

Special report: Are vehicle emissions regulations achievable?

Research by **Automotive World**

Published in April 2019 by:

**Automotive
World** est. 1992

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Executive summary

- With climate change leading mainstream headlines, city and national regulators have never been under greater pressure reduce the vehicular emissions that cause health and environmental problems. The number of cities calling for bans of diesel-powered vehicles, or even any combustion engine vehicles, is rising, and automakers face growing demand pressure to develop low and zero emission solutions
- Some automakers are embracing 48V mild hybrids for their electrified portfolios, but groups such as T&E warn that anything short of a fully electrified powertrain is not a sustainable solution
- The European Commission's bold targets for average CO₂ emissions from new trucks call for a 15% cut in 2019 emissions levels by 2025, and 30% by 2030. It is hoped the regulations will encourage the sale of low and zero-emissions vehicles, such as advanced electric, hybrid and hydrogen-powered trucks
- European truck makers reacted to the new targets with frustration, saying the stringent deadlines are unachievable without the fuelling and charging infrastructure required for a large-scale roll-out of alternative powertrain vehicles. Meeting the targets, they say, will only be possible with a sharp customer uptake of zero and low-emission trucks
- The US government continues to tussle with the California Air Resources Board (CARB) and its right to set its own emissions standards, which 13 other US states follow. Automakers want a single standard that will help them compete globally: China's NEV regulations, for example, are closely modelled on California's
- With EPA and CARB discussions on new NO_x standards ongoing, now is an ideal time for the US truck industry to take the initiative. Early involvement in rule making, and developing and promoting electrification could help increase the industry's negotiating position
- After lagging behind other markets for decades, India is beginning to turn a corner on truck emissions, with the government racing to match European emissions norms. A decision to jump from BS-IV straight to BS-VI on 1 April 2020 equates roughly to a jump from Euro 4 to 6—a long but arguably necessary jump
- China has work to do: with the first phase of China 6 taking effect in January 2020, government data suggests only 554 models on the market meet the new standards, equivalent to 12% of all China 5 compliant models. Only 20 are wholly domestic models—most are from JV brands
- Distinguishing the environmental impact of a vehicle is not straightforward. Some consumers are confused by different arguments about the balance between global warming and air quality; the Dieseltgate scandal has left others uncertain about the benefits and risks of modern diesels. The AIR (Allow Independent Road-testing) Alliance aims to help with unbiased, transparent data on vehicle emissions
- Many industry players believe that extensive electrification is the only way to meet future CO₂ targets, but this will require considerable investment. At the same time, electrification presents an ideal opportunity for emerging automotive markets to regain ground on the old guard in terms of tackling emissions
- For suppliers, tightening emissions regulations represent an opportunity and a threat; opportunity arises from the automakers' need for new technology, while the threat comes from a potential market slowdown, with future solutions likely to carry an expensive price tag
- Industry as a whole faces a major environmental challenge, and few would argue with the need to cut vehicle emissions. Yet, more often than not, automakers claim emissions regulations are unachievable, while suppliers say they have the solutions the automakers need, and environmental groups criticise regulators for being too lenient. This report presents insight and perspectives from car and truck makers, suppliers, analysts and lobby groups on the challenges and opportunities that come with ever more stringent emissions regulations

New ratings index could prove a breath of fresh AIR

The Allow Independent Road-testing (AIR) Alliance is proposing an alternative to the traditional Euro 6 standard.

By Megan Lampinen

Some of today's gasoline and diesel cars offer impressive emissions performance, and if everybody drove these models, air quality and environmental concerns would be very different. However, separating out the clean vehicles from the dirty is not always straightforward. Some consumers are confused by different arguments about the balance between global warming and air quality, and the Dieselpgate scandal has left others uncertain

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The newly launched AIR Index offers a simple, straightforward way to educate consumers of the real environmental impact of specific models and hence influence their purchasing behaviour

about the benefits and risks of modern diesels. The AIR (Allow Independent Road-testing) Alliance is designed to change that.

The Alliance was founded in 2017 by Nick Molden, founder of Emissions Analytics, and Massimo Fedeli of Fair Play Consulting. Their stated aim is to 'cut through the politics, the controversy and the commercial conflict' to deliver unbiased, transparent data on vehicle emissions. The newly launched AIR Index offers a simple, straightforward way to educate consumers of the real environmental impact of specific models and hence influence their purchasing behaviour.

Where other methods fall short

Europe has long been aware that historical vehicle testing procedures leave plenty of gaps for automakers to exploit. Some testing has shown that certain diesels certified to Euro 5 and 6 standards emit over five times the regulatory limit of NOx. "We know that about half of Euro 6 diesels are very high-emitting in practice," he pointed out. While some Euro 6 vehicles boast NOx emissions of less than 20 milligrams per kilometre, others come in with emissions as high as 1,800mg/km. "The factor from best to worst is almost 100, so any policy that is based on that is quite blunt," said

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If the anti-diesel narrative is allowed to run rampant, it will effectively starve the industry of funds to invest in electrification

Molden. At the same time, he estimates that 25% of Euro 5 vehicles are relatively clean.

The Real Driving Emissions (RDE) legislation should help. RDE is designed to require engines to operate cleanly under all conditions, but it only addresses new and forthcoming vehicles. "Most manufacturers are already meeting the RDE requirements, but we cannot afford to wait 14 years for the car park to turn over," said Molden. "We need to address those 40 million dirty diesels in Europe which were certified pre-RDE."

The AIR Index is intended to complement RDE to clean up this historical problem of dirty vehicles. The testing behind the Index shares many technical similarities with RDE, but goes further to be able to create a rating scheme. The testing is conducted on at least two cars, sourced independently from automakers, with portable emissions testing units (PEMS) recording on-road driving. The results are used to give cars a rating from A (the best) to E (the worst). "Europe now has an alternative to the Euro standards for solving this air quality problem," he added.

City restrictions

The Index also provides information on specific city air quality restrictions and which vehicles qualify for entry. European cities currently operate a patchwork of restrictions with low- and no-emission zones. One vehicle may be allowed into Birmingham city centre but not London, and only enter Stuttgart every third Wednesday. The message from consumers is that they want something simple, easy and transparent to tell them where their car is allowed. The Alliance is hopeful that once one big city adopts the Air

Index approach, it will set a template for other cities. "The Air Index gives the opportunity for cities to harmonise around an independent standard that really works," added Molden.

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While some Euro 6 vehicles boast NOx emissions of less than 20 milligrams per kilometre, others come in with emissions as high as 1,800 milligrams per kilometre

The Index currently allows users to check a range of which vehicles on the road to see if they would be allowed access to the 14 German cities which have set a NOx limit of 270 mg/km under the Federal Emissions Control Act. Other cities across Europe are considering a similar threshold. London is one of the most advanced European cities in terms of its air quality policy. The city's Ultra Low Emission Zone came into effect on 8 April 2019, and while Molden is quick to commend this, he believes it is not as efficient as it could be. The zone restricts pre-Euro 6 diesels but will allow in all Euro 6 diesel. Blunt approaches like this, he suggests, are like "using a sledgehammer to crack a walnut." The AIR Index promises to facilitate air quality compliance in London more quickly, and with more targeted action.



It mitigates the failure of the previous emissions certification regime, pulls everyone out of the hole, and then gives us a smoother path to RDE, which will quite likely be a successful regulation

Spreading the word

The AIR Index website has only just gone live and currently includes more than 200 results of the first tests conducted, with ratings A-E. Jaguar Land Rover was keen to harness the Index results as a means of highlighting the benefits of diesel technology, in which it has invested heavily over the years, and the potential for clean SUVs. Notably, the four JLR models put to the test fared well, each achieving an 'A' rating for NOx emissions. The E-Pace 2.0D 180PS was found to emit just 14mg/km.

"We have been vocal about the benefits of diesel technology in recent years and I am delighted to see simple, clear and accurate consumer information about urban vehicle emissions published and available with the AIR Index," commented Rawdon Glover, Jaguar Land Rover UK Managing Director. "For those drivers doing more than 12,000 miles a year, a modern diesel engine could be the best choice; not only are its NOx (and particulate emissions) comparable to a gasoline engine, but economy is 25% better and CO2 is 15% lower. The modern diesel engine certainly has a place in the current automotive landscape."

JLR is the first automaker to display the AIR Index rating for each of the vehicles tested on its UK website, which it believes will help consumers to make an informed choice.

Investment in electrification

While Molden is optimistic for industry progress under RDE, he believes that Euro 6 standards have failed and that the AIR Index is

needed to solve the problems of the past. "The AIR Index positions us at a point where the new regulations will in fact work," he commented. "It mitigates the failure of the previous emissions certification regime, pulls everyone out of the hole, and then gives us a smoother path to RDE, which will quite likely be a successful regulation."

