The future of diesel in trucks and buses is... The diesel.

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A study by Power Systems Research points out that fossil fuel and its renewable variants such as biodiesel and HVO will dominate the cargo and passenger transport scene for many years to come

By Pedro Kutney | Collaborated Carlos Briganti, PSR

The energy transition route to trucks and buses are the most resistant to conversion to adopt cleaner propulsion systems and reduce emissions of greenhouse gases. Fossil diesel, even if increasingly tempered with its renewable variants such as biodiesel and HVO, will continue to be dominant in road freight and passenger transport. This is what the recent study The Future of Diesel reveals in

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Volvo Flex Truck: prepared to run on biodiesel or diesel.

Commercial Vehicles in Brazil, prepared exclusively for AutoData by PSR, Power Systems Research, a global consulting firm specializing in the heavy vehicle market.

Despite the global trend towards electrification, via batteries or hydrogen fuel cells, or the growing use of fossil natural gas or biomethane, to fuel trucks and buses, in addition to biodiesel and HVO, the fact is that none of these alternatives is as economically viable as diesel itself. None of them, therefore, will be able to replace all the fossil fuel needed to push heavy vehicles for many decades ahead, it is envisioned.

According to the PSR survey, diesel, with small portions of a mixture of biodiesel and HVO, is now responsible for driving 99% of trucks and buses in Brazil, a percentage that drops to 94% in the European Union, 89% in the United States – and it is not because more low-emission alternatives are used there, but because 7% of the fleet is powered by gasoline. Another 3% run on natural gas and only 1% correspond to electric models. China is more advanced with 81% diesel, 10% gas and 9% electric.

PSR's projections until 2032 do not raise this scenario very much, especially in Brazil, where the consultancy projects that fossil diesel mixed with biodiesel and HVO will be responsible for supplying 90% of the heavy fleet, complemented by 5% electric, 4.4% natural gas and bio-methane and 0.6% hydrogen fuel cells.

As it already does with automobiles, China will have the largest and fastest conversion to electric trucks and buses by 2032, with 34% of the fleet, plus another 9% running on gas, but diesel will continue to be the largest energy source for 57% of heavy vehicles.

In Europe, despite being the second largest region for the adoption of electric trucks and buses, 25% by 2032, with an additional 3% of gas, diesel and its mixtures will still supply 72% of the fleet.

DIFFICULT ROUTE TO CHANGE

Carlos Briganti, director of Power Systems Research in South America, considers that the combination of several factors conditions makes it more difficult to convert from heavy diesel vehicles to low-emission alternatives.

This list of constraints includes the maturity of the technologies to be adopted – which requires technical development and production capacity of vehicle manufacturers and their suppliers –, global trends, installation of refueling or charging infrastructure, government incentives for

