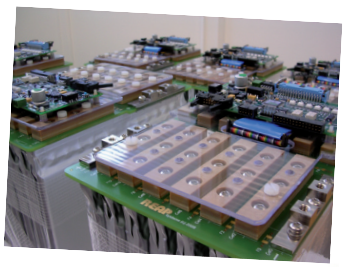
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ONLINE READER ENQUIRY NO. 548

Reaping rewards

The last 12 months have seen substantial developments within REAPsystems. As one of the leading suppliers of battery-management systems and integrated battery solutions, the constant demand for the company's expertise has seen the workforce double during the last year. Recruiting key staff across engineering, administration and business management disciplines has enabled REAPsystems to once again strengthen it's range of value-added products and services. Furthermore, with a number of long standing customers now moving toward production volumes, the company are challenging themselves to work to the highest production and process standards.

Looking into the future, next year will see REAPsystems move into their ninth year of business with the company showing no signs of relenting from it's structured growth regime. A strong order book and a large number of ongoing projects means the business looks sure to continue it's impressive development into 2012 and beyond. With the addition of key strategical partners over recent years there could be no better time to investigate what REAPsystems have to offer. From standard battery-management systems to custom designs and integration consultancy, REAPsystems have the resources and know-how to bring success to any project.



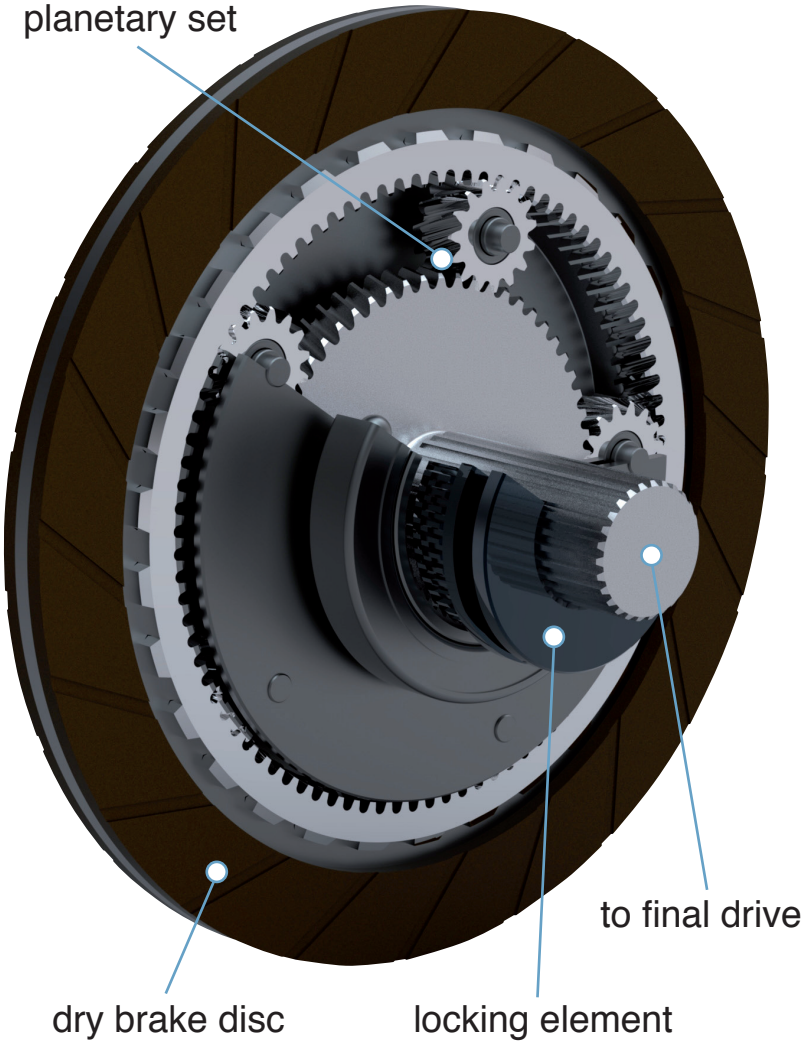
REAPsystems
W: www.reapsystems.co.uk

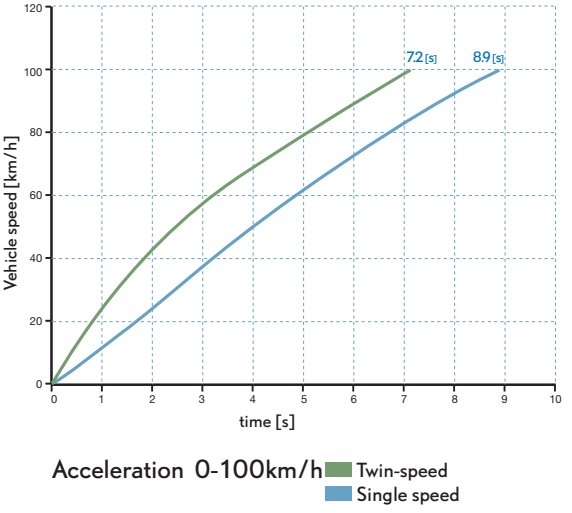
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Compact, 2-speed EVpowershift transmission-modules for 10% drive range extension and high performance





Acceleration 0-100km/h Twin-speed
Single speed

DTI can supply a wide range of twinspeed EV transmissions:

- with or without powershift capabilities
- for low- to high speed electric machines (3-20 kRPM)
- for light vehicles to heavy duty trucks and buses
- in-wheel or differential based
- extensions to 3-speed powershift functionality possible

Drivetrain Innovations develops cost-effective and fuel saving transmission solutions.

Drivetrain Innovations BV
Croy 46
5653 LD Eindhoven
The Netherlands
tel. +31 40 2931082
fax +31 40 2932885
info@dtinnovations.nl
www.dtinnovations.nl

A smarter approach to vehicle power

Zinc-Air is a proven primary battery technology, but ReVolt has pioneered what has been a holy grail in this field for nearly two generations: rechargeable Zinc-Air batteries. Today, ReVolt is recognized by the industry as a world leader in rechargeable metal-air technologies.

Why is rechargeable Zinc-Air so desirable? As well as being a dramatically enabling technology in terms of its performance signature and discharge characteristics, rechargeable Zinc-Air offers reduced costs as well as a higher energy density than any commercially available rechargeable equivalent.

Importantly for today's environmentally conscious consumers, Zinc-Air also represents a clean solution; as an element, zinc is non-toxic – it is neither flammable nor explosive – and it is relatively abundant and easy to recycle.

ReVolt's Zinc Flow air battery (Z-Fab) is a pioneering concept that has the potential to revolutionize the market for electric vehicles. It meets the needs of this burgeoning sector by combining a very practical power capacity with low cost and ease of recharge. The use of a flow battery in EV applications overcomes the need for additional infrastructure to charge batteries – instead power packs can be conveniently distributed at gas stations. By bringing the viability threshold for EVs within easy reach of the average consumer, the fundamental advantages of Z-Fab opens up tremendous opportunities for expanding the market to meet future public demand for clean transport.

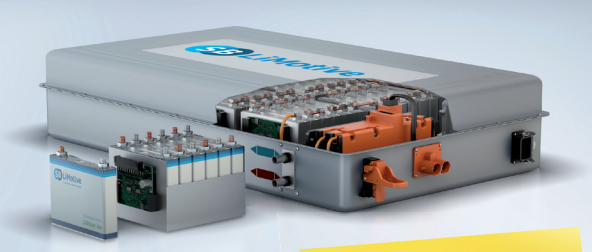
ReVolt Technology
W: www.revolttechnology.com
ONLINE READER ENQUIRY NO. 550

Joint venture success

SB LiMotive was established in September 2008 by Samsung SDI and Bosch to develop and manufacture lithium-ion batteries ready for series-production for hybrid and electric vehicles. The two companies will have invested some US$500 million in the 50:50 joint venture by 2013. SB LiMotive offers lithium-ion batteries for the whole range of applications from micro hybrid to full electric vehicles. Scalable, modular systems and flexible interfaces enable integration into diverse powertrain concepts with high safety and quality standards along the value chain.