Importantly, the AIR Index ratings are based on testing that conforms to a new European standardised method, known as CWA 17379. "This means that the AIR Index is not just another rating system. It has a legal underpinning and a framework that none of the other standards have," emphasised Molden. "That's why it can be used by policymakers much more seriously. It is consumer information, but it's so much more than that because of this legal underpinning."

While the Index focuses on gasoline and diesel engines, Molden is looking to a long-term electric future. He, and many others, believe that extensive electrification will be required to meet future CO2 targets, but this will require extensive investment. To secure the necessary funding, automakers need to maximise the return on their investment from the internal combustion engine (ICE). "I do not see it as a polemic debate of ICE versus electric vehicles," he clarified. "If the anti-diesel narrative is allowed to run rampant, it will effectively starve the industry of funds to invest in electrification. That is why this is so important; confidence needs to be regained so that the ICE gives us the bridge to a lower carbon future. Europe needs to recognise the commercial dynamic and secure the resources to invest so that eventually we can make electrification work."

Hybridisation a key influencer in helping Volvo cut emissions

Switching pure ICE-powered vehicles for hybrids represents the next stage on Volvo's emissions reduction journey.

By Jack Hunsley

Rising vehicle emissions have become an increasing concern for the automotive industry over the last few decades. As private vehicle ownership continues to rise, and so with it congestion and pollution, attempts to shift vehicle propulsion away from fossil fuels could hold the key to hitting current emissions targets.

While the prospect of totally ditching the internal combustion engine (ICE) is a monumental task, the reward could be substantial. Support for the idea has grown—as shown by the number of automakers turning their back on pure gasoline and diesel powertrains in favour of electrification.

Turning of the tide

Since the demise of GM's infamous EV1 in the late 1990s, interest in electric mobility has grown considerably. The success of models such as the Nissan Leaf has convinced many newcomers, former naysayers and industry leaders to focus on electric propulsion. In April 2019, for instance, VW unveiled its e-SUV challenger to the Tesla Model X. Jaguar Land Rover was even earlier to the party, with the Indian-owned British brand—perhaps

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Mild hybrids with a 48-volt system will be standardised in Volvo cars, significantly reducing fuel consumption and emissions

traditionally more associated with gasoline-greedy vintage sports cars—releasing its own e-SUV, the Jaguar i-Pace, in the latter half of 2018. Even still, however, there are few automakers whose electric ambitions have generated more headlines than Volvo.

In 2017, it was widely and incorrectly reported that Volvo was to ditch the ICE from 2019, due largely to the wording of its 'Volvo to go all electric' press release. While this was understood in the mainstream media to mean a total abandonment of gasoline and diesel propulsion, it instead represented the next step on Volvo's electrification roadmap, marking the

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We have chosen to invest in electrification as we see this technology as an efficient way to reduce our environmental footprint, and we see a number of factors pointing towards customers embracing electrified cars

company's aim to move away from pure ICE vehicles and towards hybrids.

This move has its logic, as Karin Thorn, Vice President of Vehicle Propulsion Engineering at Volvo Cars told *Automotive World*. “Volvo Cars’ strategy focuses on electrification, where we have said that as of 2019, all newly launched Volvo cars will be electrified with 48-volt or high voltage systems. This means a shift away from pure ICE cars,” said Thorn. “This will play a crucial role in the move towards electrification. Mild hybrids with a 48-volt system will be standard in Volvo cars, significantly reducing fuel consumption and emissions.”

Ease into electric

Indeed, the move towards hybridisation is a common strategy within the automotive industry due to a belief that it will not just be a useful first step in introducing consumers to the value of electric mobility, but also in how it could help begin to shape public charging infrastructure.

When quizzed on how Volvo aims to address tightening emissions regulations for today's ICE vehicles, electrification was at the core of Thorn's reasoning. “We have chosen to invest in electrification because we see this technology as an efficient way to reduce our environmental footprint, and we see a number of factors pointing towards customers

embracing electrified cars,” she said. “One is a growing network of charging infrastructure which is essential for customers to switch to electric vehicles (EVs). Also, as with all new technologies, the cost for batteries will go down while performance, in terms of range, will improve. We believe that these factors will contribute to a major shift towards EVs in the next couple of years.”

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All in all, we believe that by 2025 half of our sales will be fully electric cars

Deliberately ambitious

For Volvo, hybridisation has been a core part of its electrification roadmap for several years. The automaker has offered plug-in hybrid models since 2012 and, in 2016, the company's Chief Executive, Håkan Samuelsson, outlined Volvo's target to sell one million electrified cars by 2025—a target which he described at the time as “deliberately ambitious”. A year later, Volvo's electrification strategy was highlighted



The targets that have been defined are tough, but we believe we are on the right track

by the United Nation's Global Impact report, which focuses on the progress that members have made in supporting the delivery of the UN's Sustainable Development Goals.

That ambition has shown no sign of slowing over the previous three years, with Thorn detailing how Volvo's entire product line-up is now offered with the additional option of gasoline plug-in hybrid technology. "From 2019, we are also introducing mild-hybrid technology in all new cars, and this technology will be standardised," she added.

On the all-electric front, Volvo has step-up its efforts via its EV brand Polestar. In 2019, it is scheduled to unveil its first all-electric car, the Polestar 2, which Thorn confirmed will be followed by a range of fully electric cars under both the Volvo and Polestar names in a move to strengthen Volvo's overall EV credentials. "All in all, we believe that by 2025, half of our sales will be fully electric cars," said Thorn. "When going through this transformation of electrifying our product range, it will be crucial to focus on our supply chain—both to secure the supply of all necessary components, but also to make sure we have a sustainable and transparent chain of suppliers all the way back to the source of the raw materials going into our cars."

A place for the old world?

While electric mobility appears to be the future, the question remains as to what will remain of the old world. Gasoline powered hybrids are likely to retain some prominence during the transition to full electric mobility,

but, for Volvo Cars at least, diesel is nearing its final days. As Thorn confirmed, in parallel with Volvo's electrification strategy, no new cars will be launched with the option of a pure diesel engine in the future. Going forward, diesel Volvos will only be available in current car models and for only as long as customers continue to ask for them.

"We have shown a steady reduction of CO2 from our cars, thanks to a dedicated focus on downsizing and emission reducing technologies," said Thorn. "Right now, consumers tend to shift from diesel to gasoline which increases average CO2, but in the long run we expect a continued downward trend thanks to electrification."

Overall, however, it looks like the writing is on the wall for the pure ICE. Whether or not Volvo does succeed in hitting its 2025 targets remains to be seen, but its decision to push plug-in hybrids should aid the brand in meeting the upcoming Euro 7 emission standards. However, the automaker is certainly laying down a marker in regard to trimming its own contributions to emissions—its announcement in March 2019 that it intends to replace its current paint shop at its Torslanda manufacturing plant in an attempt to cut paint shop energy consumption and emissions is perhaps testament to how deep its sustainability ambitions run throughout the company.

"With our strategy towards electrification, we are in a strong position to achieve the lower emission levels that are expected from the car industry," said Thorn. "The targets that have been defined are tough, but we believe we are on the right track."

Facing EU city bans, are diesel's passenger car days numbered?

European automakers wanting a future-proof solution for emissions regulations might need to double down on pure battery electric offerings. By Xavier Boucherat

Euro 6d-temp, and eventually Euro 6d, represents the latest challenge in emissions regulations for automakers operating in Europe. To comply with these, new

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When it comes to the effect of mild hybrid (MHEV), plug-in hybrid (PHEV) or hybrid electric vehicles on real-world CO₂ and pollutant emissions, we have not seen any proof of a significant improvement compared to internal combustion engine (ICE) only vehicles, and do not consider them a viable solution

registrations will need to satisfy requirements in Real Driving Emissions (RDE) tests that will be introduced alongside the new Worldwide Harmonised Light Duty Test Procedure (WLTP). 6d-temp will take effect for all new registrations from 1 September 2019, requiring an nitrogen oxides (NO_x) conformity factor of 2.1, meaning NO_x emissions cannot exceed more than 2.1 times that required in the lab, which is under 80mg/km. 6d, which will apply to all new registrations from January 2020 onwards, requires a conformity factor of 1, but with an error margin of 0.5.

