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Brains, Brawn, and Billions: Realizing Clean Diesel Technology

By

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At a recent Clean Diesel Technology Tour in California, the Diesel Technology Forum and its members displayed a wide variety of clean diesel engine technology: a full range of trucks meeting the world's most stringent emission standards; hybrid electric school and transit buses; low-emitting farm and construction equipment; retrofit technology; fuel efficient, powerful, quiet, and clean passenger cars, and even a pick-up with an engine meeting 2010 standards. And, the most impressive thing? It all is available today. Today's diesel technology represents something great – diesel engines that are durable, energy efficient, and with emissions levels near zero. We've come a long way.

When I first began working with the diesel engine industry in 1977, the biggest long-term concern was Section 202(a)(3)(B)(ii) of the Clean Air Act. Simply put, it required diesel engines to meet a 4.0 g/bhp-hr NOx standard in 1998. For many, that requirement, coupled with the well understood trade-off between NOx, PM, and fuel economy, was viewed as the end of the diesel engine.

How times have changed. In 2010, on-highway diesel engines will meet a 0.2 g/bhp-hr NOx standards; which is on top of a 0.01 g/bhp-hr PM standard; which is on top of no loss in fuel economy (and, indeed, some improvements over that time period). The significance of those numbers might not mean a lot to many of you. But what they mean is that the diesel industry has reduced emissions of the major criteria pollutants and air toxics by approximately 99%. Advances in diesel technology have taken us from black smoke and visual opacity standards to clean white handkerchiefs; from concerns about how to make a working diesel engine that emits only 4 grams of NOx to today's worries that emissions are so low, we cannot accurately measure them.

Diesels are not what they used to be – clean diesels are here today. And, with clean diesel we also have a power source, here now and readily available, that can help reduce CO₂ emissions.

How did we get to this point? Interestingly, engine manufacturers didn't try to respond to what many thought were impossible goals with a we can't do it attitude or a push for delay. We rolled-up our sleeves and worked with regulators and other stakeholders on implementation. Science, engineering, significant capital investment and simple hard work have prevailed. And, the real winners are the environment, the breathing public, and all those who rely on an efficient, durable, cost-effective, and available means of power generation and goods movement – which is everyone. What a difference when your product goes from being labeled “dirty diesel” to being called “clean diesel.” Viva la difference.

So, where does this leave us? Diesel can be, should be, and is a part of our long-term emissions, energy, and environment needs. But, we are not done. We cannot rest on our laurels. We can, and will, do more. And, in doing more, we face enormous challenges. Understanding those challenges will help us to continue to work together, even better and more effectively, to overcome them.

- We have morphed from addressing new emission requirements with relatively simple, in-cylinder engine improvements to a full-blown “systems” approach to compliance: improved engines, improved fuels and the addition of aftertreatment. But, the “system” is bigger, broader and more complicated than the three-legged stool of engine, fuels, and aftertreatment. It also requires improved lubricants, test procedures, test measurement techniques, sensors, supplemental fluids (with a supporting infrastructure and delivery system), and vehicle integration – all with renewed emphasis on fuel economy and with no ability to tolerate reduced performance or customer acceptability. Solving these problems -- really minimizing their impact -- is not impossible. But, it does involve multiple players working together to solve extraordinarily complex problems. And solving them is fundamentally changing the business model. Differentiation, customer choice and lack of coordination are out. Product and systems integration is in. All of that adds cost and complexity, and requires leadtime and flexibility.

- Some might liken what has been accomplished to “A Field of Dreams.” But unlike the movies, and the iconic catch-phrases they create, with clean diesel technology there is no guarantee that “if you build it, they will come.” The regulations only require that engine manufacturers make complying engines. No one is required to buy them. Further, old diesel engines can be rebuilt almost indefinitely. If there is no value proposition to the customer – who typically is making a capital investment to buy a commercial product which contributes to their livelihood – they won’t buy the new product. If no one buys, environmental benefits are lost or delayed. From the manufacturer’s perspective, if no one buys, profits are lost, or worse. There are two confounding elements of the “if you build it, they will come” conundrum. First, if the regulatory goal cannot cost-effectively be met, we have an obvious problem: no one will buy. But, second, and more profound, if our customers perceive that costs are too high (and they look at total life cycle costs), they also will decide not to buy the new technology. We must work to address both the perception and the reality, and we must keep our eye on the prize: A smooth implementation of new technologies, and an avoidance of any needless “piling-on” of minor requirements that add costs without significant benefits. We must assure that nothing impedes the production availability of product, or creates the perception that customers should hold on to their older products.