SB LiMotive started out with 140 associates in 2008. Today, it employs some 650 associates and is active in all the main automotive regions of the world. In Giheung, Korea, the headquarters, cell development and validation is located. In Ulsan, Korea, a mass-manufacturing site with facilities to produce battery cells was constructed in just 12 months. Lithium-ion cells are already being produced here for pre-series projects and large-scale production will begin in 2011.

The German subsidiary of SB LiMotive is located in Stuttgart. It is here that battery packs and systems are developed and prototypes built. From its location in Germany, SB LiMotive has also built up a global team for sales, marketing, and project management.



SB LiMotive
W: www.sblimotive.com
ONLINE READER ENQUIRY NO. 551

Ricardo technical consulting in China

Developing new and cost-effective solutions for the global problems of emissions reduction, fuel-consumption improvement and energy security, in an increasingly complex market, requires an organization that understands all the elements that need to be combined to produce a competitive vehicle powertrain. Having the ability to deliver all components for future powertrains is the essential characteristic of a world-class technology partner, such as Ricardo. Fuel efficient engines, multi-modal transmissions, high-performance electrical drives and machines, state-of-the-art energy storage devices and sophisticated control systems that can deal with vital safety considerations, deliver excellent system efficiency, and still provide performance that makes the end user smile, are all part of Ricardo's engineering portfolio.

Ricardo has been active in China for more than a quarter of a century and has delivered numerous projects, from concept studies to complete production programmes. The company continues to invest in the development of new technology and the facilities needed to deliver them in China, as well as Europe and North America. China presents special opportunities, and with a strong global capability and a growing engineering presence based in Shanghai, Ricardo is on the spot to partner hybrid and EV developments.

Ricardo
W: www.ricardo.com
ONLINE READER ENQUIRY NO. 552

Laminated busbars

The automotive market is changing at a fast pace. Hybrid and electric vehicles are gathering market momentum, especially hybrid-electric cars, buses and light-duty trucks. Pure electric vehicles are in an intense, but still early, market phase. While increased electrification of the vehicle is a fact, there is also a trend for higher power ratings of power modules. This requires not only specific engineering capabilities in power electronics, but an increased need for power-distribution systems dealing with higher currents in complex designs.

Rogers Corporation is a global designing and manufacturing company of laminated busbars. RO-LINX busbars are a result of decades of experience in electric propulsion applications, such as rail, truck, and other vehicles, requiring and featuring high reliability and longevity. Rogers brings experience in laminated busbars to full hybrid, electric cars and commercial vehicles with engineering and research capabilities.

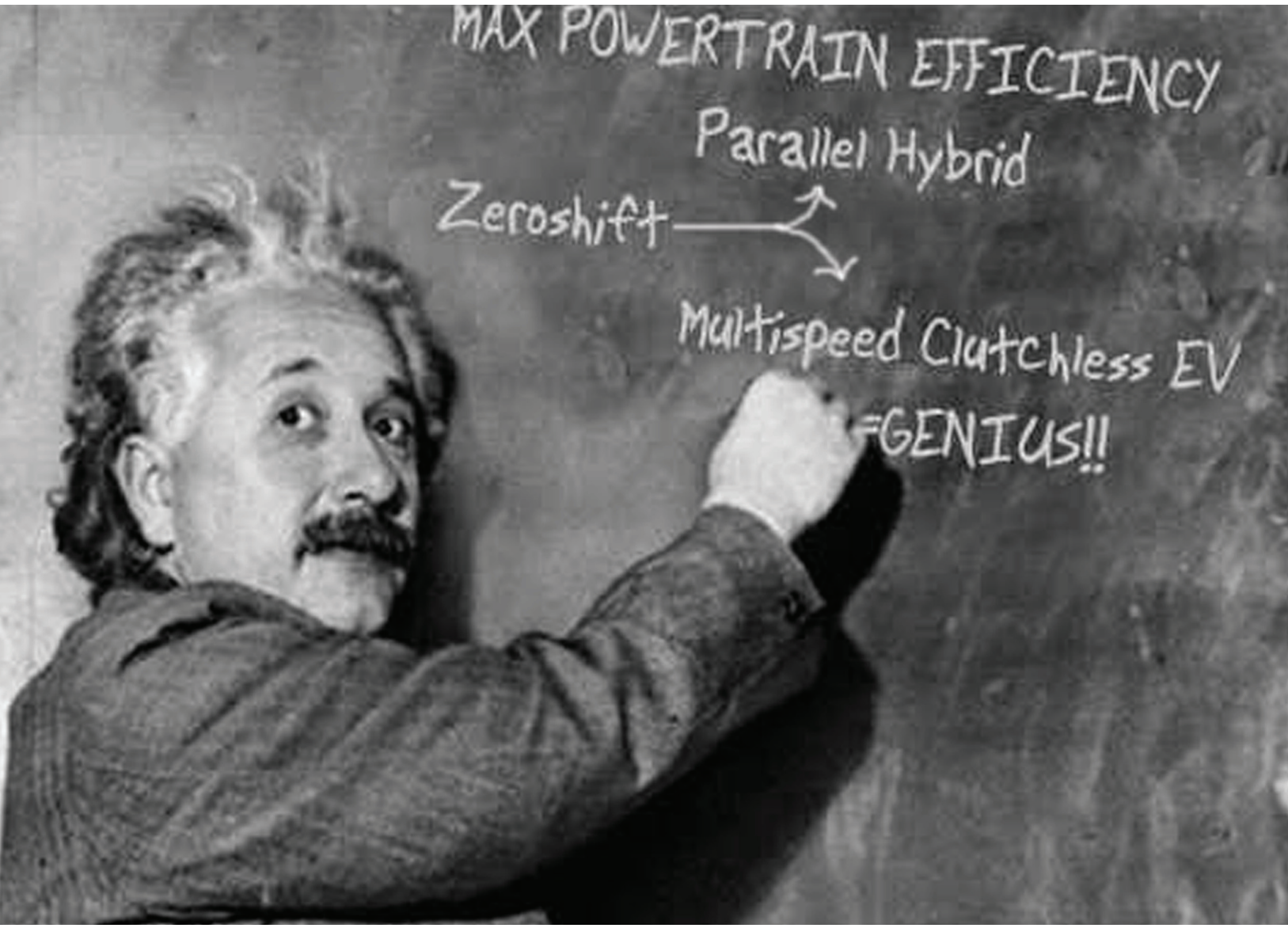
These capabilities provide solutions that find their way into various powertrain components for hybrid and electric vehicles. In an energy storage module, a laminated busbar construction connects different battery cells in a battery package, combining battery-management systems. RO-LINX busbars offer compactness, easy installation and maintenance for high-current connections, therefore resulting in much improved cooling/heat-dissipation possibilities.

In the motor drive, the laminated busbar will connect the semiconductor and the capacitor mechanically and electrically, featuring compactness, lightweight and 3D capabilities. For limiting switching losses, low inductivity of a busbar will contribute to an increased performance of the motor drive.

The laminated busbar in a DC-DC Converter module will deal with higher switching frequencies and higher currents (typically >100A) while connecting the transformer to the rectifier, enabling 3D connection.