This is spurring action from automakers. Anna Krajinska is Emission Engineer at the European Federation for Transport & Environment (T&E), a European umbrella group for non-governmental organisations working in sustainable mobility. As she points out, the database on RDE testing done to date, held by the European Automobile Manufacturers Association (ACEA), shows that whilst many models are meeting Euro 6b and 6c standards in the lab, there has not been the same success on the road, even with the 2.1 conformity factor. To make things worse, the 2.1 figure has been ruled illegal by the European Court of Justice, following action brought by the cities of Paris, Brussels and Madrid.



Ford has managed to overcome this challenge, and has adjusted its processes to meet new regulations without impacting its customers

The first RDE expert group came together in 2011, and the first set of regulations was public in 2016. Automakers have had the better part of eight years to prepare themselves, and confidence is, predictably, high. A Ford spokesperson told *Automotive World* that RDE represented a significant challenge, but that the automaker was ready. “Ford has managed to overcome this challenge, and has adjusted its processes to meet new regulations without impacting its customers.”

The importance of the consumer cannot be stressed enough, say automakers, and a change in behaviour will be necessary to meet future regulations. “The customer plays an important role in reaching future CO2 goals,” said the Ford spokesperson. “Therefore, we are offering a portfolio of solutions tailored to customer needs, so that the customers can choose an option that best fits their individual drive cycle. “On the level of individual vehicles, battery EVs achieve the highest CO2 reduction, but looking at overall fleet impact, mild hybrids make the biggest difference due to their higher share in the fleet.”

But whilst a varied portfolio of electrified options might be important for bringing more customers on board with an electrified agenda, groups like T&E are not convinced a sustainable way forward is available for vehicles not embracing fully electric powertrains. “When it comes to the effect of mild hybrid (MHEV), plug-in hybrid (PHEV) or hybrid electric vehicles on real-world CO2 and pollutant emissions,” says Krajinska, “we have

not seen any proof of a significant improvement compared to internal combustion engine (ICE) only vehicles, and do not consider them a viable solution.”

As the organisation further points out, full battery electrics (EV) are now the fastest growing type of electrified vehicle in the bloc, with sales increasing by 53% compared to PHEVs at 26% and MHEVs at 36%. This has been driven in part by action taken by Paris, Brussels and Madrid and is indicative of wider trends across the bloc. These are cities which are keen to rid their streets of diesel, and London is among them. The UK capital has very recently put its Ultra-Low Emissions Zone (ULEZ) into effect, which levies charges on vehicles with tail-pip emissions above 75g/km. EVs are exempt. Research suggests that as things stand, only 73 in every 10,000 vehicles in the city qualify.

If the EU were to take T&E’s view, it could potentially be very bad news for some automakers whose electrification strategy has side-lined or fully ignored pure electrics. Toyota is a case in point, which is relying only on hybrids moving forward.

The D Word

Schools of thought around diesel have been irrevocably altered since Dieselgate. Once thought an environmentally friendly alternative which could meet demanding CO2 targets, most automakers are understandably putting

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There are serious doubts over whether diesel engines can ever truly be clean. There are pollutants they emit that are currently not regulated, but can be very dangerous for our health and the environment

distance between themselves and the technology. “We expect a continued decline for diesel, with changing customer sentiment and regulation,” said the Ford spokesperson. “Our diesel mix is about equal to industry in 2018.” Demand in the CV market is expected to remain, they added, with diesel models still accounting for 95% of sales in the segment.

At one stage, there were whispers of a comeback: around a month before his removal from the post, ousted VW boss Matthias Mueller told attendees at the 2018 Geneva International Motor Show that there would be a renaissance for diesel. It is certainly true that newer models are cleaner in terms of CO2 emissions. However, says Krajinska, there are problems beyond this: “There are serious doubts over whether diesel engines can ever truly be clean. There are pollutants they emit that are currently not regulated, but can be very dangerous for our health and the environment.”

Beyond Euro 6

These unregulated pollutants may form part of the focus for Euro 7, including nitrous oxide (NO2) and carbon monoxide (CO)—indeed, China will soon introduce regulations for both of these in its upcoming sixth generation standards. “This should be the main focus for Euro 7,” argues Krajinska. “Other pollutants that will be considered are ammonia, which is already regulated for heavy duty vehicles, and particulates that are smaller in diameter than the current 23 nanometre limit.”

That said, automakers can expect more work in the same direction. One area in which Krajinska suspects there may be developments is standardisation of emissions across ICE type. “The current situation where

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I don’t think anyone wants to find themselves in a situation where Chinese cities have cleaner air than cities in the EU

diesel is allowed to emit a third more than gasoline vehicles is completely unnecessary,” she says, “and we shouldn’t accept a situation where one ICE technology is able to pollute more. We should move to a fuel neutral approach where all powertrains have to respect the same limits.” Without some tightening up come Euro 7, the EU is due to fall behind both China and the US in terms of NOx limits. “I don’t think anyone wants to find themselves in a situation where Chinese cities have cleaner air than cities in the EU,” she concludes.

Can truck makers and fleets meet new European CO2 targets?

The trucking industry has calmed its initial response to recently ratified European emissions laws but warns that a struggle lies ahead. By Betti Hunter

The European Union has made its first attempt to regulate heavy-duty vehicles. In May 2018, the European Commission (EC) presented a legislative proposal that set targets for average CO2 emissions from new lorries. The proposal was bold—aiming to slash the emissions of new vehicles registered in the EU by 15% of 2019 levels by 2025 and stretching to 30% by the end of the decade. This year, the rules received the green light.

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The first-ever CO2 targets for trucks for 2025 and 2030 are highly demanding, especially as their implementation does not depend solely on the commercial vehicle industry

Negotiators celebrated and claimed that the new regulations would lead to a host of benefits, including lower fuel costs for transport operators and the continued technological leadership of European truck manufacturers. Most importantly, the regulations could also result in a reduction of up to 54 million tonnes of CO2 between 2020 and 2030—equivalent to the total annual emissions of Sweden. Despite making up less than 5% of vehicles on the road, trucks currently account for almost a quarter of European transport emissions. According to the Commission, the new measures will help the bloc towards its goal of cutting overall greenhouse gas emissions by 40% by 2030.

The European trucking industry, however, was not impressed.

“Over the past years, ACEA members have worked hard to drive down CO2 emissions from trucks and remain fully committed to continue doing so,” a spokesperson from the European Automobile Manufacturers Association (ACEA) told *Automotive World*. “However, the first-ever CO2 targets for trucks for 2025 and 2030 are highly demanding, especially as their implementation does not depend solely on the commercial vehicle industry.



Transport operators cannot be expected to suddenly start buying electric or other alternatively-powered trucks if there is no business case for them

The new regulations are in place partially as a mechanism to encourage the sale of low- and zero-emissions vehicles, such as advanced electric, hybrid and hydrogen-powered trucks. Manufacturers whose sales comprise at least 2% electric and hydrogen vehicles will receive more relaxed CO2 targets as part of a voluntary 'supercredits' system. Those who fail to meet the goals will face heavy financial penalties.

The initial backlash from the truck industry was ferocious. In late 2018, ACEA released a statement saying it was "alarmed by the excessively aggressive CO2 reduction target... [that] blatantly ignores the fact that the potential for electrifying the truck fleet is far lower than for cars." The ire has since cooled, but many automakers still worry that the targets are unachievable, especially where alternative powertrains are concerned.

"We are concerned by the total lack of infrastructure today," said ACEA. "There is currently no public charging or refuelling infrastructure suitable for electric or hydrogen trucks at all. Even in the case of truck-specific filling stations for compressed and liquid natural gas (CNG and LNG), availability remains very low and patchy across Europe."

According to the organisation, the Commission also needs to take into account the fact that there is no clear action plan for the roll-out of such a necessary infrastructure in the near future. Delivering on the targets will only be possible if customer uptake of zero- and low-emission trucks increases drastically within a short timeframe.

"For this to happen, it will be necessary for member states to step up efforts to roll out the infrastructure required for charging and refuelling alternatively-powered trucks," ACEA said. "Transport operators cannot be expected to suddenly start buying electric or other alternatively-powered trucks if there is no business case for them and it is not possible to easily charge the vehicles along all major EU motorways."

Introducing VECTO

As truck manufacturers race to develop and sell effective, green heavy-duty models, they will also have to focus on lowering emissions in their internal combustion engine (ICE) vehicles. In 2009, the European Commission kickstarted the development of the Vehicle Energy Consumption Calculation Tool (VECTO), a standardised CO2 testing simulation tool for heavy-duty vehicles with a Gross Vehicle Weight above 3500kg. From January 2019, the tool has been mandatory for new trucks under certain vehicle categories, with truck manufacturers required to calculate both the CO2 emissions and fuel consumption of any new vehicles they produce for the EU market.