HVO: green diesel is a good solution but still costs a lot

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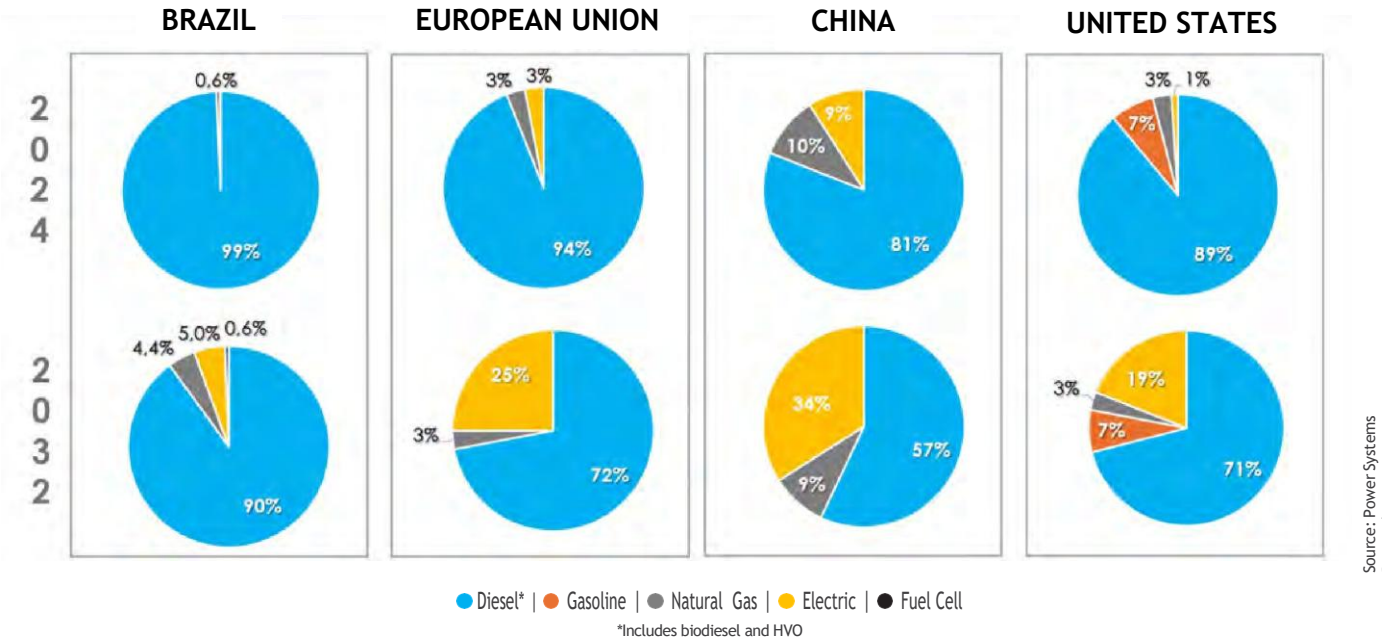
Propulsion of heavy commercial vehicles



Source: Power Systems

compensate costs and the very important operational cost of transporters, because without economic viability nothing goes forward. But the preponderant factor over all others is legislation, which imposes paths.

"Legislation is the biggest driver of technological change," Briganti stresses. "In Brazil we have several regulations coming into force by 2030. The ones that will most affect the use of fossil diesel are those that address toxic emissions and energy efficiency."

The consultant notes that Brazil has not yet defined the energy efficiency targets of Mover, the Green Mobility and Innovation Program, which will contribute to reducing CO2 emissions, but Proconve, the Vehicle Emissions Control Program, has already made great progress in limiting toxic emissions of particulates and NOx from heavy diesel vehicles. The eighth phase of the legislation, P8, came into force at the beginning of 2023 and forced manufacturers to adopt Euro 6 engines, in line with the levels of pollutant emissions allowed in Europe.

Looking at the regulatory framework adopted in some of the world's largest CO2 emitting countries, it is noted that in Brazil as well as in the European Union, the United States, China, India and Japan, there are no major developments in emissions legislation, which seem to have reached a certain limit of technical and economic feasibility. It is difficult to go beyond what is already in place today. The United States and the European Union are more advanced in the severity and deadlines for tightening legislation, but there are difficulties, realignments and setbacks. The Trump administration, for example, has a political direction to reduce requirements and extend deadlines for the introduction of new phases of emissions legislation. It has in its favor all the entities linked to long-distance road transport, urban transport and the majority of the population, which does not want cost increases that generate inflation. The European Union still maintains its targets, but has been suffering technological difficulties, from the lack of charging infrastructure for electric vehicles and the high operational cost of electrification, which

are quite antagonistic to the moment of economic crisis that the region is experiencing. Briganti evaluates that "as in the United States, the European entities linked to transport have been pressuring the European Parliament to extend the deadlines, and it seems very likely that they will succeed".

China is currently the best structured country for the introduction of hybrid and electric vehicles. It has advanced technology, dominates the production of batteries and has installed infrastructure. On the other hand, it has an energy matrix based mainly on coal, which is a disadvantage in measuring the carbon footprint from well to wheel, which considers emissions from the production of the fuel and its distribution to its use in the vehicle. Thus, Chinese electric models may not even emit CO2, but the plants that generate electricity to supply them emit a lot, in record volumes in recent years.