Rogers Corporation
W: www.rogerscorp.com
ONLINE READER ENQUIRY NO. 553

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ZEROSHIFT

Advanced Transmissions

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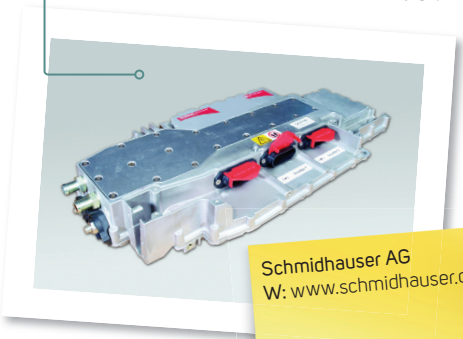
T +44 (0) 1908 303 000 F +44 (0) 1908 671 282

www.zeroshift.com

High-tech box for auxiliary power

Schmidhauser AG, a subsidiary of the drive and automation specialist, Lenze SE, has designed the multiple converter box (MCB) for drives of electrical auxiliary units in buses and other commercial vehicles. The three motor or generator outputs of the compact, liquid-cooled module, which operate in the power range of 7.5-30kW, can be used for controlling synchronous and asynchronous motors (two- or three-phase, with or without encoders). The MCB, measuring just 680 x 300 x 85mm, weighs a mere 12kg, and features a 5kW on-board transformer for supplying the vehicle with 14VDC (14V MCB) or 28VDC (28V MCB).

The MCB is programmable and can therefore be suitably tailored to individual configurations and operating conditions. It comes equipped with a unified diagnostic services interface that enables easy analysis by an external diagnostics device supporting this standard. It can therefore be integrated into a uniform diagnostics concept.



In close cooperation with a semiconductor specialist and a commercial vehicle manufacturer, the MCB has been developed for use in vehicles and meets the strict quality standards required in the commercial-vehicle construction industry. The module stands out from competing products due to its special thermal endurance and vibration resistance.

Schmidhauser AG
W: www.schmidhauser.ch

ONLINE READER ENQUIRY NO. 554

Dry rooms for low dew-point processing

A dry room for R&D and production of hybrid-electric vehicle lithium-ion batteries ensures precise control of low dew-point conditions. Room humidity control at 0°C to -45°C (32°F to -49°F) dew point is common, with dry supply air direct distribution to critical workstations at -55°C to -65°C (-67°F to -85°F) dew point.

Dry rooms can be configured to meet processing requirements with personnel access airlocks, product cart airlocks and pass-through openings. Separate areas for coater equipment can be integrated to provide easy access and product flow. Vapor-tight insulated panel enclosures ensure uniform and stable temperature and humidity conditions.

The dehumidification system includes pre-cooling of fresh air for personnel, room-positive pressure, replacement of room-exhaust air, and system-purge air for consistent dry-room operating conditions. The desiccants dehumidifier treats the air through an adsorbent medium to provide long-term performance capacity at extremely low dew-point conditions. Post-cooling and post-heat of the supply air maintains room temperature control within close tolerances.

Scientific Climate Systems
W: www.dryrooms.com

ONLINE READER ENQUIRY NO. 556

Sensor-bearing solutions

SKF, a leading knowledge engineering company, has been delivering sensor-bearing solutions for industrial traction motor control for more than 12 years, and for starter alternator control for the last two years.

Based on this knowledge and experience, the company has developed the SKF rotor positioning sensor-bearing unit to fulfill the requirements of permanent magnets or induction traction motors for electric and hybrid vehicles.

This new product provides several advantages to the electric motor control: it gives a zero speed true power on absolute rotor position angle, with accuracy below 1° and repeatability below 0.1°. The integration of the sensor function into the bearing, according to SKF patented design, enables for very precise management of the sensor-bearing unit air gap, leading to a product able to withstand continuous temperatures up to 150°C, insensitive to severe magnetic field disturbances, and robust against application vibrations.

Depending on the required accuracy, the electric consumption of the SKF rotor-positioning sensor-bearing unit varies from 20-35mA. The solution is compliant with the automotive environment, is very compact and enables motor dimension reduction.

The application knowledge SKF has developed enabled the company to design the required sensor-bearing features to improve the electric-motor efficiency, on a large range of bearing sizes.

SKF
W: www.skf.com

ONLINE READER ENQUIRY NO. 555

State-of-the-art controllers in new hybrid EV drivetrains

A pioneering project to develop a new generation of hybrid-drive systems for electric vehicles will incorporate state-of-the-art motor control technology engineered by Sevcon. The company is part of a consortium, which includes UK-based Ashwoods Automotive, working on the US$2.8 million project to develop the next generation of hybrid drivetrains that are scalable from 25-150kW. The groundbreaking initiative also involves Citroën and LifeBATT and is part-funded by the UK Technology Strategy Board.



The hybrid drivetrain, which will be suitable for commercial vehicles, will incorporate Sevcon's latest Gen4 AC motor controller. The proprietary system consists of Sevcon's Gen4 AC motor controller and an intelligent power pack module (IPPM). It has a stop/start engine system that reduces fuel consumption and emissions and can be retro-fitted to a van in a short time. The system is entirely self-powered and works by recovering the kinetic energy usually lost through braking or deceleration, which is stored in a lithium-ion battery and delivered to the wheels via a high efficiency electric motor.

Gen4 controllers can be integrated into very tight engine components without sacrificing performance and are designed to handle a wide range of electric vehicle requirements. The range is designed to control either AC asynchronous or PMAC synchronous motors and incorporates the latest in electronic-motor control technology and enclosure assembly to provide the smallest controllers in the industry relative to power delivery.

Sevcom
W: www.sevcom.com

ONLINE READER ENQUIRY NO. 557

www.ever-monaco.com

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Parylene conformal coatings

Vehicle management systems for emissions, lighting, fluid monitoring, powertrain and fuel systems are comprised of high-tech electronic systems that often come in highly miniaturized, multi-layer packages. These devices and materials must be able to survive hostile automotive environments that include high temperatures, corrosive fluids and vapors, and prolonged UV exposure.

Parylene conformal coatings are inert, pinhole-free coatings that are applied via a room temperature, vapor deposition process. Parylenes have been used for nearly 40 years because of the excellent chemical, moisture and dielectric barrier protection they provide. Parylene coatings are lightweight and ultra-thin, and penetrate even the smallest of crevices, resulting in complete encapsulation.

Parylene HT offers unmatched protection in high-temperature environments (up to 350°C long-term, 450°C short-term), making it an excellent conformal coating to protect components such as MEMS, sensors, LEDs and circuit assemblies used in leading-edge automotive technologies. Parylene HT also provides excellent dielectric protection and superior UV stability.

SCS
E: ahardy@scscoatings.com

ONLINE READER ENQUIRY NO. 558

Powertrain partner

TM4 is staking out its place as a driving force in an automotive industry that's currently experiencing a major shift. From concept to series manufacturing, the company is forging new paths with exciting products designed to respond with agility and creativity to this rapidly changing automotive landscape. TM4, a wholly owned subsidiary of hydroelectric giant Hydro-Quebec, is recognized as an outstanding innovator in the development of highly adaptable, efficient, and affordable electric-vehicle propulsion systems and wind-turbine technology, geared toward a greener, more sustainable tomorrow.

TM4 is home to an impressive team of world-class engineers, chosen for their innovative combination of expertise and experience with electrodynamics and mechanics, power and control electronics, and control software, all working toward one goal – the design and production of quality powertrain components with outstanding value and performance. The company's portfolio of permanent-magnet electric motors and controllers is only one example of this expertise set in motion. Affordable, impressively efficient, and compact, they are integrated in a wide range of vehicles being designed, developed, and road-tested today.