"By the end of the year, companies will have to declare their numbers," said Andy Skipton-Carter, Head of Commercial Vehicles Europe at Ricardo. "But it will be based on the numbers for this year. As a result, there is a slight disincentive to introduce new lower fuel consumption technology this year, but clearly customers are still interested in the best fuel



Clearly customers are still interested in the best fuel consumption products. Now they will likely get these numbers written on the side of the trucks in washing machine efficiency style, so they can directly compare

consumption products. Now they will likely get these numbers written on the side of the trucks in washing machine efficiency style, so they can directly compare.”

Measuring CO2 output by simulation is preferable to on-road measurement due to the many varieties of truck model and the difficulty of ensuring consistent results. However, many in the industry have concerns about VECTO’s efficacy.

“There’s plenty of discussion, because how good the tool is will influence the outputs you get and how that compares to what happens in the real world,” said Skipton-Carter. “Currently, VECTO is fairly crude and does not include much of the technology we will be seeing in the future. For example, it doesn’t take account of a hybrid system. There’s no way of dealing with that, so in parallel with automakers having to work on the solutions, the tool is being developed to accommodate the relevant technologies.”

Though VECTO is intended as a tool to ease automakers through the process of reducing emissions, many have found it difficult to implement. “Companies have had to create whole new departments to work out how they can use VECTO and how it relates to the technology they currently have,” said Skipton-Carter. “There’s much work to be done.”

The long and short term

As 2025 looms, the trucking industry is rushing to find the best combination of technology to achieve the first round of

targets. For many logistics operators, the initial solution might be to average the technology across a fleet. This could be achieved by investing in a mixture of aerodynamic, tyre, engine and transmission system improvements for all vehicles. Fleets could also take advantage of the credits system by investing in a small number of alternative powertrain vehicles and making minor changes to the rest in order to reach the necessary 15% reduction. However, ICE vehicles are likely to remain the standard for at least the next five years, as fleets weigh up the benefits and challenges presented by alternative powertrain trucks at this stage.

“The number of electric, hybrid, or hydrogen fuel trucks will still be very small, certainly by 2025,” said Skipton-Carter. “If a company is selling 20,000 trucks and five of them are hydrogen fuel cells, that’s not going to influence their average number much. Right now, the target is almost certainly achievable by refining existing systems.”

Reaching the 2025 goals will be a struggle for players across the industry, but a 15% CO2 reduction could feasibly be achieved without racing to roll out new green models and a Europe-wide fuelling infrastructure. Meeting the ambitious 2030 deadline, however, will require drastic action on the part of automakers and fleet owners.

“This is where new technology will be needed,” said Skipton-Carter. “That will be technologies such as hybridisation, electrification and natural gas, even for long-haul trucks.”

For suppliers, efficiency push proves major development driver

Megan Lampinen explores some of the ways in which ZF is helping cars and trucks meet upcoming emission standards around the world

Both passenger car and commercial vehicle manufacturers around the world face tightening emissions standards in the years ahead. As concerns around air quality and warnings about global warming heat up, regulators are cracking down. For industry suppliers, these increasingly challenging targets represent both a lucrative business opportunity and the chance to demonstrate technological prowess.

ZF has established a global reputation with its highly efficient transmission systems and has long been helping manufacturers across all

vehicle segments improve their efficiency and lower their emissions. Chief Executive Wolf-Henning Scheider flagged tightening standards as a key area of uncertainty for 2019. At a media event in January, Scheider commented: "We are not so happy about what's been decided with emissions regulations as it could mean a market slowdown. Future solutions may be more expensive than today's solutions."

That said, ZF is determined to contribute to those future solutions. "Since these standards are coming, we have decided to look forward and intend to play a significant role in providing what's needed," Scheider confirmed.

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Four pillars

ZF has identified four major fields of action for the development of next generation mobility solutions: vehicle motion control, integrated safety, autonomous driving and electrification. "These are the major drivers for CO2 reduction for all our customers, worldwide," explained Jörg Grotendorst, ZF's Head of Division eMobility, which was set up in 2016 to provide all products and solutions for combustion engine hybridisation and full electric powertrains. "As well as pure electric powertrains, another significant contribution to emissions reduction is hybrid powertrain solutions which we have been

producing since 2008. We also announced the fourth generation of our 8HP automatic transmission recently, as well as our first full electric vehicle drivetrain, eVD.”

The company supplies automakers in all key global markets. “We have regular discussions with all our major customers on current and future technology roadmaps, as well as market and societal trends,” explained Grotendorst. “Naturally, we have some close alignments and once we identify these, we set up advanced engineering projects to devise concrete product and systems solutions. To ensure we are able to respond quickly with solutions, we work with established automakers and new start-up companies, which very often have their DNA in agile software technology. With these partnerships we combine mature system expertise and product know-how with new agile methods and ideas.”

The company is investing heavily in electromobility and hybrids; it has more than 17,100 employees working on electrification and automation development, and has allocated €12bn (US\$13.7bn) for these two trends over the coming five years.

The hybrid edge

ZF expects plug-in hybrid technology to play an especially important role in the coming years, and company executives have said that in terms of CO2 emissions, the current electrification mix in Europe is unfavourable, giving hybrids the edge.

Within ZF, the plug-in hybrid is known as 'the next generation EVplus', reflecting the close links it has with all-electric driving. The argument is that when drivers charge their plug-in hybrids from the local power supply, they are basically operating an electric vehicle. The current generation of hybrid technology, which offers an electric range of 80-100km (50-62 miles), can cover most trips in all-electric mode.

Scheider went so far as to assert that "hybrids represent the perfect approach for the mass market to meet emissions standards." These

vehicles, he suggested, are much easier for one-car households to use, as they entail no range anxiety and can handle long-distance journeys. "Full BEVs are more of a second or third car option for multi-car households in urban areas. If you want one family car—as is common in Europe and Asia—then the hybrid is the obvious choice," he added. "That's why we are developing solutions to make the hybrid more compelling."

In 2008, ZF became the first company in Europe to produce hybrid modules at volume. The technology promises to slash CO2 emissions by up to 70% compared to vehicles with traditional combustion powertrains. Since then, a number of automakers have begun producing various car models equipped with the ZF 8-speed plug-in hybrid transmission. This plug-in hybrid transmission is based on 8-speed automatic and 8-speed dual clutch transmissions. ZF has just inked a landmark supply agreement with BMW for this transmission, which represents the largest order of automatic transmissions in the history of the company, and ZF interprets it as confirmation of the importance of hybrid technology for future individual mobility.

The supplier is currently investing €800m in its Saarbrücken transmission factory to transition it for electrified cars. The share of hybrid drives in production at this plant should jump tenfold over the next few years, from 5% to 50%.

Electric axle drives

Besides hybrid systems, ZF also offers electric axle drives. A highly integrated electric axle drive system is scheduled to enter volume production for a European car manufacturer later this year. The electric axle drive can work with anything from compact cars up to light commercial vehicles with different performance classes and overall lengths.

In addition to these different systems for passenger cars, ZF offers electrification solutions for light and heavy commercial vehicles, such as the TraXon Hybrid

transmission for trucks. Its purely electric drive systems are designed to meet even the strictest emissions regulations for city centres. The AxTrax AVE electric portal axle for buses is one such product. Public transport operators can make a major contribution to addressing air quality, and this is one tool in their arsenal. "ZF has made e-buses marketable in Europe," commented Scheider.

The electric drive axle, both powerful and environmentally friendly, drives low-floor buses up to a maximum axle load of 13,000kg (28,660lbs). The electric motors integrated into the wheel heads have a total output of 250kW. The product launched in 2012 and has since been deployed in applications around the world. It can be combined with hybrid or fuel cell configurations or be powered by a battery. ZF is particularly proud of its flat design, which gives manufacturers more freedom when it comes to interior design.

Fredrik Staedtler, head of the Commercial Vehicle Technology Division at ZF, described the AxTrax AVE drive axle as the "ideal solution for manufacturers and municipalities to shape their local inner-city traffic with zero emissions, while at the same time providing an attractive mobility offer."

London is just one of the cities that has worked with ZF on deploying this technology, which has been installed in a fleet of 31 double-decker buses from Optare. In Central London, buses have to meet one of the strictest emissions regulations in the world and the city is working towards electrifying its entire bus fleet by 2037.

This technology is also tackling air quality in the US. There, several transport associations have ordered a total of 100 buses from New Flyer's Xcelsior Charge model series equipped with the AxTrax AVE electric portal axle. ZF flagged these orders as a demonstration of how both it and New Flyer "have benefited from this collaboration in the age of electro-mobility." The buses will be delivered to the Los Angeles County Metropolitan Transportation Authority, King County Metro Transit in Seattle, Massachusetts Bay Transportation Authority in Boston and Metro Transit in Minneapolis by 2020.