ALTERNATIVES FOR BRAZIL

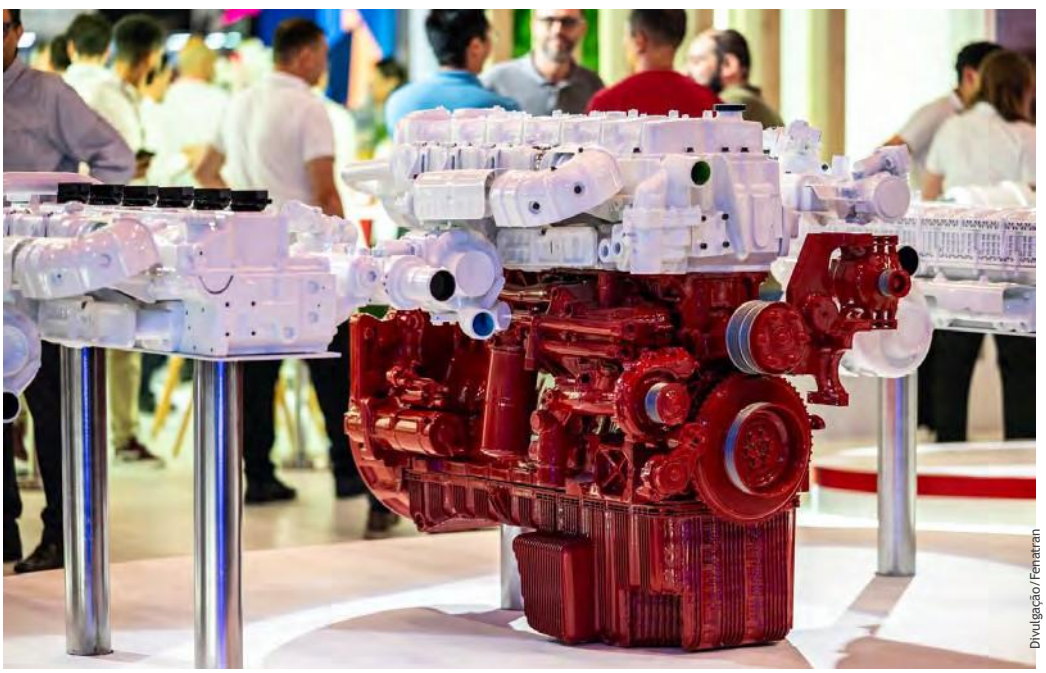
"Brazil does not necessarily need government incentives to introduce alternatives to fossil diesel but, above all, a strategy aligned with the necessary infrastructure for new technologies", says Briganti. He endorses that, in addition to developing technology, the country needs to be globally competitive, hence the importance of a clear plan on this topic.

The PSR study lists the pros and cons of the low-carbon alternatives available in the country to boost heavy commercial vehicles:

"Brazil is certainly the country that has the best alternatives for energy transition, whether for local application or export. Even so, diesel will surely be the best option, even for many years beyond our projections that go until 2032."

Diesel is not an easy product to replace, because despite its toxic emissions of particulates and NOx, which the P8 Program forced to be reduced to a minimum, it remains a cheaper fuel than all other possibilities of replacement, in addition to having an already established distribution network and excellent energy density. which allows you to drive hundreds of kilometers with a tank.

>> MORE EFFICIENCY - The diesel cycle is already the most efficient of combustion engines and, even before thinking about replacing



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Cummins Helm Engine: Multi-Fuel Proposal Operates on Diesel, Gas or Hydrogen with Head Change.

fossil fuel, it is possible to make it even more economical. Manufacturers of engines for commercial vehicles already estimate that improvements can raise thermal efficiency to 50% – the energy that actually reaches the wheels – compared to the 45% accepted today as a baseline, which is already an exceptional advance in reducing CO2 emissions through reduced consumption, in addition to being something fully accepted by transporters. as they would save on operating costs.

>> ETHANOL - It is the most produced and distributed biofuel in Brazil, but it is best suited to light vehicles, including hybrids. For trucks and buses with engines

Electric axle developed by Suspensys generates 200 hp auxiliary traction for trailers and tractors: VWCO has already adopted the solution to launch the hybrid Meteor.