TM4
W: www.tm4.com

ONLINE READER ENQUIRY NO. 560

Electronic product and development services

TorLab AB in Göteborg, Sweden, provides electronic product development and services. Primary customers are the Swedish automotive OEMs. Consulting services include concept studies, test automation, power electronics and software development. Among the current projects are electric vehicle development and transmission control systems. The product range includes Tadco CAN and K-line displays, remote control systems for the Android platform, and PDA based test tools.

TorLab recently developed an analysis tool used by Saab Automobile to analyze and assist test drivers in testing the new Saab 9-5 DriveSense chassis-control system. The PDA application shows the DriveSense controlled dynamics of the car in real-time graphics. A TorLab CAN-to-Bluetooth Gateway is used as an interface to the vehicle CANbus and the PDA application then show essential information in a quick and easy to understand graphics on the PDA screen.

An upcoming application for electric cars will show battery charging and power states, utilizing the versatility of the Android operating system. Other applications for the automotive industry are available using custom-made displays and wireless systems developed by TorLab.

TorLab
E: tor.anderson@torlab.com

ONLINE READER ENQUIRY NO. 559

Safety systems for next-generation vehicles

In 2011, the automobile industry expects the authoritative safety norm ISO 26262 to become an international standard. The ISO 26262 norm defines functional safety for electronic systems in a way that is appropriate for the automobile lifecycle. This norm was derived from the IEC 61508, and, for example, provides for a safety lifecycle differing from the safety lifecycle for industrial projects, as well as for the fact that safety-relevant and non-safety relevant functions in the automotive industry are often intertwined, and therefore cannot simply be separated from each other. At this time, developments in the electric and hybrid vehicle sector are demanding new safety needs, whose implementation will be affected by the ISO requirements.

Currently, TTTech is supporting Aptera Motors in the development of the fully electronic high-performance automobile Aptera 2e. In addition to the serially produced HY-TTC 90 and the associated software modules, TTTech is providing know-how in the area of functional safety. The HY-TTC 90 is a multi-functional control unit that was specially designed for the deployment of electronic control of safety-relevant functions in mobile working vehicles and niche vehicles. The architecture corresponds to safety integrity level (SIL) 2 according to the IEC 61508 Standard, or to performance level (PL) d, as defined in ISO 13849. The safety-relevant use of the HY-TTC 90 was implemented in cooperation with the company Hydac Electronic with the development of a new generation of a hydrostatic drive.



TTTech Computertechnik
W: www.tttech.com

ONLINE READER ENQUIRY NO. 561

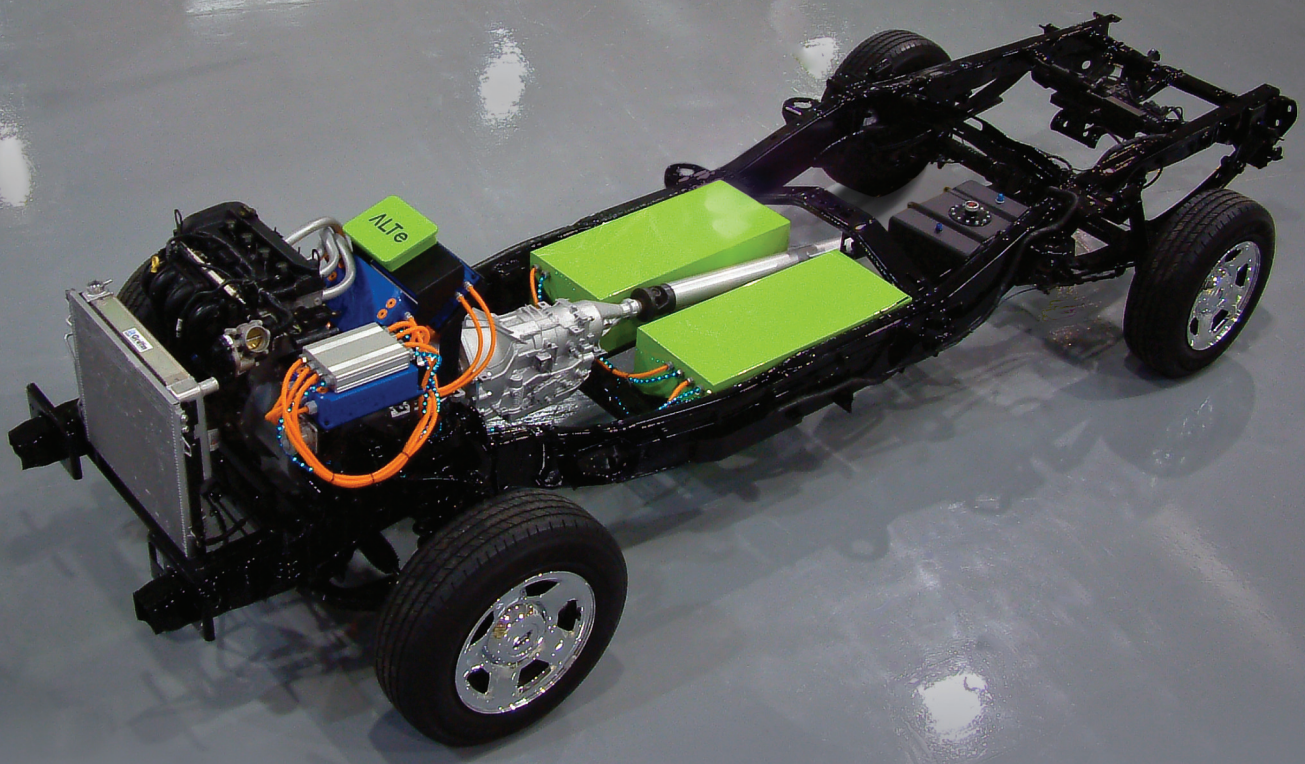
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PowerPhase breakthrough

In creating the PowerPhase 200, UQM Technologies will build upon the existing design of the 405mm-diameter, frame-size model, but increasing the peak power output to 200kW. This system has a continuous power rating of 115kW and delivers peak torque of 900Nm.

"We are pleased to add the PowerPhase 200 system to our lineup of electric propulsion systems for heavy-duty vehicle applications," says Jon Lutz, UQM Technologies' vice president of technology. "The higher peak output rating of this system will improve the operating characteristics of larger vehicles, most notably for grade climbing and acceleration."

UQM offers a complete line of matching power-electronic motor controllers to intelligently manage the operation of its motors and generators, as well as DC-to-DC converter and DC-to-AC inverter power-conversion products.



UQM Technologies
W: www.uqm.com
ONLINE READER ENQUIRY NO. 562

Fast energy storage solutions

AFS Trinity is a privately owned Delaware corporation headquartered in Bellevue, USA. The company is developing fast energy storage for vehicular, spacecraft, and stationary power systems that utilize batteries, flywheels, and ultracapacitors. The company has conducted programs with private and government organizations including DARPA, NASA, the US Navy, US Army, US DOT, Honeywell, Lockheed, and Ricardo.

American Flywheel Systems (AFS) received the first patent ever given for a flywheel battery in 1992 and merged with Trinity Flywheel Power to create AFS Trinity Power in 2000. Although AFS Trinity is not currently using flywheels in systems that are designed for consumer cars, it is actively engaged in developing flywheel power systems for F1 racing and is currently developing such a system for one of the world's top F1 teams.

AFS Trinity and Ricardo have a technology partnership agreement under which Ricardo is helping integrate AFS Trinity's Extreme Hybrid drivetrain technology into passenger cars and SUVs. The first result of this collaboration is the XH-150, a 150mpg plug-in hybrid SUV prototype.