Beyond drive technology

Electrification constitutes the bulk of ZF's emissions efforts, but it is not pursued in isolation. "ZF's four fields of action go hand in hand with a ZF initiative to combine these activities with the Internet of Things," said Grotendorst. "Here we will see the biggest impact on all our activities, defining next generation mobility. Electrification will contribute most to CO2 reduction once we can align CO2-neutral energy availability from the power suppliers with the actual demand for electrified vehicles out on the streets. Therefore, the charging infrastructure must be smart and the number of charging spots needs to be sufficient. For general societal acceptance, this is one of the most important issues. The trend having the greatest impact on our work is connectivity—vehicles of the future must be connected and embedded into the surrounding infrastructure, anywhere, any time."

ZF is also working on other approaches beyond drive technology that will help manufacturers achieve their CO2 targets. These include lightweight solutions and power-on-demand systems such as electromechanical steering systems, which in the future will also be used in commercial vehicles.

Achievable targets

As for the next generation of emissions standards, Grotendorst is convinced the targets can be met, and that ZF technologies can play a major role.

"The key to emission reduction is the electrification of all powertrains at a level which allows full electric drive functionality," confirmed Grotendorst. "Having said that, it is the installed battery size which determines the emission-free riding distance." Furthermore, the technology exists, he noted, and the company can begin work immediately, even on existing platforms. And there's a further bonus: "The overall package is cheaper when compared to an equivalent long-range battery electric vehicle—but in the long term, there is no doubt: the future is electric."

India's auto industry struggles to keep up with new emissions regulations

Change is needed to clean up India's air, but automakers and consumers may find Bharat Stage VI burdensome, writes Betti Hunter

India has a problem with pollution. According to a 2018 report from the World Health Organisation, the country is home to 14 of the 20 most polluted cities in the world, with Delhi ranked as the most polluted capital. A 2018 emissions inventory by the System of Air Quality and Weather Forecasting Research (SAFAR) found that pollution from vehicles in the city had risen by 40% from 2010 levels. Data from other major cities across the nation suggest that the picture is much the same across the board. This is having a significant impact on the country's population, which has seen a dramatic shift in the demographics of lung cancer patients and people suffering with Chronic obstructive pulmonary disease.

"There is reason to worry about vehicular pollution in Indian cities," said Anumita Roy Chowdhury, Executive Director for Research and Advocacy at the Centre for Science and Environment India (CSE). "Citizen exposure to vehicular pollution and toxic fumes is very high, which is compounding the public health risk. India is motorising very rapidly, and there are special concerns around diesel emissions, which are highly carcinogenic. Early action is needed."

Two decades ago, India had no emissions regulations to speak of. A large price discrepancy between diesel and gasoline fuels

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India is perhaps the only country in the world to have taken a decision like this, and it will happen within a very short span of time. The automobile industry has just three to four years to make the transition

incentivised many to purchase diesel vehicles that were cheaper to run, but worse for air quality. Following a Right to Clean Air campaign by CSE, in April 1999 India's Supreme Court ruled that all vehicles in the country would be required to meet Euro 1 standards by June the same year.

"Imagine the situation 20 years ago, when India had started to motorise very rapidly," said Chowdhury. "We were not even at Euro 1 level. We were at Euro 0 level in terms of emission standards. The whole fleet was

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Therefore, it makes a lot more sense for India to invest in new vehicle technology now because once the vehicles are out on the road, they will stay there for another ten to 15 years and lock in a huge amount of pollution

saddled with very old carburettor and diesel technology, which was responsible for a huge amount of pollution.”

Skipping a level

Since then, the Indian government has raced to keep up with rapidly evolving European emissions norms, developing its own classification system to mirror the regulations. The standards have been progressively introduced across the country, starting in major cities before being implemented nationwide. In 2001, Bharat Stage (BS) II was rolled out in Delhi, Kolkata, Mumbai and Chennai to match 1996's Euro 2 stage, covering the rest of the country by 2005. It was followed by BS-III between 2005 and 2010, and BS-IV between 2010 and 2017.

However, this stepped introduction was criticised for not being far-reaching enough, encouraging only a handful of cities to attain better standards and largely neglecting the freight sector. To those pushing for tighter emissions controls, a more radical approach was required.

“The government was discussing introducing the equivalent of Euro 5 in 2020, and Euro 6 in the 2025-2026 timeframe,” said Chowdhury. “CSE said no, that is not acceptable. If we do that, India is going to languish at the bottom of the technology ladder.”

An unlikely ally was found in the country's oil companies that, according to Chowdhury, took a proactive stance by stating an intention to supply 10ppm sulphur diesel nationwide.

“CSE saw a bigger opportunity in that,” explained Chowdhury. “By introducing ultra-low sulphur fuel by 2020, India would be able to bypass Euro 5 altogether and go directly to Euro 6.”

Following extended discussions, in 2017 the Indian government agreed to the proposal and announced that BS-V would mostly be skipped in favour of introducing Euro 6 equivalent emissions standards. BS-VI, the country's most ambitious emissions regulations yet, will come into play on 1 April 2020.

“All vehicle categories, including off-highway, are expected to be impacted by the new emission norms,” said Rahul Gangal, Partner at Roland Berger. “While personal vehicles, commercial vehicles, two and three wheelers are expected to migrate to BS VI, off-highway equipment will witness phased migration to BS IV and BS V.”

“India is perhaps the only country in the world to have taken a decision like this, and it will happen within a very short span of time,” said Chowdhury. “This means the automobile industry has just three to four years to make the transition.”

Tough ask for automakers

The ambitiously tight deadline is a response to rapidly increasing motorisation across India. Despite recent rises in carpooling, ride-hailing, public transit improvement and cycling, many Indians living in cities still prefer to use a personal vehicle as their primary mode of transportation.



By introducing ultra-low sulphur fuel by 2020, India would be able to bypass Euro 5 altogether and go directly to Euro 6

“It took close to 60 years in India to get the first 115 million vehicles on the roads,” Chowdhury told *Automotive World*. “And then it took just another seven to eight years to reach another 115 million vehicles. Therefore, it makes much more sense for India to invest in new vehicle technology now, because once the vehicles are out on the road, they will stay there for another ten to 15 years and lock in a huge amount of pollution.”

Though campaigners welcomed the announcement and swift enactment of BS-VI, the limited timeframe has proved a challenge for the country’s automakers. In 2017, a consortium of manufacturers addressed the Supreme Court, stating that it would be difficult to start making Bharat Stage VI-compliant vehicles from 2019 to meet the 2020 deadline, and that the regulations would lead to less model launches. They also argued that equating the price of diesel and gasoline would be a more effective way of discouraging consumers from buying consumer vehicles. Though all players have been spurred into action, concerns remain.

“While the upgradation from BS-IV to BS-VI within three years is a complex engineering task as it takes a considerable amount of time, we are in an advanced stage in terms of BS-VI migration,” said a spokesperson from Tata Motors. “However, BS-VI vehicles cannot be introduced without the availability of the fuel of the requisite quality throughout the country for sustained emission performance.”

According to Chowdhury, however, the industry’s initial misgivings might have created something of a self-fulfilling prophecy.

“The automotive industry is saying it has been tough for them to mobilise investments to develop their products, but the certification for BS-VI has already begun in the country. Several models have already been certified which are expected to roll out in April 2020,” she said. “But the very fact that India has seen such delays in ramping up its emission standards roadmap has a lot to do with the pushback that happened initially from the industry.”

Despite reservations, the hard deadline, ultra-low diesel fuel assurances and the impending inability to sell old inventories of BS-IV vehicles gave India’s automotive industry no alternative other than to prioritise production of BS-VI compliant models.

“Now the entire industry is focused on meeting the standards,” said Chowdhury.

As BS-VI draws closer, authorities will also need to find a way to deal with the so-called ‘legacy’ vehicles already on the roads that do not meet the standard. The CSE advocates a gradual phase-out policy that could be engineered to ensure that consumers are able to trade their old models for new, compliant ones. However, consumers might still find it difficult to purchase new vehicles, especially considering the expensive advanced emissions control systems that will be mandatory in new diesel cars.

“A 7-10% price increase is expected to be passed on to the consumer, which could subdue demand,” said Gangal. “Countering this with compelling offerings is critical for automakers who will do everything to ensure consumers are burdened less than the overall impact, thereby resulting in new pools of cost optimisation that will be addressed going forward.”

