



The Bolt EV is powered by Tata's new e-drive powertrain. A 80kW electric motor mated to a single-speed transmission can help the car travel 100km

# Half price

**T**ata Motors European Technical Centre (TMETC), based in Coventry, UK, is currently developing a low-cost EV for India, its parent company's domestic market. Progress is at such an advanced stage that, in September 2016, the company demonstrated a prototype based on Tata's Bolt, an existing B-segment hatchback created under its Falcon program.

Tata's Bolt EV Concept Demonstrator (not to be confused with the Chevrolet Bolt) uses a GKN Evo liquid-cooled drive motor, developing 80kW and 240Nm. It drives the front axle through a fixed-ratio transmission. The battery has been developed in-house by TMETC using lithium-ion pouch cells from A123 Systems.

TMETC has created a modular design that's suited to a variety of configurations. Pouches are paired in cassettes, wired in parallel, and the cassettes are stacked into modules linked in series. With 24 modules of 10 cells, the battery runs at 396V and has a nominal capacity of 15.6kWh.

"The aim is to achieve a driving range of 120-140km," reveals David Hudson, group chief engineer at TMETC. "It's not intended to be an interstate vehicle. It's for congested cities and there are a few of those in India."

**Tata is aiming to create low-cost EVs for the masses and much of the R&D learning for that goal stems from the Bolt EV Concept Demonstrator**

WORDS: LEM BINGLEY

The Bolt's e-drive system is designed as a straight-up replacement for IC powertrains. The battery completely replaces the fuel tank and supplants the spare wheel. "It's fully under the floor, so there are no weird lumps and bumps," says Hudson. "All of the crash systems of the car are unaltered; the engine is also smaller, which is further good news for crash scenarios."

### IC engine efficiency benefits

The battery is split into two parts, either side of the twist-beam rear axle. Chilled coolant is supplied via a dedicated system, although in production it would be integrated with the car's HVAC system.

At 1,265kg, the EV conversion fits within the weight range of existing Bolts, enabling brakes to carry over, although there is still work to do to integrate both regenerative and mechanical braking. Meanwhile, the suspension has been retuned to reflect the new weight distribution, but Hudson says the project "hasn't disrupted a car that we make in the tens of thousands".

The relatively modest battery helps to meet the project's goal of developing an EV that might be profitable in India. Trends in battery cell prices are also helping, as are changes in conventional engines. "Things such as electric water pumps have become commodity items," Hudson states. "We can go to Pierburg for an off-the-shelf item for US\$50 and it's fully validated, compact and reliable. Five years ago they were all weird prototypes costing hundreds. The wider drive



for efficiency in IC engines is building a component library that helps us deliver.”

Given the ready availability of parts, the OEM’s job is seamless integration, Hudson argues. “We’ve put a lot of work into the driveability calibration and the energy management, which are all software functions,” he notes, adding that this task will increasingly define brand values as EV makers converge on the same key suppliers. “How a car drives will come down to decisions in software tables,” he states.

The approach to energy recuperation is already a key differentiator, from the fierce retardation of BMW’s i3 to the default gliding

1. The Tata Bolt EV sprints from 0-100km/h within 10 seconds with a top speed of 135 km/h

2. The Low Cost Auxiliary Power Unit (LowCAP) project is looking into integrating Tata’s two-cylinder engine with Ashwoods’ motor generator and inverter technology, to develop a low cost auxiliary power unit for range extender EVs



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David Hudson, group chief engineer, Tata Motors European Technical Centre

mode of VW’s e-Golf, supplemented by selectable levels of regeneration.

“We don’t intend to give people a choice, though there might be two power modes – an eco mode and a sport mode,” Hudson says. “If you’re going for sport mode you might want more engine braking.” The prototype Bolt EV offers a lively sport mode through its rotary gear selector – a part borrowed from Tata-owned Jaguar Land Rover (JLR).

TMETC has also been working with JLR on the thorny issue of range prediction. “A storage battery is a very complicated thing, subject to a lot of variables,” Hudson notes. “But the only thing the customer wants to see is how many miles they can go, so how do you tell people that? The answer the driver needs is what’s most useful on the day; it may not always be the same. We’ve put a lot of work into this and have done a lot of collaboration with JLR, because the problem is the same for every EV manufacturer.”

