# Supercharger market potential not blown out of proportion – supplier

*The market leader in automotive supercharging believes there is a new lease of life in store for the supercharger*

Turbocharging has become a well-established strategy to improve the performance, efficiency and cleanliness of an internal combustion engine (ICE), but the supercharger has yet to benefit from the gust of mass-market demand.

Both technologies are forms of forced induction, with a preamble to push greater air density into the engine. But while traditional turbochargers run off exhaust gas, the supercharger is belt-driven and suffers limited 'lag' when accelerating. At a basic level, superchargers are also generally simpler to integrate into an ICE in comparison to a turbocharger. With a similar function and benefits, why then has the supercharger seen less success in the market?

Economy of scale accounts for a significant part of the equation. The simple fact is that the size of the turbo market provides a scale benefit with which supercharger technology struggles to compete. "The price of a turbocharger today has almost reached the point of a commodity," noted Dan Ouwenga, Engineering Manager, Boosting at Eaton.

By contrast, the supercharger remains a more niche application, but various market research firms believe it is set for significant growth past 2020. Technavio forecasts the global supercharger market to grow from 5.45 million units in 2016 to 10.65 million in 2021. The US remains a stronghold for supercharger demand, and in 2016 accounted for 40% of global market demand. Research and Markets projects the global automotive supercharger market to grow at a CAGR of 14.34% between 2017 and 2021.

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Indeed, Brian Contat, Product Director of Boosting at Eaton, is similarly optimistic on the outlook for supercharging. "The supercharger is evolving in its application," he said. "We are at a transition point where the traditional uses of a supercharger – which were for performance and transient response – are now evolving towards providing a dependable flow of air through the drive cycle in order to enable advanced combustion."

This, he said, is driven by various global regulations placing pressure on OEMs to make less polluting, more fuel-efficient vehicles. With the major regulations of Euro VI, China 6a and US Corporate Average Fuel Economy (CAFE) regulations in mind, there has arguably never been greater global impetus to tackle

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tailpipe emissions. "We are excited to be a part of it as the OEMs look at different solutions in order to meet these regulations," he added.

As a component, the supercharger has improved its operational efficiency and performance somewhat compared to early examples. Most superchargers first operated at around 60% efficiency – in terms of how well the system could utilise the energy powering it – and span at speeds of around 14,000 revolutions per minute (RPM). Today, certain applications can hit 24,000 RPM and run at efficiencies well above 70%. The devices themselves have also become physically smaller without sacrificing performance.

With the focus less on power and performance and more on improving combustion efficiency, Eaton is currently eyeing opportunities to bring the supercharger into the mainstream market, with a number of contracts already in the pipeline. "There will be new supercharging applications on very compelling and more advanced combustion engines in future," advised Contat. "We'll be on mainstream B, C and D segment platforms in future."

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## Fast or frugal?

Whether an OEM opts for the integration of a supercharger depends on its ultimate goal, be that to focus on high performance or to maximise fuel efficiency. There is also no set formula or segment in which a supercharger is used. Eaton superchargers can be found on anything from a jet ski, which requires a small engine with high power density, to the V8 engine used in a Chevrolet Corvette. "Then there are other applications that are looking for downsized, boosted applications that need to maintain the transient response of a naturally-aspirated engine, while getting high fuel economy," said Ouwenga.

Generally speaking, the supercharger has historically been favoured first and foremost for its abilities to increase the horsepower and torque of a naturally-aspirated internal combustion engine (ICE). This is expected to remain largely unchanged, but Ouwenga again emphasised that superchargers will find new applications for efficiency purposes in future. "The big supercharged V8 engines get plenty of media coverage, but our opportunities lie in helping OEMs to meet these emissions regulations, as they continue to become more stringent," he said. "The controllable airflow with very fast response times helps OEMs to calibrate their engines, and by combining what our superchargers offer with continued advances in the ICE, there is a compelling argument that superchargers can enable fuel economy benefits, and are not reserved solely for high performance vehicles. They will continue to be used in those applications as well, but that's not all they will do."

Superchargers have already been utilised in combination with a turbocharged engine for this very reason. In 2015, Eaton announced that it had supplied the supercharger used in the Volvo T6 Drive-E engine, a 2.0-litre, 4-cylinder, direct-injection engine that combines a supercharger with a turbocharger. "The supercharger is used to supplement the turbo, and it

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works very well," explained Contat. "It is also a scalable engine platform that can go in anything from a premium sedan, all the way up to a 7- or 8-passenger vehicle."

## Supercharged efficiency

Compared to a traditional turbocharger that relies on exhaust gas to spool up, belt-operated superchargers naturally offer faster transient response at low speeds. This provides OEMs with the option to change engine-operating conditions in a more controlled manner, noted Ouwenga. "If you want to go from your idle condition to a higher loaded condition, the engine computer can demand that airflow and respond in a very fast manner," he explained. "The opportunity to do that provides them with benefits enabling them to choose exactly how much fuel they want to add, and precisely how to control that air-fuel mixture."

Superchargers also work well in conjunction with exhaust gas recirculation (EGR) systems, which as the name would suggest, recirculate part of the engine's exhaust gas back into the engine to reduce nitrogen oxide (NOx) emissions. Superchargers can allow for better control over the air and fuel going into the engine cylinders, which mix with this exhaust gas. "As engines are evolving, they're using more and more EGR in advanced combustion. We give OEMs precise control over that airflow into the engine, and a supercharger can be a key enabler to help pump that EGR as well," explained Contat. "EGR is a trend where no matter what segment of the market you are in, it is one of the major trends for the ICE."

## Electrification and fuel cells

Among other future trends is powertrain electrification, something that is being developed by almost all major OEMs. Logic would suggest that greater use of electric propulsion would reduce the number of opportunities for forced air induction. This may be true, but as long as an internal combustion process is involved, suppliers see continued – and new – opportunities. For example, various turbocharger and supercharger suppliers have relayed considerable interest from OEMs for electrically-powered engine boosting systems. Eaton sees similar opportunities.

"With greater electrification, there are other options for OEMs to boost or supplement their engines," said Contat. Ouwenga ageed, suggesting that "the more voltage you have on a vehicle, the more opportunities there are to boost or supplement the powertrain via the electric motors." However, both admit that a battery electric vehicle clearly makes no use of an ICE, and thus the available market to integrate a supercharger is limited to say the least.

Then there are hydrogen fuel cell vehicles, which offer a continued opportunity to boost in the traditional sense, given that an air management device is still vital to the combustion process. In 2006, Eaton worked with Ford to provide 'advanced air delivery compressors' as part of the OEM's fuel cell demonstration programme. In 2008, the supplier was involved in providing a 'fuel cell cathode blower' to Shanghai Automotive Industries Corporation (SAIC) as part of a demonstrator vehicle, which would later be shown at the 2010 Shanghai World Expo. This small-scale electrically-driven supercharger pushes air through the fuel cell stack, in which oxygen in the air combines with hydrogen to generate electrical propulsion. In 2012, Eaton then received a US$2m grant from the Department of Energy (DoE) to work on cost-efficient fuel cell components.

Clearly, while the supercharger may have lost out to turbocharging so far in terms of market penetration, it is set for a new lease of life thanks to continued advances in combustion – be that with gasoline, diesel, or indeed as part of a hydrogen fuel cell.