India's truck industry is slowly cleaning up

Having lagged behind other international standards for more than a decade, India is beginning to close the gap.

By Jack Hunsley

The truck industry is evolving rapidly. Given the major role trucking plays in keeping global economies ticking over, the technology used to keep trucks on the move has contributed greatly to global emissions over the past decades. In India, the case is no different.

In December 2018, for instance, figures from the Global Carbon Project found that India's annual emissions had risen by 6.3%, making India the fourth highest emitter behind China, the US and the EU. While, of course, the

trucking industry is by no means solely responsible for this rise, mobility still represents a sizeable chunk of these emissions. Just as the rest of the world begins to turn towards new mobility trends as a key combatant in tackling climate change, interest in India is growing.

Standards delay

Indian truck emissions regulations at present are mimicking Europe's, albeit with a slight delay and different name. The current Bharat Stage IV (BS-IV) standards have been in place since 2010 and use the Euro IV specifications—which operated from 2005 to 2008 in the EU—as a reference. However, while at present India's regulations are upwards of a decade behind Europe's, this will not be the case for long.

Beginning in 2020, the goal in India is for all vehicles to leapfrog directly to BS-VI, a standard which is based on the current Euro 6 standard in a move which Ben Sharpe, a Senior Researcher for the International Council on Clean Transportation (ICCT), described as 'unprecedented'. "It's the first time any jurisdiction in the world has made the leap straight to BS-VI," he said. "Given the technological progress that's been made in

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There's really been a groundswell of support in the public for the government being very aggressive in terms of controlling emissions



These are not novel technology solutions; these are extremely proven and mature technologies. It is just a matter of rolling them out for the Indian market

several regions, and the fact that India is now skipping BS-V—which requires progress on nitrogen oxide emissions, but it does not have the additional particulate matter requirements—we see that as a very positive development.”

There has also been progress on the efficiency side. As Sharpe detailed, the Indian government has for some time now been working on efficiency standards for commercial vehicles, with norms for fuel economy for trucks and buses greater than 12 tonnes having been already finalised. However, these norms have yet to be implemented after being scheduled to start in April 2018. “There’s a bit of a political delay with the implementation of that regulation,” said Sharpe. “It remains to be seen if that ruling ends up being implemented, but it’s technically on the docket.”

Pressure groups

The reasons for evolving India’s emissions standards are clear. Much like other countries’ major cities around the world and particularly in Asia, Indian cities are struggling to cope with poor air quality. Figures from the Environmental Performance Index (EPI) in 2018, for example, ranked the UK, the US, and China, sixth, 27th and 120th respectively in a study evaluating how close each country is to achieving established environmental goals. In contrast, out of 180 countries evaluated, India

ranked 177th. As such, there is not just government and industry pressure to consider, but also public health.

“There’s really been a groundswell of support in the public for the government being very aggressive in terms of controlling emissions,” explained Sharpe. “The government has been trying to implement measures to get to the best available control strategies across the economy, and principally in the vehicle sector, given how immediate the emissions from vehicles are in terms of impacting human health.”

The public has been supported by the efforts of the Indian Supreme Court here, which Sharpe described as playing a significant role in making several landmark decisions around emissions over the past 15 years—the most recent being the decision to jump to BS-VI.

Cost incentives

This public support has also been met by increasingly attractive cost incentives amongst manufacturers and truck owners to go green. Given that, unlike other major markets, trucks and buses account for the majority of overall fuel use in India, there is a country-wide interest in making more efficient use of that fuel. “The fuel efficiency regulations are geared towards the manufacturer in that they are putting the onus on them to deliver more efficient products. They are now being expected to install appropriate fuel-saving



The last two decades have seen real improvement, but the rate of progress is still modest

technologies to deliver those cost-savings to truck and bus customers,” said Sharpe.

However, not all are keen to adopt new technologies, as Mike Savage, Chief Engineer at Drive System Design explained by pointing towards reservations over hybridisation in the Indian market. “A full hybrid system for a truck involves quite some investment in a sizeable electric motor and a pretty large battery, but you still have the diesel engine and everything else attached to it,” explained Savage. “A smaller commercial vehicle could use a belt starter motor generator unit (BSG) which might yield savings of around 5%, But, for a big truck where the engine is churning out 250bhp, a BSG which puts out 60bhp to 70bhp does not really add much at all.”

As Savage continued, while this cost-performance problem is not unique to India, the make-up of India’s trucking industry is exacerbating the problem. Whereas typical western markets are filled with large fleet buyers operating hundreds of vehicles, India’s trucking industry instead has more owner operators that will struggle to recoup investment costs quickly. “These owner-operators do not think about whole lifecycle costs in quite the same way because they are not running hundreds of vehicles in a fleet,” said Savage. “If you go to India you are beginning to see what you might call conventional western-styled trucks with modern cabs, but there are still trucks being produced without cabs where purchasers are paying third parties to build a wooden cab instead. The market is still maturing.”

Proven concepts

Even if such progress is being restrained by cost concerns, this does not mean there are no effective measures that could be taken today to improve the efficiency and sustainability of India’s trucking sector. Fuel efficiency, of course, is not only impacted by regulation. Seemingly simple measures such as adopting proven fuel-saving technologies and components, or even implementing driver training courses, could help India make significant gains today.

“Our engagement has really been centred on the fuel economy side, looking at new vehicles and technologies that we think are very cost effective, have been introduced in other markets around the world, and are certainly applicable in the Indian market,” explained Sharpe. “These are not novel technology solutions. These are extremely proven and mature technologies. It is just really a matter of rolling them out for the Indian market.”

This motto is also applicable to hybridisation and electrification. While hybrid and full electric powertrains may not make economic sense for the typical Indian heavy-duty truck, other similarly-sized commercial vehicles such as buses could find real value in such technologies. While the trucking industry lacks the required fleet charging infrastructure to make electrification affordable for all players, given that buses are run largely by city authorities it is much easier to install infrastructure at local depots that can keep electrified bus fleets on the go.

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I do not see any technical barriers as to why India could not pull itself in line with other major markets, and even exceed other markets around the world

Indian automakers have already spotted the opportunity here. News of the Supreme Court's decision to jump directly to BS-VI, for instance, has prompted Tata Motors to make its single largest capex investment in its history due to a need to re-engineer, reindustrialise and recertified “each and every vehicle” it produces, as its Chief Executive, Guenter Butschek, told *Automotive World* in March 2019. Tata Motor's rivals are also getting in on the act, with Mahindra, Ashok Leyland and Olectra-BYD all helping to drive competition.

However, even while progress is ongoing, it is difficult to ignore that India is still behind the major markets. Even though the country has made significant progress over the past decade, it is still too early on in its journey to be able to compare itself directly with North America or Europe, for instance.

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If the Indian Government wants to be very aggressive around rolling out electric commercial vehicles, there are opportunities to put the incentives and the regulatory measures in place

“The last two decades have seen real improvement, but the rate of progress is still modest,” said Savage. “Probably the area that has advanced most is engine emissions, as large diesel engines are only a couple of years behind EU standards now. It would be great if India could catch up, but it is a step by step process.”

With this in mind, the move towards increased electrification perhaps presents the opportunity India has been waiting for. With electric mobility still in its relative infancy, developments in this space have suddenly placed all markets on a very similar standing. “Battery prices globally have been cascading rapidly downwards in recent years and our projections show that phenomenon will continue out into the future. I do not see any technical barriers as to why India could not pull itself in line with other major markets, and even exceed other markets around the world,” said Sharpe. “If the Indian Government wants to be very aggressive around rolling out electric commercial vehicles, I certainly think that there are opportunities for them to put the incentives and the regulatory measures in place.”

For the time being, however, the focus remains firmly on improving today's vehicles. A combination of overwhelming public support, government incentives and cost-saving potential has created a melting pot of collective ambition. While India may still be an emerging automotive market, it still possesses engineering and software heritage that should aid it well as it continues to claw back in line with other markets. While the full picture may not be revealed until the arrival of BS-VI in 2020—providing, of course, that India sees this through—it appears the right pieces are beginning to fall into place.

ICE optimisation may not be enough for future US emissions regulations

From 2020, some electrification could be necessary for all vehicles made for the US—but will the consumer play ball, and will California's emissions sovereignty remain? By Xavier Boucherat

At a time when vehicle electrification is becoming a mainstream concept—if not in practice, then certainly in theory—it is easy to forget that automakers building cars for the US have achieved much through the ongoing optimisation of standard internal combustion engines (ICE).