**Range extender development**

In September TMETC also demonstrated a potential application for LowCAP, an auxiliary power unit jointly developed over the past three years with Ashwoods Electric Motors and the UK’s University of Bath.

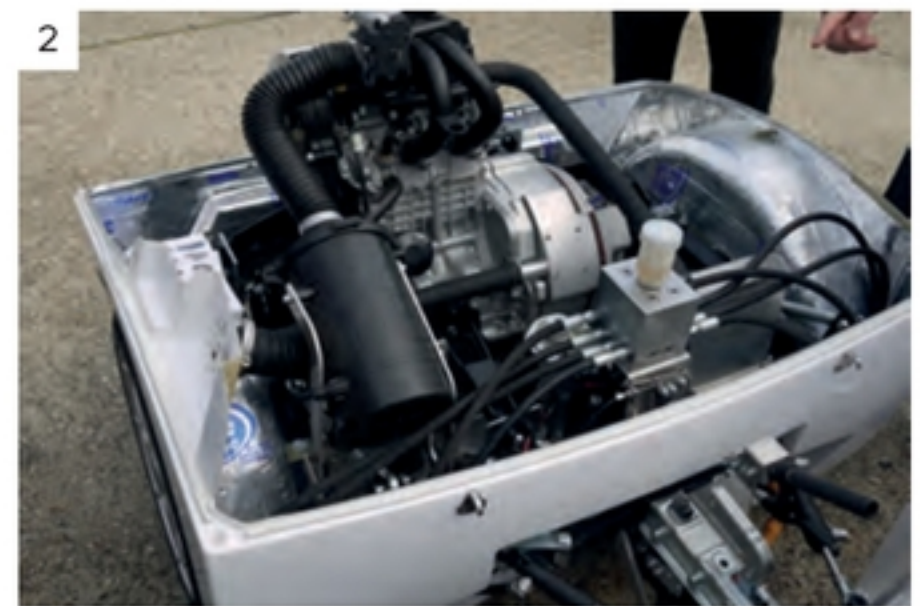
is the LongRanger trailer developed by AC Propulsion for Toyota’s electric Rav4. EP Tender’s business model is to hire out trailers to enable EV owners to tackle the occasional long journey.

The demonstrator trailer can generate up to 25kW and could provide up to 500km of range between fuel stops.

EP Tender will need to persuade EV makers to cooperate and provide a socket. Prototype units are connected via a junction box on the EV’s DC feed, although software changes are not necessary. “The car just thinks it’s doing really long regen,” says Hudson. “There is also a CAN connection, so the trailer knows the host EV’s state of charge.”

LowCAP was initially developed as a potential internal range extender. It’s based on the 624cc twin-cylinder engine from the Tata Nano, with an Ashwoods generator, controller and inverter.

The company is cooperating with French startup EP Tender, which aims to launch towable range extenders for short-range EVs like Renault’s Zoe. The concept isn’t new though – the best known precursor



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3. The LowCAP system has been integrated into an EP Tender trailer, with a common coolant loop shared by the engine, generator and power electronics



“We worked together on thermal and mechanical integration to allow a common coolant circuit,” notes Hudson. “The engine is running a bit cooler than it might normally like, with the power electronics a bit warmer, but we have mapped all the efficiency losses and concluded that it’s a very effective thing to do.”

Coolant runs from the radiator to the power electronics, through the generator, up through the engine and back to the radiator. “It effectively runs an open thermostat, so you have as much temperature drop as possible,” Hudson says. Output is from 10kW at 2,000rpm to 25kW at 4,000rpm, with claimed economy better than 270g/kWh. ◻

4. Development of the Bolt EV prototype took place at the Tata Motors European Technical Centre (TMETC). In 2017, the Indian OEM’s hybrid and EV capabilities will be further developed following completion of the National Automotive Innovation Centre. This new facility will bring together TMETC, Jaguar Land Rover and WMG



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