AFS Trinity
W: www. afstrinity.com
ONLINE READER ENQUIRY NO. 564

Clutchless, multi-speed transmission creation

Transmission specialist Zeroshift has devised a multi-speed gearbox for EVs that needs no clutch – a damper inside the gear hubs and electronic control of the motor make ratio changes seamless. Having more than one gear ratio and the ability to shift without interrupting torque means the motor runs at higher efficiency, extending range by up to 10%.

"Our studies suggest that by using a compact, multi-speed transmission and a smaller electric motor, manufacturers can gain an operating efficiency of up to 10%," says Zeroshift's managing director Bill Martin. "You can use that 10% to improve EVs' range or reduce the size, weight and cost of packs."

Zeroshift is developing its compact transmission with several vehicle manufacturers. The company is also working with highly regarded consultancy firms and manufacturers on the integration of its technology into the next generation of seamless layshaft automatic transmissions for hybrid medium-duty trucks, buses and passenger cars.

The company's technology replaces the synchromesh in a conventional manual gearbox with paired interlocking rings that change ratios without interrupting the torque. To provide the required levels of shift refinement, Zeroshift's concept uses electronic control of the electric motor(s) to match the shaft speeds and an integrated passive damper system within the drive hub to isolate any vibrations. The combination of sealed pockets of silicone fluid and mechanical compression springs make shifts virtually unnoticeable to occupants.

Zeroshift
W: www.zeroshift.com
ONLINE READER ENQUIRY NO. 563

High-tech batteries for Optare Solo EV



The Optare Solo fully electric bus powered by Valence batteries marks a significant technological advance in the UK bus market. Delivering on the UK's Green Bus Fund incentive to reduce carbon emissions, Optare and Valence are proud to be amongst the pioneers of this technology supplying a practical emission-free, full-sized bus.

The Solo EV is a fully electric, zero emissions bus. This means zero PM10s, so no nitrogen oxide, no carbon monoxide, and no carbon dioxide. Replacing the IC engine installation is an all new electric drive provided by a Siemens ELFA system, using two 67kW motors, a controller, three power inverters and powered by a bank of U-Charge XP batteries from Valence Technology.

Valence's lithium iron magnesium phosphate batteries (LiFeMgPO4) were chosen due to their inherent safety and very long lifecycle. Utilizing the latest generation batteries, the battery system includes: patented battery management system; the onboard charger can be plugged into a standard three-phase outlet; a full charge in less than eight hours; optional boost charging can be undertaken through the day; and fully automated charging process.

Valence Technology
W: www.valence.com
W: www.optare.com
ONLINE READER ENQUIRY NO. 565

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1989: Alan Cocconi develops propulsion system for GM Impact

1992: Alan Cocconi starts AC Propulsion

AC PROPULSION

2003: tzero technology debuts & wins Michelin Challenge

tZero

2004: tzero technology powers Tesla Roadster

2008: BMW launches MINI E powered by ACP

2010: E-Tracer wins X-Prize with ACP power

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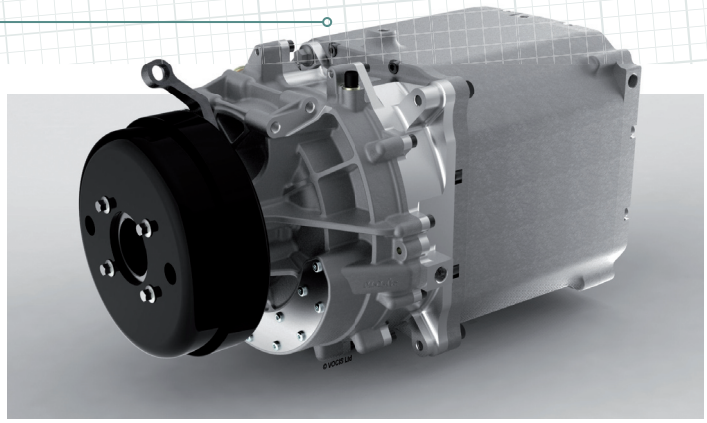
LG Chem

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View the Congress Video for reasons to attend and the latest event information at **www.sae.org/congress**

P101372

Next-generation compact 70kW drivetrain



A new 70kW electric-vehicle powertrain has been developed by Zytek Automotive. Building on the knowledge gained from more than 15 years of niche EV design, manufacture, and operation, this new design optimizes the installation of the 70kW Zytek motor, where space for the e-drive and transmission is significantly reduced. This new product will be particularly useful in vehicle conversions where the powertrain installation space is at a premium.

The new e-drive system is based on Zytek's permanent synchronous machine, developing a continuous output approaching 60kW, with a peak performance of 70kW and up to 960Nm of propshaft torque. Should additional performance be required, the motor torque and speed can be increased, generating significantly increased performance. The electric engine is mated to a highly efficient, lightweight, concentric, single-speed transmission. This compact unit was developed by Vocis Graziano specifically for Zytek in only 12 weeks, and weighs just 26kg. If required, the system can be supplied with a drum brake attached to the rear of the transmission to provide a simple cost-effective, park brake installation. The compact dimensions of the new drivetrain enable easy integration into a range of vehicles, leaving maximum space available for batteries. The 3.1:1 gear ratio has been designed to work in conjunction with high-volume transverse rear axles, the ratio of which can be changed to alter vehicle top speed and wheel torque. The motor and gearbox are both water cooled, enabling prolonged operation at high power, high speed, should sufficient battery capacity be available.

Zytek Automotive
E: steve.tremble@zytek.co.uk

ONLINE READER ENQUIRY NO. 566

High-tech suppliers

In less than four years since Vocis was formed by the core team that conceived, designed, and developed the DCT in the Bugatti Veyron, the company has become recognized as one of the leading specialists in the field of DCT control systems design and development. Today Vocis is working with many high-profile OEM customers around the world to assist in new transmission developments.

Vocis can offer complete design, development, and integration of driveline control systems for any automated transmission system or active torque distribution axle system. Vocis is heavily involved in electric and hybrid vehicle activities and has completed many projects in this field. The leading supplier is continually investing in R&D to ensure it remains at the forefront of transmission controls.

Vocis is part of Oerlikon Graziano and can therefore offer engineering services backed up by complete transmission design and development for customer specific applications.

Oerlikon Graziano is a global player in power transmission field with more than 58 years of experience. Today the company is focused on the major automotive markets, including the zero emission sector, off-highway and industrial application. Through its global footprint in markets such as the USA, China, India, Italy, Russia, and the UK – and its innovation, experience and high-tech solutions, Oerlikon Graziano is able to meet the customer needs, providing complete driveline systems as well as single gearing components. The company's sales amounted to US$420 million in 2009 with a workforce of almost 3,300 worldwide.

Vocis
W: www.vocis.co.uk

ONLINE READER ENQUIRY NO. 567

Battery recycling solutions

Toxco has been at the forefront of the battery recycling industry for the past 25 years. It is excellently qualified to effectively and efficiently manage the hybrid and electric vehicle batteries reaching their end-of-life now and in the future.

Toxco maintains processes to recycle both NiMH and Li-Ion battery packs and production scrap. Currently, it provides its recycling services to an assortment of OEMs, managing prototype and production model batteries. All Toxco's facilities are fully permitted and follow a strict program to ensure persistent compliance with all applicable state and federal regulations. Additionally, all of the company's facilities are covered by comprehensive liability and environmental insurance to provide an extra level of protection to customers.

Toxco operates three facilities across the USA, strategically situated to provide a convenient end-of-life destination for batteries and production scrap from companies located worldwide. Each facility gives the utmost consideration to proper confidentiality procedures and ensures that no intellectual property will be compromised during the recycling process.