Xavier Mosquet, Senior Partner, Boston Consulting Group, estimates that year-on-year, the industry has seen fuel efficiency improvements of 2.9-3% with reasonable consistency since 2007, driven by the continued fine-tuning of fuel-burning powertrains. Downsizing, turbo-boosting and direct injection tech have all played a role.

Now, however, the industry is entering what he dubs a critical period of evolution, with the combination of Corporate Average Fuel Economy (CAFE) standards, as amended by the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule, and the Low-Emission Vehicle regulations (LEV) in California and the 13 other states which follow the lead of the California Air Resources Board (CARB). CAFE wants average fuel economy of 54.5 miles per gallon (mpg) by 2025. Meanwhile, LEVIII means California wants low energy vehicles to represent



After 2020, automakers can't meet the regulations without some form of electrification. This is particularly the case in the US given that it is a gasoline market, which unlike diesel as used in Europe is not CO2 efficient

between 3 and 4% of new vehicle sales by 2022, and 8 to 9% by 2025—and where California goes, the remaining 13 are likely to follow. LEV represents both battery electric vehicles (EV) and plug-in hybrid electrics (PHEV).

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A crossover or utility vehicle that has the same powertrain and technology as a sedan with the same footprint will achieve two to four miles per gallon lower fuel economy. In a world of low gas prices, this has proven to be a trade-off that consumers are willing to make for the versatility of these vehicles

Meeting these targets means the end of incremental ICE improvement alone. “After 2020, automakers can’t meet the regulations without some form of electrification,” says Mosquet. “This is particularly the case in the US given that it is a gasoline market, which, unlike diesel as used in Europe, is not CO2 efficient.” All the automakers know it, and electrification must start now, he claims. But there’s a problem: will the consumer play ball?

American appetites

As it stands, no. One US automaker which has proven outspoken on the topic is FCA. It believes that market realities are the main reason behind the industry failing to meet the Environmental Protection Agency’s greenhouse gas (GHG) emissions standards in 2016 without the use of previously accrued credit, as reported in the EPA’s Manufacturers Performance Report. In comments to the US Environmental Protection Agency (EPA) and the Department of Transportation (DOT) published in October 2018, the automaker suggested that regulators had clearly not anticipated the direction the market would take when drawing up standards for the model years 2017-2025. Initial forecasts referenced predicted that cars—which is to say non-SUVs—would represent 57% of annual

vehicle sales by 2025. Instead, they have fallen from 51% in 2008 to roughly 31% in 2018. Over that time period, utility vehicle sales, including SUVs and crossovers, have risen in popularity, and now dominate the sales mix at roughly 60:40.

In addition, the automaker argued that continually low gas prices, which are hovering around the US\$3 per gallon figure, mean that consumers benefit less from fuel savings at the pump when they buy fuel economy improvement technology, thus lowering the incentive. “A crossover or utility vehicle that has the same powertrain and technology as a sedan with the same footprint will achieve two to four miles per gallon lower fuel economy,”

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There’s nothing Donald Trump can do to stop us from advancing our policies



What the automakers want is a single market in the US: they do not want to have to manage two types of regulations. They also realise that they are competing globally, and will have to develop electrified technologies for other markets, such as China

wrote the automaker. “In a world of low gas prices, this has proven to be a trade-off that consumers are willing to make for the versatility of these vehicles.” This has inhibited adoption of EVs and hybrids, and the automaker wants stringency reduction.

However, Mosquet believes it is not a case of whether consumers want electrified vehicles, but an issue of cost: they remain too expensive for many. The falling cost of batteries could prove the solution. “In 2010, the average battery cost stood at US\$700 per kilowatt hour,” he says. “That has dropped to today’s level of around US\$150. BCG believes that in the next few years, that could reduce again by 50%.” Acceleration is already happening in California, he adds, with sales of low-emission vehicles counting for around 7.7% of new registrations. In addition, electrified SUVs have already emerged on the market, and talk of electric pick-ups is getting louder—Ford, for example, has said that hybrid and full-electric versions of the F-150 are in the works.

Will Trump get his way?

Amid all this, the Trump administration continues in its efforts to roll back the proposed regulations, as well as rescind the rights of California and the 13 states that follow it to set their own emissions regulations.

“Clearly there is a discussion right now in the US at the federal level as to whether efficiency standards should be slowed down,” says Mosquet. “It is not clear at all where they will go. They could try to align the 14 states with federal rules, but we would expect there to be a battle if that happens. Those states have already said they’re not willing to slow down in their search for improved fuel efficiency and lower emissions.” Resistance has indeed been fierce: “There’s nothing Donald Trump can do to stop us from advancing our policies,” said Washington Governor Jay Inslee back in 2017, and New York Governor Andrew Cuomo took a swipe at Trump’s infamous election campaign, when he said, “You don’t get great going backward.”

A potential rollback of standards may sound like good news for automakers—Trump has billed it as such, saying it will strengthen the industry—but between those set by the 14 and those set on a federal level, automakers are more likely to prefer the former. “What the automakers want is a single market in the US: they do not want to have to manage two types of regulations. They also realise that they are competing globally, and will have to develop electrified technologies for other markets, such as China, where NEV regulation virtually replicates California’s.” For its part, California state has announced it will sue the White House should it need to, in order to keep requirements in place.

US truck emission talks continue, and the auto industry is on the CASE

CARB and EPA continue to develop US truck emissions regulations, but the arrival of CASE trends is giving the auto industry a greater say. By Jack Hunsley

The dual-standard approach to regulating vehicle emissions in the US has for decades caused headaches for the automotive industry. While the end goal for both the California Air Resource Board (CARB) and the Environmental Protection Agency (EPA) is theoretically the same—to reduce vehicle emissions—there is little doubt that the automotive industry would prefer to follow one consistent standard, rather than two.

Both bodies have co-operated in the past, but ongoing difficulties between CARB and the EPA are only adding to the existing confusion. In April 2019, for instance, CARB filed a lawsuit against the EPA and the National Highway Traffic Safety Administration (NHTSA). CARB alleges that the pair failed to comply with a Freedom of Information Act request submitted

in September 2018 for information used in proposing a rollback of the Obama administration's vehicle emissions standards.

The turmoil may continue behind the scenes, but for the automotive industry it is vital that the cogs keep turning. As mobility begins to further embrace new trends, and particularly those that could enable low or zero emissions propulsion, understanding where future trucking emissions standards in the US are likely to lie is of huge importance.

EPA and CARB

The differences between EPA and CARB's approach to heavy duty emissions standards have for a long time led to slight divides. Since

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We know that CARB will be aggressive on the NOx standards because they have told us the ranges they are looking at and that they are looking at coupling it with many other requirements

1987, California has often required automakers and manufacturers to meet sterner particulate matter and oxides of nitrogen (NOx) limits than required by the federal schedule. However, the pair are currently working somewhat in unison, with Laurie Holmes, Senior Director, Environmental Policy at the Motor & Equipment Manufacturers Association (MEMA) noting that EPA and CARB are working together on future limits, albeit with CARB on a slightly different time schedule. As such, while this cooperation is expected to result in somewhat similar standards, there remains a degree of curiosity as to where the two standards will differ.

“We know that CARB will be aggressive on the NOx standards because it has told us the ranges it’s looking at, and that it is looking at coupling it with many other requirements. EPA has not released that because it’s much earlier in their process. We do not know where the EPA will be,” added Holmes.

The industry view on the EPA is that the current Trump administration is very eager to regulate NOx limits for the heavy-duty industry given the input it receives from stakeholders. It is believed that several states are also pushing EPA on this front, given that many have tightening individual air quality standards requirements to meet.

Left in limbo

But, while the two bodies to-and-fro on where such limits will lie, there is a danger that the automotive industry will be left in limbo. Without clear, defined standards, it could be difficult for automotive players to act beyond outlining the broad goals of continuing research and the development of low emissions technology. There lies a real case for automotive players to get involved in the decision-making process and to get ahead of legislation.

This need to stay ahead of the game has led to a shift in the balance of power when it comes to designing emissions standards. For example, Don Ake, Vice President, Commercial Vehicles

at FTR has previously highlighted that in the past this process was largely driven by government mandates, whereas now the increasing desire within the automotive industry to go green has begun to make the process a more market-driven one.



The industry has not strongly opposed the mandates unless they were perceived to be overly severe

In 2016, for example, the US finalised phase two of its trucking regulations for greenhouse gases, a move which the industry itself generally supported. However, when Congress in 2017 considered repealing the phase two ruling, a united industry effort followed to reiterate the industry’s support for the standard. As such, as EPA and CARB continue work on upcoming HD NOx standards, the industry is keeping a firm eye on proceedings.