- Be certain, manufacturers must re-coup their capital investments, and make a profit. Without that, there will be no manufacturers, and no new products and technology. The low hanging fruit is long gone. We’re even beyond the stretch goals. The changes that are still to come will provide smaller benefits at higher costs with greater burden and higher risk. Those future benefits – many of which are very near-term – include NOx aftertreatment, in-use testing, and on-board diagnostics. And, they are not just for trucks and busses. We’re in the process of implementing new technologies, fuels, and systems for the myriad of non-road and marine engines and applications, as well as for stationary sources.

- For a substantial number of engine manufacturers, the regulatory requirements Nationwide, in California, and throughout the world have resulted, essentially, in a never-ending cycle of R&D and continuous improvement. For example, in the 10 year period from 1998 through 2007, diesel engine manufacturers had to meet 19 new emission regulations – and that’s not even including stationary, locomotive, Nonroad Tier 4, or test procedure and certification compliance changes. That’s an incredible work load. There is nothing inherently wrong with that, but the relatively small volumes of products with which to spread and absorb those costs, and the ever shorter time periods in which to attempt to recoup them, is problematic. It is important to spread costs and balance the burden to be successful. And we all want to be successful in producing cleaner products - - products which must remain customer acceptable.

- Let me provide one small, but critically important, aspect of how far we have come -- and how it creates new challenges. We have gone from saying “how can we get that low” to now saying “how can we measure that low.” It is a huge problem when the standards, and the engine’s performance, are better than the ability of the equipment available to measure, or the inherent variability in measurement. Where the emission limit is 1/100th of a gram and the certification level is, say, 2/1000^{ths} of a gram below that (e.g., .01 and .008), no one wants to fail a certification or compliance test because variability or equipment accuracy is only good to .003 (3/1000^{ths}). Some pragmatic rationality must be applied.

- In a changing world, what is beautiful about diesel power has stayed beautiful and that which was ugly has been eliminated. We embrace the fuel efficiency, power, performance, reliability, durability, low HC and CO emissions and high torque of diesel power. We have essentially eliminated NOx and PM emissions, minimized noise, and we burn a very low-sulfur fuel. And more is still being done. Manufacturers are enacting a ground-breaking in-use testing program; implementing robust engine-based emission diagnostic sensors and systems; and expanding the extraordinary technological advances and emission improvements that have been achieved with on-highway diesel engines to the significantly broader and more complex world of non-road diesel engines.

So, what are some of the viable options for helping all of us achieve the important goals that still lie ahead? Well, some things are quite simple. It is essential that we maintain the degree of regulatory alignment that exists today, and strive to achieve alignment where it does not fully exist. The market for diesel engines, and the hundreds of applications in which they are installed, and the thousands of OEMs, simply is not big enough to support multiple configurations of advanced technology engines. Production often resides in one plant (which could be located anywhere) with distribution throughout the world. The smallest little change in a regulatory requirement – often a question of form over substance, and generally having no or insignificant impact on emissions – can nevertheless have enormous effect on costs and severely impact manufacturers and their customers. We must be mindful of, and avoid, the ripple effect of small procedural inconsistencies in what is a worldwide market, and which must be governed by a worldwide set of regulations.

We also must greatly expand the funding available to improve the performance of legacy products. And, we must do a better job of triaging the costs and benefits – and feasibility – of various retrofit opportunities. Converting pre-regulation engines to early tier emission levels likely would provide literally tons more benefit at a fraction of the cost, then taking a few more recent technology engines and making them the cleanest possible. We don't want the perfect to be the enemy of the good when it comes to addressing legacy products.

The quality of fuels have improved dramatically in the last decade, with the focus primarily on sulfur. We shouldn't be done with our efforts to improve fuel quality. The goals outlined in the Worldwide Fuel Charter, which will help both emissions, performance, and sociability, should be implemented.

And, fuel quality isn't just limited to traditional diesel. Bio-fuels potentially can help address emissions, fuel economy, and energy dependency issues. But not all bio-fuels are created equal. We need better fuel specifications for base and blended fuels that work worldwide, irrespective of feedstock.

Finally, we must focus on the challenges associated with climate change and the reliance on petroleum fuels. There, too, we think that diesels, with their inherent efficiency and their ability to burn bio-mass based fuels, are an answer – available today.

Engine manufacturers have solved what many thought was an impossible challenge of physics and engineering. Brains, brawn and billions of dollars can and have achieved greatness. Today's diesels are very different from previous generations. They are clean, quiet, and efficient. Today's clean diesel technology can and will be an essential tool in driving the world's economy.

EMA and its members want to continue to be partners in the solution, and contributors to further improvements in the world's air quality, transportation and energy efficiency needs. Diesel technology has changed tremendously. We should look at diesels – not as liabilities from the past – but as solutions for cleaning the air, providing jobs, and growing the economy. The diesel industry has been a partner with legislators, regulators, and various other stakeholders at the state, federal, and international level. We believe that we can continue to be a partner for the future.