Toxco is expanding its NiMH and Li-Ion recycling operations with the help of a US$9.5 million dollar grant from the US Department of Energy. This grant is being used to construct a new recycling line specifically to process and recover crucial materials from the large format EV/HEV batteries of the future.

As the HEV market grows, Toxco will continue to provide comprehensive end-of-life management for all batteries in a safe and environmentally sound manner.

Toxco
W: www.toxco.com

ONLINE READER ENQUIRY NO. 568

The Future
of Power Management Technology

From hybrid traction inverters to Power-Pro power distribution modules and high-voltage PowerPro-Max junction boxes, Arens is driving the development of power management technology required by today's rapidly expanding hybrid vehicle market.

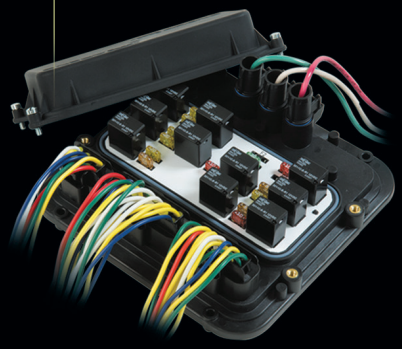


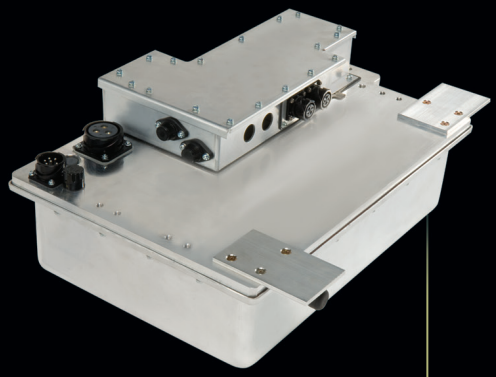
Arens is North America's leading producer of HEV drivetrain components and systems, providing traction inverters with capacities up to 500kw.



Arens power inverters are available in DC to DC, or DC to AC configurations up to 25kw with either single or three phase output in 120, 208 or 240 Volt.

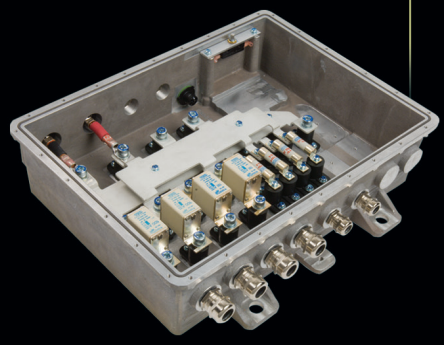
Arens has developed a series of intelligent power distribution modules for today's complex vehicle electrical systems. These units use state-of-the-art digital electronics to improve both power distribution and management.





Arens is designing and producing automotive-hardened traction inverters for the passenger car market. With production volume capacity and output capacities ranging from 30kw to 150kw, Arens is becoming a key supplier to the hybrid automotive market.

Arens also produces a wide range of high-voltage junction boxes for routing power throughout hybrid vehicles, using CAN technology to communicate with various vehicle electrical systems.



If you are developing a hybrid vehicle or HEV component systems, you need to talk to Arens about your power management requirements. Visit www.arens.com and see the future in power management technology for today's and tomorrow's hybrid vehicles.

ARENS

Arens Controls Company, L.L.C. | Phone: 847.844.4700 | www.arens.com

Eco-friendly exhibition and conference

Under the patronage of HSH Prince Albert II, 'EVER Monaco' is an international event recognized as the meeting place for manufacturers of ecological vehicles and the parties involved in the renewable energies sector. For the sixth year, 'EVER Monaco' will be held in the prestigious Grimaldi Forum congress center, in the Espace Ravel, a 4,000m² area at the heart of the center, looking out onto the Mediterranean Sea, from March 31 to April 3, 2011.

The exhibition will welcome manufacturers of ecologically friendly vehicles as well as battery manufacturers, and the equipment suppliers.

There will be two ride and drive circuits: one for licensed vehicles and one for two-wheeler vehicles, including a parade past the most famous landmarks of Monaco. The two-wheel electric circuit is a challenge open to series vehicles from exhibitors only. There are two tests: an autonomy test and an acceleration test. At the end of the challenge, the winners will be presented with an award.

The Monte-Carlo Rally for Alternative Energy Vehicles is registered in the calendar as an FIA alternative energies cup, and this event will run over two days and one night and is open to all types of ecological vehicles.

The sector of the exhibition on renewable energy will welcome services, equipment, and products associated directly or indirectly, in whole or in part, with renewable energy, the environment, and energy saving.

The conferences will have a scientific orientation, bringing together specialists from universities and industry in the ecological-vehicles and renewable-energy sectors.

MITI
W: www.ever-monaco.com

ONLINE READER ENQUIRY NO. 569

High power products

Lear Corporation is a leader in providing electrical power management systems for hybrid and electric vehicles. Among these critical systems are high voltage wire harnesses, high voltage terminals and connectors,on-board battery chargers, Electric Vehicle Supply Equipment (EVSE), and other key power distribution and electronics products.

"We have contracts with more than eight global OEMs to deliver high power products," says Eric Partington, Lear's director of product strategy, "Lear's systems offer leading efficiency, compatibility and industry acceptance and our portfolio includes electrical and electronic products that span the entire range of electrified vehicles from micro hybrids to full electric vehicles."

A proven innovator, Lear has over 130 issued and pending patents in this space. Their highly efficient on-board battery chargers, level-I and level-II EVSE systems, and high voltage power management capability all combine to deliver complete battery charging systems for plug-in electric vehicles.

Lear's rich heritage and expertise in electrical power management systems has also propelled its high voltage electrical distribution business. Today, Lear is developing and delivering efficient high voltage distribution systems including manual service disconnect, battery disconnects, and ultra-compact high voltage terminal and connector systems in addition to the high voltage wire harness for hybrid and electric vehicles.

Lear Corporation
W: www.lear.com

ONLINE READER ENQUIRY NO. 570

Magnetics application engineering

Optimal efficiency in high-voltage and high-current applications associated with EVs presents innovative technical challenges for power-conversion designers. Designers must consider performance across a variety of environmental and internal system conditions. Magnetics distributed gap material, Kool Mμ, is an excellent choice for both charging and onboard power-conversion applications for EVs. The flux capacity of Kool Mμ is consistent over a wide temperature range, giving a stable design for EV applications in varying conditions.

Kool Mμ cores exhibit excellent stability and reliability at high temperatures up to 200ºC. The low-core losses and distributed gap structure enable Kool Mμ to handle high currents without developing hot spots, leading to increased efficiency and a cooler inductor/inverter. Magnetics Kool Mμ cores are available in a variety of shapes, including toroids, E cores, and U cores. Several block sizes provide the option to custom design large inductors for the needs of a specific application.

Magnetics
W: www.mag-inc.com

ONLINE READER ENQUIRY NO. 571

On-vehicle automotive high-voltage battery chargers

Delta-Q Technologies, founded in 1999, supplies vehicle manufacturers with power-conversion solutions, enabling the shift toward environmentally friendly electric-drive systems. For the automotive battery, plug-in, and hybrid electric vehicle markets, Delta-Q has developed an automotive-grade, high-voltage, high-power battery charger, designed to be integrated into onboard electric-drive systems.

Delta-Q introduced the QMX on-vehicle charger at the EVS25 show in Shenzhen, China. The current Delta-Q QMX is now into its third generation and reflects the evolving needs and design flexibility demanded by major automotive OEMs. The QMX3.3 is an extremely compact, liquid-cooled, 3.3kW charger, implementing many state-of-the-art components to improve efficiency and packaging. It has full CANbus functionality, J1772 compatibility, and is available with or without an auxiliary 12V power supply, making it suitable for any electric drive-vehicle system. The first of a family, the 3.3kW onboard charger will soon be followed by 6.6kW and 1.5kW versions.

