DRIVEMODE

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Why reducing drivetrain size can make electric cars even greener

Battery electric vehicles (BEVs) already go some way to reducing air pollution in Europe. The latest developments in electric drivetrain technology, however, are helping to take that one step further

Battery electric vehicles (BEVs) are starting to win market share in Europe, as consumers opt for cleaner technology and lawmakers strengthen emissions rules for automakers in a bid to bring down pollution levels.

BEVs already go a long way to improving the environment, particularly in cities, by helping to cut CO_2 and particulate pollution. But the latest developments in electric drivetrain technology are helping to take that one step further.

Making motors smaller and encapsulating them in modular systems with other key components could not only be the next step to **cutting the costs of electric motoring**, but it will help **make it even greener too**, in a variety of ways.

Automakers are under intense pressure to move beyond the initial euphoria of introducing zero-emissions vehicles to the market and start using these models to help make serious inroads into reducing CO_2 pollution.

This project has received funding from the European Union's Horizon 2020 research and Innovation programme under grant agreement N° 769989.

The European Union's target this year aims **to reduce average fleet emissions of new cars** sold in the bloc to 95 grams per kilometre. Automakers that fail to hit this target will face fines of 95 euros for every excess gram of CO_2 they emit. Understandably, they are keen to comply and avoid penalties that can quickly mount up to many millions of euros.

"The incentive is rather big. The reaction of most automakers - complaining and at the same time saying 'yes, we will do more' - speaks for itself," says Juergen Pieper, an auto analyst and director of research at Bankhaus Metzler in Frankfurt.

The emissions targets are one of the reasons Pieper believes the shift towards an electric future is now fully underway, despite the fact that technology needed for the next generation of BEVs is still in its infancy, technology such as higher-voltage electrical systems.
While most manufacturers have traditionally used 400-volt layouts, automakers such as Porsche and Hyundai have started to introduce larger 800-volt units with big environmental benefits.

Professor Damijan Miljavec of the University of Ljubljana's Faculty of Electrical Engineering was instrumental in developing a high-voltage unit for the **European Union research project Drivemode**, which is seeking to develop a highly efficient and **compact modular electric drivetrain** consisting of power electronics, a gearbox, and the motor. These modules are designed to be **scalable according to the power requirements of different vehicle segments**.

Video showing how the modular drivetrain components, developed by the EU project Drivemode, work

Professor Miljavec's initial task was to choose a smaller, greener motor for the module as he explains: "We increased the speed [of the motor] by a factor of two, from 10,000 [revs per minute] to 20,000, which means, to maintain the same power output, we can halve the size of the motor, **which reduces the amount of copper and the amount of magnets**."

This is significant because permanent magnet motors use rare-earth materials that are very **environmentally unfriendly** to mine. The ores that rare earths are extracted from are often separated using large amounts of toxic compounds such as sulphate, ammonia and hydrochloric acid. Processing one ton of rare earths can result in many more tons of toxic waste.

In addition to halving the use of these materials in their motors, Drivemode also claims the **modules are fully recyclable**: "You can take out the copper and reuse the parts by melting them down and

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producing new parts. You can also quite easily remove the magnets and reuse them, so it is 100% recyclable," Miljavec says.

From a practical view, these smaller, lighter motors also offer energy savings for consumers. **Reducing the weight of the vehicle means it can travel further on a single charge**. This leads to an increased vehicle efficiency of about 3% or 10 miles (16 km) more range for an average BEV, industry observers say.

The **silicon carbide inverter** used by the EU project also reduces power leakage between the battery and the motor by up to 2%, which represents a significant saving for BEV drivers.

Additionally, smaller, high-voltage systems such as Drivemode's are much faster to charge: Hyundai, which launched its Ioniq 5 last month using an 800-volt setup, says the BEV can reach 80% of its full power within 18 minutes on a fast charger, which is about a fifth of the time needed by a conventional 400-volt car. This could remove the need to pack cars with additional batteries in a bid to extend range and avoid lengthy charging stops. Since batteries contain materials such as lithium and cobalt that are mined using high levels of energy and water, **any reduction in battery demand has a positive effect on the environment**.

As automakers move away from fitting electric drivetrains to existing combustion-engine vehicles and more towards developing brand new BEVs**, modular systems can offer obvious environmental benefits in standardising**, simplifying and ultimately speeding up the manufacturing process.

"In principle, standardised modular designs could offer pre-set capacities, voltages, and form factors in much the way that AA or AAA batteries do for many small electrical products today," says Professor Peter Wells, of Cardiff University's Centre for Automotive Industry Research. Wells also sees the benefits of an industry-wide move to pool next-generation BEV technology that could help smaller, less cash-rich automakers build their own electric vehicles.

This will lead to a larger market for BEVs that will not only help automakers, but also the environment around us.

By David Jolley

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