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The Otto cycle has low energy efficiency, which increases consumption and reduces refueling mileage, and can be a problem in regions without ethanol production. CO2 emissions are also increasing, although in the case of biofuels this is not a problem, as biogenic carbon dioxide is largely reabsorbed in the production process. Electric buses with autonomy extended by a flex-fuel combustion generator engine, as is the case of prototypes already developed by Marcopolo and Volkswagen Caminhões e Ônibus, can be a feasible solution for the use of ethanol in weighed vehicles, but still the operating cost higher is a barrier.

>> BIODIESEL - It is an ester produced from the addition of methanol to vegetable oils, mainly soybeans and animal fat, already in use in Brazil for almost two decades mixed with diesel, in a proportion that in 2024 reached 14% and is expected to gradually advance to 20% by 2030.

The Biodiesel has the advantage of reducing particulate emissions, but the disadvantage of increasing NOx, which requires greater injection of arla into the aftertreatment system of diesel engines, increasing operating costs. There are also storage problems due to water contamination, and distribution in Brazil has variations in quality with possible contamination by heavy metals. Manufacturers such as Scania, Volvo and DAF have already adapted engines to run on 100% biodiesel. At the same time, Be8 is successfully testing Bevant, a bi-refined and additive biodiesel, which results in methyl ester without other variations, so it can be used 100% in diesel engines without the need for adaptations. The product is about 15% more expensive than regular biodiesel, but costs half the price of HVO green diesel.

>> HVO - Simply, HVO is the product of the hydrogenation of vegetable oils, resulting in a hydrocarbon purer than

fossil diesel itself, which can thus replace mineral fuel in 100% or be blended in any proportion, preserving the same operating characteristics and consumption of the engine, without the need for modifications. Petrobras' HBio is produced by this process and results in the same product.

HVO replaces fossil diesel with technological advantages, but it has a major competitiveness challenge, as it currently costs up to three times more than diesel or biodiesel. Until this price drops, the transition should take place through better quality biodiesel.

In addition, HVO competes with the production of green aviation kerosene, SAF, which has characteristics similar to those of HVO, is produced by the same process, so it will be more dedicated to fueling aircraft that have no other alternative to decarbonize their emissions.

>> NATURAL GAS/BIOMETHANE - Both are An extremely interesting alternative to replace diesel, but it is used in OTTO cycle engines, which are less efficient than diesel cycle engines. Brazil has a growing production of both fossil natural gas and biogas, which have the advantage of zeroing particulate emissions and greatly reducing NOx emissions. And the technology is already available: Scania and Iveco offer gas models in their regular product portfolio in the country.

Gas or biomethane tractors from Scania, Iveco and VWCO: an alternative to diesel on the rise in the country.

The supply of 119 million m3 of natural gas per day is expected to grow year by year, reaching 175 million m3 in 2034, according to estimates by EPE, the Brazilian Energy Research Company, linked to the Ministry of Mines and Energy. And it can be much more, because very little pre-salt reinjection gas is used and the country has the potential to produce 80 million m3/day of biogas – from which biomethane is purified, which has the same characteristics as fossil methane and can be used 100% or mixed in gas-fired engines.

One of the main sources of biogas in Brazil is sugarcane mills, which extract gas from its by-products sugarcane bagasse and vinasse. Landfills and sewage collection stations also have great production potential, with the advantage of transforming a scourge into

Divulgação/Fenatran e VWCO

the environment into fuel, also avoiding the emission of methane into the atmosphere, which has a greenhouse effect ten times greater than CO2. Another source of biogas is the so-called "free-range pre-salt", through the use of agricultural waste in general, such as pig farming. The biggent barrier to large-scale adoption of natural gas an biometrics is the still insufficient distribution infrastructure, in addition to the price. International quotations have increased a lot due to the conflict between Ukraine an Russia, reaching US$ 2.61 per MMBtu, a million British thermal units, but they are already showing a downward trend, falling to US$ 2.30/MMBtu this year. In Brazil, however, the price of natural gas remains six times more expensive: US$ 12.50/MMBtu.