In just over a decade, Delta-Q has become a leader in onboard chargers for battery-powered vehicles and equipment such as golf cars, industrial floor-cleaning machines, utility vehicles, and low-speed electric vehicles. Over 600,000 Delta-Q chargers are in use around the world, demonstrating the company's expertise in supplying high power from the electricity grid to a variety of lead acid and lithium battery packs from any conventional electrical outlet.



Delta-Q
W: www.delta-q.com/products/qmx3_3.html

ONLINE READER ENQUIRY NO. 572

COMING SOON!



The new Tri-Polar Lead Cobalt Battery, now under development, is designed to replace Lithium-Ion Batteries in Electric Vehicles with approximately the same energy density, fast charge capability, longer life and lower cost.



The Silver Volt GT is being designed to have a range of 250 miles with Lead Cobalt Batteries combined with Apollo's Alkaline Fuel Cells.

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VINCI ENERGIES

EUROVIA VINCI

Turnkey charging-point installation

EVolution, the joint venture between Eurovia and Vinci Energies, has completed the installation for Nissan Motor GB of four electric-vehicle charging points at the O_2 Arena in London. As part of its recent three-year deal to become the official automotive partner for the O_2 Arena, Nissan has created an innovation Center on the site, which will be used as the communications hub for the launch of the Nissan Leaf, the world's first, mass-produced, 100% electric family car. As part of that center, Nissan turned to EVolution to provide the complete turnkey charging-point installation.

"We chose to work with EVolution as they are ideally placed to provide us with the technological expertise and full service that we require for such a high-profile launch venue," comments marketing communications manager, Nissan Motor GB, John Parslow.

The works completed by EVolution included all civil infrastructure works, trenching, concrete supports and plinths, reinstatements, electrical works, switchgear upgrades, cable installation and the installation and commissioning of Elektromotive 'Elektrobay' charge points.

Taking advantage of its wealth of expertise, and benefiting from both civil and electrical-engineering know-how, EVolution was able to perform a site survey, then design and engineer an appropriate solution around the existing site infrastructure. A three-phase 160A supply was installed to a new distribution board, local to the electric vehicle charging points. This design will accommodate two 13A single-phase, two 32A single phase-standard charging points and a 50kW-DC rapid charger, offering electric vehicles a choice of charging solutions.

EVolution
E: mike.halliwell@evolution-vinci.co.uk
ONLINE READER ENQUIRY NO. 573

Optimum sounds for eco-friendly vehicles

NoViSim has developed a robust and efficient process, supported by easy-to-use software tools, for designing, evaluating, and delivering appropriate sounds for electric and other quiet low-carbon vehicles. In conjunction with NoViSim's partners Brüel & Kjær, ECTunes, and Meridian Audio, these tools will be available as hardware and software systems that are suitable for use throughout the development process from initial sound design, through on-road validation, and sign-off and to final production solutions.

The process starts using the exterior sound simulator, an interactive audio-visual simulator for creating the exterior sound experienced by a pedestrian as a vehicle is driven around a virtual scenario. It enables, in an extremely efficient manner, the controlled evaluation of many potential sounds throughout a variety of realistic scenarios.

When sounds are ready for prototyping on real vehicles, SimSound, a compact, ultra-portable but powerful eight-channel sound generation system, controlled by parameters from the vehicle's CANbus, is excellent for demonstrating, fine-tuning and signing-off the sound or sounds developed using the exterior sound simulator on a real vehicle in a long-term trial on public roads.

SimSound has been embedded onto a DSP-based solution by Meridian Audio to enable manufacturers to make their own solutions for delivering sounds on production vehicles, using the SimSound algorithms and a common dataset with the development tools. Alternatively, a turnkey solution using the SimSound engine is available from EC Tunes.

NoViSim
W: www.novisim.com
ONLINE READER ENQUIRY NO. 574

Innovative drive-shaft systems for testing

Tectos has set new standards for testbed drive-shaft systems, with new drivetrain concepts for testing electric and hybrid vehicle transmission systems. The company excels in customized solutions, especially in the area of testbed driveshafts, as demonstrated by the t1000 elastic coupling and the automatic docking device. In addition to easy and quick maintenance, the t1000 elastic coupling lets users adjust stiffness by changing elastic inserts. This guarantees the highest possible longevity. The tDock is a quick docking device and is a proven extension to the company's outstanding driveshaft systems. It compensates for all misalignments and is practically noise-free in operation. Installation is effortless, as it can be positioned on the original engine or gearbox flange.

Tectos
W: www.tectos.at
ONLINE READER ENQUIRY NO. 575

Pioneering vehicles

Imagine the pleasure of passing the pump in a vehicle that travels over 100 miles on a single gallon of fuel (or energy equivalent). During the recent Automotive X Prize competition, three pioneering vehicles made this goal a reality with the support of innovations from BorgWarner. To recognize their achievements in developing fuel efficient and environmentally friendly vehicles, BorgWarner presented innovation awards to Edison2, Aptera, and ZAP. BorgWarner's VTG turbo boosts the performance and fuel economy for the four-passenger Very Light Car by Edison2, the Mainstream Class X Prize winner. Two finalists in the Alternative Class for two-passenger vehicles, the battery-powered electric Aptera 2e and ZAP Alias, benefited from the BorgWarner 31-03 eGearDrive transmission.

BorgWarner
E: enielsen@borgwarner.com
ONLINE READER ENQUIRY NO. 576

Integrated circuits

Linear Technology designs, manufactures and markets a broad line of standard high-performance analog and mixed-signal integrated circuits. Applications for the company's products include telecommunications, cellular telephones, networking products, notebook and desktop computers, video/multimedia, industrial instrumentation, factory automation, process control, military and space systems, and automotive electronics.

Linear's family of multicell, high-voltage battery stack monitors are complete battery monitoring ICs that include 12-bit ADCs, precision-voltage references, a high-voltage input multiplexer and a serial interface. Parts can be connected in series, without optocouplers or isolators, therefore enabling the monitoring of every cell in a long string of series-connected batteries. Applications include electric and hybrid electric vehicles, high-power portable equipment and back-up battery systems.

Linear Technology
W: www.linear.com
ONLINE READER ENQUIRY NO. 577

Comprehensive reports

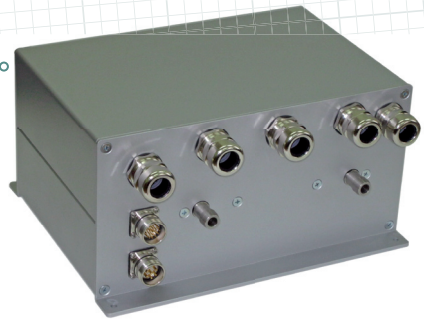
EVs are appearing in the air, on the land, and on and under water, whether hybrid or pure electric, military or non-military.

Electric cars will be about half the value of the market over the next ten years, so better information is needed in this area. IDTechEx offers reports on the whole scene, 'Electric Vehicles 2010-2020' and 'Electric Vehicle Traction Batteries 2010-2020', with more detail on cars from 'Hybrid and Pure Electric cars 2010-2020' and 'Car Traction Batteries: The New Gold Rush 2010-2020'. East Asia is and will remain where most electric vehicles are made and used, and the report, 'Electric Vehicles in East Asia 2011-2021' scopes this data. All these reports are updated. One hour of free consultancy from IDTechEx global experts, by phone or email, comes free with each report.