“The industry has not strongly opposed the mandates unless they were perceived to be overly severe,” said Ake. “This time it is different because the industry is being proactive. They know more restrictions for diesel engines are coming at some point and are planning to convert to electric trucks in the future. The speed of change is dependent on battery technology and how severe future government emissions requirements are.”

This growing interest in electrification is well publicised. For example, in September 2018, Volvo Trucks followed suit by announcing its plan to introduce all-electric trucks to the North American market as part of its Volvo LIGHTS (Low Impact Green Heavy Transport Solutions) project, a project made possible by a US\$44.8m



It is the suppliers that are the ones making much of the technology so the EPA and NHTSA do reach out to suppliers to learn about what technologies they are working on and what will be out there and available

grant from CARB. In December 2018, Daimler Trucks North America followed suit by delivered its first electric Freightliner truck to Penske Truck Leasing in Los Angeles.

Promising developments, but such moves only begin to tackle the problem. Much work is still to be done both in developing powertrain technologies and installing the required infrastructure to facilitate larger fleets of e-trucks in the US.

Supplier role

Many commercial vehicle suppliers are also preparing for the future ahead of regulation as the wait for a set of standards continues, with suppliers already making investments in NOx control technology.

Likewise, suppliers with expertise in fuel efficiency and sensors are involving themselves in the rulemaking process.



This time it is different because the industry is being proactive

Despite expectations that the CARB and EPA proposals may not be implemented at the very earliest until 2023 and 2027 respectively, there appears little room for the industry to stand still.

Government cooperation

This growing industry interest in shaping regulations has not gone unnoticed at the federal level. For example, as the NOx standards begin to take shape, the EPA has begun reaching out to industry players for guidance. “It is the suppliers that are making much of the technology, so the EPA and NHTSA do reach out to suppliers to learn about what technologies they are working on and what will be out there and available,” said Holmes. “They also talk a fair amount to the automakers about what they think is reasonable and feasible and I think it is the automakers that probably have the best idea as to what they can do.”

Overall, the arrival of the new mobility megatrends has coincided with an interesting time for truck emission regulations in the US. As the discrepancy between CARB and the EPA continues, albeit amongst a degree of collaboration, the industry has suddenly found itself with a considerable degree of power. The potential for the industry to drive regulation through the early adoption of low emission technology is very real, and an opportunity that must not be taken lightly.

China's auto industry prepares for sixth generation emissions standards

The Chinese government has shown it means business when it comes to emissions compliance, and now manufacturers must prepare for China 6's wide range of measures. By Xavier Boucherat

Manufacturers operating in the world's biggest car market are readying themselves for China 6 emissions standards. Modelled on European Union standards, these will arrive in two phases. '6a' will take effect from January 2020, which calls for a carbon monoxide reduction of 30% from 1g/km to 0.7. 6b is scheduled for January 2023, which along with further carbon monoxide reductions down 0.5g/km will put stricter limits on nitrogen oxides and particulate matter (PM) into effect. In addition, the sixth generation of standards will introduce metrics not previously used in the country: limits for nitrous oxide, and particle number, the number of solid particles a vehicle can emit as measured by unit/km.

Nicolas Pechet, Senior Partner at Solidiance, a strategy consultancy focusing on Asian markets, says the incoming regime is indicative of a more wide-ranging approach to tackling the Chinese emissions problem, but that it will clearly take some time for change to benefit the lives of its citizens. "It's clear that emission reductions are expected to happen across the board," he says, "however the first phase deals only in CO2 reduction. The rest will not arrive until 2023. NOx and PM are the critical air

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China's pollution has led to a national health crisis. Images of China's smog-ridden megacities, suffused with dangerously high levels of the carcinogenic PM2.5, have circulated throughout the world. It is true that the situation in urban centres is improving, with Beijing recording less heavily polluted days in 2018; 15 such days were recorded,



48V mild hybrids are expected to reduce CO2 emissions of a vehicle by 13% to 21%. As such, fitting a China 5 vehicle with a mild hybrid system may not be enough to comply with China 6

compared with 2013's 58. The average PM2.5 density dropped to 51mg per cubic metre, a 12.1% drop.

However, central government wants more. A June 2018 report from the Ministry of Ecology and Environment confirmed that along with coal-burning, vehicle emissions were a major source of what air pollution remains. The total Chinese car parc rose to 310 million vehicles over the course of 2017. As part of the 'War on Pollution', President Xi Jinping has previously expressed his wish to 'return the blue sky to the people'.

So, can the manufacturers do it? Pechet suggests that some are already on track. "Several models from Chinese automakers, both Sino-foreign JVs and Chinese companies, are already China 6 ready," he says. "For example, Geely has six compliant models, whilst Changan and SAIC have five and four respectively." Automakers have already witnessed the state's willingness to step in when manufacturers fail to comply: in January 2018, production of more than 500 model variants across several smaller automakers that did not meet standards was suspended. This affected both domestic manufacturers and the joint ventures which foreign automakers are required to start to build in the market.

But as DuckerFrontier's Markus Pfefferer points out, government data would suggest only 554 models on the market meet the China 6 standards, which is equivalent to around 12% of China 5 models. "Most of these are JV brands and imported brand models," says Pfefferer, the consulting company's Managing Director for the Asia-Pacific region. "There are only 20 models from domestic independent brands. It is difficult for car companies to adjust in a short

period of time, and difficult to iterate products in the short term. Therefore, this has caused insufficient supply among the dealers."

The introduction of technologies to clean up internal combustion engines (ICE) will be key, including fuel injection, optimising engine burn and modern intake and exhaust structures. "Beyond the engine, we'll see electronic control unit improvements, carbon tank volume increases, fuel system saleability improvements and upgrades of on-board diagnostic systems." But of course, automakers are also eyeing up the opportunities for electrification, in the world's largest electric vehicle (EV) market.

New energy vehicles

Manufacturers will embrace models from across the electrification spectrum, says Pechet. "Currently, plug-ins account for around 25% of all new energy vehicle (NEV) sales by volume, and are expected to increase its share over the next few years," he suggests. "Meanwhile, 48V mild hybrids are expected to reduce CO2 emissions of a vehicle by 13% to 21%. As such, fitting a China 5 vehicle with a mild hybrid system may not be enough to comply with China 6." The national target for overall battery EVs and plug-in hybrid production is two million units by 2020, and major players have expressed confidence. In China, VW, for example, has announced a major push into the EV market with a fully electric vehicle on Chinese roads by 2021.

However, the government's recent decision to cut back EV subsidies will not make the challenge any easier for automakers. The



China is working towards improving its energy mix, by reducing dependence on coal to 50% by 2030, and substituting today's needs with renewables. However, this is being done independently of vehicle emission regulations

previous incentive of Yuan 50,000 (US\$7,457) will be cut in half to 25,000. Furthermore, vehicle ranges must exceed 250km to qualify. The government has previously indicated it wants to eliminate subsidies altogether by 2020.

China's coal dependence remains an issue—electricity generated by coal rose 6% in 2018 to 4.9 trillion kw/h—but for now it would seem regulators are not about to make moves that could hinder EV deployment through taxation on electricity used to charge the vehicles. “At the moment, there are no indications that energy production and energy consumption for charging EVs will be linked,” says Pechet. “China is working towards improving its energy mix, by reducing dependence on coal to 50% by 2030, and substituting today's needs with renewables. However, this is being done independently of vehicle emission regulations.”

The *MIT Technology Review* believes that China is likely to achieve its commitments under the Paris Agreement. The country was the largest emitter of greenhouse gases in 2017, at 27%, but its carbon use could peak before 2030, and by that point it hopes to source 20% of its energy cleanly.

Heavy-duty rules

Accompanying China 6 regulations will be China VI, which like in Europe applies to heavy-duty vehicles. Older diesel trucks are thought to be among the main offenders in harmful vehicle emissions, and the government has announced it is targeting compliance rates

of at least 90% by the end of 2020. Some regions of the country will be directed to start applying the China VI-a standards as early as summer of this year, with models not meeting the requirements barred from entering the market. It is thought that in the regions surrounding Beijing, more than a million outdated diesel-fuelled trucks could be taken off the road. Full implementation of China VI-b will arrive by July 2023.



China VI will force wider use of diesel particulate filters to remove. This could mean that two thirds of new trucks will be soot-free by 2021. Were China to take no action, this figure would stand at only 50%

As the International Council on Clean Transportation (ICCT) has highlighted, what China does in this market really counts on a global level. For truck manufacturers, China VI will force wider use of diesel particulate filters. This could mean that two thirds of new trucks will be soot-free by 2021. Were China to take no action, this figure would stand at only 50%.