>> ELECTRIC AND PLUG-IN HYBRIDS - Theoretically, the mass adoption of electric vehicles in Brazil makes perfect sense, as the country has a clean energy matrix, with almost 90% of electricity generated from renewable sources in hydroelectric, wind and solar plants. With this , CO2 emissions would be minimal if measured by the well-to-wheel concept.

It would be a very favorable scenario, but commercial electric vehicles will have many difficulties to increase penetration in Brazil, despite being already offered by almost all manufacturers in the country, including local production of electric and hybrid trucks and buses. The electric axis

Electric truck options in Brazil: Volvo and Scania in tests and the national VW e-Delivery in ironic operation Supply fossil fuel at airport.

e-Sys with 200 hp, developed in Brazil by Randoncorp's Suspensys, is being tested and may be a more viable electric auxiliary traction solution to equip trailers and tractors, with the function of saving fuel.

But there are enormous barriers, which are in line with most of the conditions for the adoption of this alternative: low technological and production of manufacturers and their local suppliers, high cost of acquisition of vehicles,

three to four times more expensive than diesel, few incentives, no tax legislation and insufficient charging infrastructure to compensate for the low energy density of batteries, which makes long-distance transport, which is the most important of the truck segments in Brazil, unfeasible.

Under these conditions, electric and hybrid vehicles will be viable and will grow mainly in niche applications, such as port, city buses, and short-distance deliveries.

>> HYDROGEN FUEL CELLS - This solution for generating electricity, by reacting air with hydrogen in a catalyst, has been successfully tested for more than thirty years to power 100% electric vehicles. The biggest problem lies in the cost of the technology, which makes it economically unviable.

The advantage of hydrogen over all other alternatives is that the fuel does not generate CO2 emissions but only water vapor, both in the reaction of the cell and in combustion. It is the most abundant substance on the planet and can be obtained from various sources, with differences in emissions. Green hydrogen is emission-free because it is produced from the electrolysis of water using renewable electricity, wind or solar plants. Gas can also be extracted from other fuels, such as natural gas and ethanol, and in this case, there is a small emission of CO2. In the case of ethanol or methanol reform, emissions are greatly reduced.

These multiple ways of obtaining make Brazil the most important producer of low-emission hydrogen in the world. The main barriers to the development of technology for heavy vehicles in the country are the distribution and the vehicle's fuel tank, which requires very high resistance to store the liquid gas under high pressure.

>> HYDROGEN GENERATION IN THE VEHICLE- Green Fuel has successfully tested hydrogen production by hydrolysis of water in a tank installed in the vehicle's engine room. The gas is injected into the engine at the same time as the die-sel, enriching the mixture and generating less CO2 in combustion. The technology is relatively cheap, with an estimated return on investment in two years, and has provided an increase in energy efficiency of around 10%.

>> HYDROGEN ENGINES - Hydrogen can also be used directly in combustion engines without any CO2 emissions. The solution is more efficient than fuel cells in the case of larger, high-load vehicles. The technology is based on combustion using otto cycle thrusters but can be changed to a much more efficient diesel cycle.

Tupy MWM is a pioneer in Brazil in the production of hydrogen combustion engines, including the development of materials resistant to hydrogen corrosion. The most viable market for the adoption of this technology in the short term is the European Union, where legislation imposes severe reductions in CO2 emissions in a few years.

>> FLEET RENEWAL - The fastest and most efficient solution to reduce toxic and CO2 emissions is not in any of the new alternatives mentioned above, but in replacing old trucks with new ones, with diesel engines that emit less gases because they are more economical and equipped with pollutant reduction systems. The PSR study points out that, of the 2.8 million heavy commercial vehicles in circulation today in the country, almost 500,000 are equipped with emission technology prior to Euro 3 motorization – that is, practically without any control – another 834,000 are Euro 3. There are 1.2 million Euro 5 and only 190 thousand Euro 6. Conclusion: "The simple retirement of older vehicles would have a greater effect on reducing emissions than any introduction of new technology". ■