IDTechEx
W: www.idtechex.com

ONLINE READER ENQUIRY NO. 578

Latest SAC motor-controller product



Sensorless AC drive control is not a very new technology in its basic form. However, it can bring high cost reductions, especially through the increased reliability and lower installation/maintenance costs. Experience in many applications has shown that speed or position sensors very often fail due to shock, vibrations, temperature, chemicals, and damaged cables/connectors. Problems with noise captured at the sensor inputs are also eliminated. The main problems of the sensorless control are very low speeds, high speeds and very high torques. These things have to be addressed properly in traction and similar applications where very high starting torque and high-end speeds are required.

Piktronik is an Austrian-Slovenian company working on the research, development, and production of components and complete solutions for electrical or hybrid vehicles and boats with more than 20 years of experience with battery-powered vehicles/boats and almost 10 years of experience with sensorless AC-motor control. The product range is very broad: from freely programmable battery chargers with built-in battery monitoring functions to the state of the art sensorless AC-drive motor controllers with the power range from a few kVA up to 140kVA peak.

The recent addition to the SAC motor controller family is the SAC41. With its compact size, integrated power switch, liquid cooling and high power density it is well suited to the weight and size-sensitive battery-powered propulsion systems. It offers nominal power of 80kVA and 120kVA peak at 340Vdc. In addition to pure sensorless solutions, it is possible to use either a wide variety of position sensors or low-cost sensors for very low-speed control, combined with sensorless control at higher speeds.

Piktronik
W: www.piktronik.com

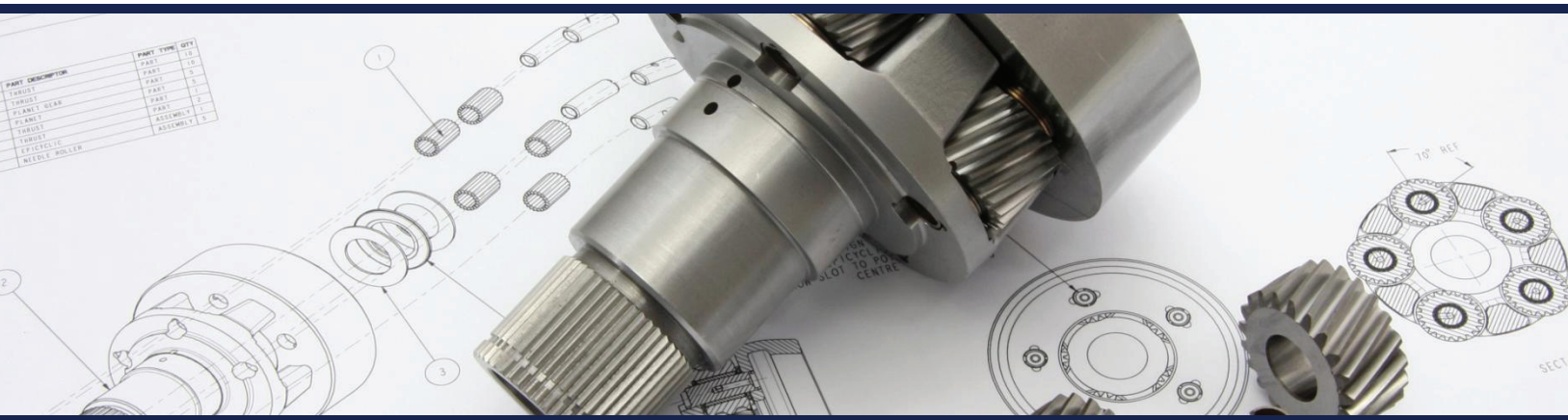
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LAST WORD



Films such as *I, Robot* with the Audi RSQ are pointing to a future where fully autonomous vehicles are the norm



"We shouldn't just focus on building hybrid and electric vehicles as quickly as we can"

The subject of population has returned as a politically correct topic after a decade or two in the wilderness. And it's about time too, when you consider the challenges facing our world. So, what about having a similar discussion over vehicle population? Nobody can deny that we have seen an increasing growth rate of the global vehicle fleet in recent decades. Today, it stands at over 800 million vehicles, but demand for mobility is set to treble that figure to more than two billion by 2050.

Most of us focus on the fuel problem, and very few would argue that we will be able to produce more oil in 2050 than the amount we consume now. So how will these two billion vehicles be powered? The answer, we keep hearing, is electrically. Long term, it is important that there is no limit on the amount of electricity that we produce. Unlike oil. However, a recent Deutsche Bank report argued that disruptive hybrid and electric vehicle technologies will have a much more positive impact on oil efficiency than the market expects. Indeed, their model predicts that after a price spike later this decade, the take up of hybrid and electric vehicles will be so rapid that by 2020 global oil demand will be in unstoppable decline. This will be seen as a challenge for some but an opportunity for others, but the question remains as to whether we can roll out these vehicles fast enough.

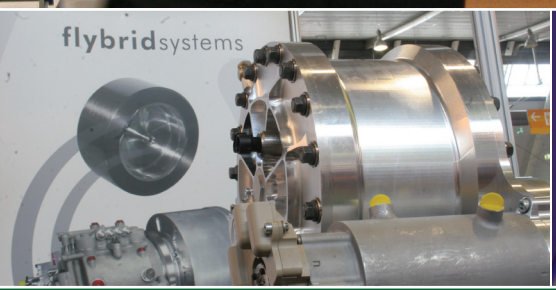
Even if we solve the problem of using non-sustainable fuels in inefficient engines, we also need to use the vehicles themselves more efficiently. Most vehicles sit idle on the driveway or parking lot for 90-95% of the time, and we should view this as a waste of resources. The fact is that the availability and cost of materials will limit our ability to support a fleet of two billion vehicles. New ownership models such as car clubs, combined with autonomous vehicles, will mean that we should be able to meet mobility expectations with a fraction of the number of vehicles, which will also help reduce congestion. The Lexus concept in *Minority Report* or the Audi RSQ in *I, Robot* should not be confined to the realms of science-fiction; they should be the future. The technology exists now but we need to implement it on a large scale. Imagine sending a request via your iPhone and a minute later a car picks you up. It drives you where you want to go while you relax, work, or watch a movie, all at a fraction of the cost of owning your own vehicle.

We shouldn't just focus on building hybrid and electric vehicles as quickly as we can. We need to think about how they are going to be used. Ideally, we will redefine our attitudes toward private transport to maximize efficiency. Going electric is half of the solution, but redefining ownership models, and combining them with autonomous vehicle technologies, is equally important.

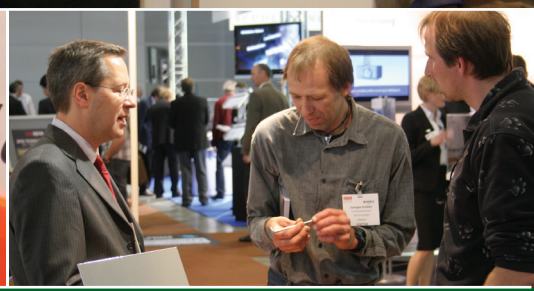
Although most of us, with the exception of investors, will not notice it, the next decade will be a period of change. From 2020, these alternatives should emerge on an unheard of scale. If this happens, a change of attitude could be just around the corner. When something cheaper, cleaner, faster, and more fun comes along, history teaches us that the old way dies out much more quickly than we were expecting.

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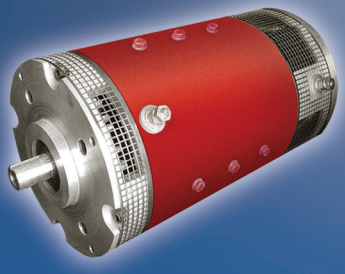
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