

More sustainable buses

A Brazilian company launches a cleaner hybrid electric vehicle in line with multinational manufacturing trends

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A flexible and environmentally advantageous transportation technology has been in operation in Greater São Paulo since mid-October 2015. Dual-Bus is a hybrid electric bus manufactured by Eletra, a 100% Brazilian-owned company headquartered in São Bernardo do Campo (metropolitan São Paulo). Hybrid vehicles use two power sources—a diesel generator and a battery bank—and are far less polluting than buses powered exclusively by fossil fuels. The advantage of the Dual-Bus is its versatility; it can operate not only as a trolleybus, when connected to an aerial electric grid but also as a purely electric vehicle powered by batteries fed by a diesel generator. It does not need to be connected to an outlet for recharging and is the first bus of its kind produced in Brazil. Other

Dual-Bus: works as a trolleybus or electric or hybrid bus that runs on batteries recharged by a small diesel engine



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manufacturers, such as the Swedish company Volvo and the Chinese manufacturer BYD, are also investing in Brazil's in new urban passenger transportation technologies based on electric traction and rechargeable batteries.

“The possibility of the same bus operating as a hybrid, trolleybus or purely electric vehicle brings several benefits to the operation, because the same fleet can meet the needs of various systems,” says engineer Paulino Fumio Hiratsuka and Eletra’s engineering, development and product manager. “Furthermore, the energy matrix can be modified according to the evolution of generation and storage technology or even the costs involved therein.” He notes that the Dual-Bus can be used initially as a trolleybus on any line, then continue as a hybrid vehicle by activating a generator, which is smaller than a traditional engine, and a battery bank. The Dual-Bus finishes its route as an electric vehicle, with no polluting emissions. In the event of a power failure, a trolleybus can disconnect from the overhead line and continue its route for a few kilometers with battery power. A key on the control panel allows the operator to choose the mode of vehicle operation.

“Buses such as Eletra’s Dual-Bus are ideal for large city centers, where concern with the level of pollutants is constant. These sustainable mobility technologies are gaining ground in the public passenger transportation sector,” says engineer Wanderlei Marinho, member of the Electric and Hybrid Vehicles Committee of the Society of Mobility Engineers (SAE) and graduate professor of Automotive Engineering at the Mauá Institute of Technology located in São Caetano do Sul (metropolitan São Paulo). The Dual-Bus operates in the ABD Metropolitan Corridor, a rapid transit line in greater São Paulo dedicated exclusively to buses and trolleybuses. Stretching for 33 km, the corridor connects the São Mateus neighborhood in the east to Jabaquara in the south, crossing the municipalities of Mauá, Santo André, São Bernardo do Campo and Diadema.

ELECTRIC TRACTION

The model developed by Eletra operates entirely on an electric engine and its power comes from a battery bank and a generator engine; this combination also recharges the vehicle’s batteries. This hybrid electric vehicle model works with two energy sources (a generator engine and batteries) operating simultaneously. Since the generator engine is used only for energy production

not for driving the bus, it is smaller than a conventional diesel engine. The result is a 95% reduction in emitted pollutants when compared to a conventional diesel-powered bus.

Another noteworthy feature of Eletra's new model, according to Hiratsuka, is that it does not require infrastructural investments in electric vehicle charging stations. "When operating as a hybrid or electric vehicle, batteries are also recharged when braking, through a system known as a kinetic energy recovery system (KERS)," says Hiratsuka. When the brake is applied, the electric engine becomes a generator, and the energy that would normally be wasted in braking is reused and stored in the battery bank. The bus can run up to 20 kilometers as a purely electric vehicle, using only battery power.

With a passenger capacity of 153, the Dual-Bus is 23 meters long; its four-axle articulated chassis is manufactured by Mercedes-Benz. The electric engine was developed by WEG, located in the southeastern state of Santa Catarina. The generator engine, in turn, combines a Mercedes-Benz diesel-powered vehicular engine and a generator, also made by WEG. According to Eletra's sales manager, Iêda Maria Alves de Oliveira, the Dual-Bus costs 35% more than similar diesel buses, but maintenance costs are about one-third lower. Eletra has been a presence in the Brazilian market for 30 years, specializing in the manufacturing of trolley, electric and hybrid buses. In 1999, the company introduced the first hybrid electric bus with Brazilian technology into the market (*see Pesquisa FAPESP Issue No. 92*). Today, about 320 of Eletra's electric buses operate in Greater São Paulo and another 82 in cities outside Brazil, such as Rosario, Argentina, with 20 vehicles, and Wellington, New Zealand, with 62.

SWEDISH ELECTRICS

One of the world's leading bus manufacturers, Volvo Buses, is also investing in vehicles with low or no pollutant emissions. Its public passenger transport solutions portfolio includes versions of hybrid electric, electric and hybrid buses (electric engine, diesel engine and electric batteries). Only the latter type is produced in Brazil. In 2012, two years after the hybrid's global launch of, the

Double-decker bus launched in 2015 in London by China's BYD. The company is opening a plant in Campinas, São Paulo State



Electric vehicles continue to exhibit an operating cost lower or equal to diesel-powered buses

Curitiba unit, located in Paraná State, was the first to build the model outside Europe. With a passenger capacity of 100, the Volvo hybrid bus uses the two-engine technology—one diesel and one electric, operating independently. More than 400 units have already been produced in Brazil. They are operating in Curitiba, Foz do Iguaçu, Campinas and Sorocaba and have been exported to Bogotá, Colombia. Worldwide, there are more than 2,000 of these vehicles operating in 21 countries.

"Our model uses an electric engine to start the bus and accelerate it to about 20 kilometers per hour. When it reaches this speed, the diesel engine takes over," says Idam Stival, Volvo's sales engineering coordinator in Brazil. "When the vehicle stops in traffic, at bus stops or traffic lights, the diesel engine turns off. Our vehicle operates 20% of the time in electrical mode and 80% in diesel mode." According to Stival, the Volvo hybrid consumes up to 35% less fuel, emitting 35% less carbon dioxide. In one year of operation, the vehicle prevents 33 tons of CO₂ from being emitted into the atmosphere, compared to diesel buses with the same passenger capacity. "Although the technology was developed outside Brazil, the model operating in Brazil has been tropicalized and meets the local content rules for funding by the Brazilian Development Bank (BNDES)," says Renan Shepanski of the sales engineering department.

A year ago, Volvo began selling its first hybrid electric bus model in Europe. Unlike the version manufactured by Eletra, the vehicle uses plug-in technology, which enables fast recharging at points of passenger entry and departure by means of a connector attached to a kind of post that can be connected to an adapter on the roof of the bus. It is thus

The Volvo hybrid manufactured in Brazil has two engines, one electric and one diesel



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able to run 70% of the time in electric mode, using only battery power, and the remaining 30% in hybrid mode using diesel power. The result is reduced fuel consumption and up to 70% less carbon dioxide emissions, compared to conventional diesel buses. Quick recharges give it greater operating autonomy when in electric mode.

“The Volvo hybrid electric is a system that works well, but it requires investment and intervention in road infrastructure for the installation of battery recharging stations,” says Marinho of SAE. According to Volvo, its hybrid electric is suitable for longer routes with fewer stops, such as along corridors reserved exclusively for buses.

CHINESE ELECTRICS

Another company that has begun to produce environmentally sustainable buses in Brazil is China's BYD (Build Your Dreams). The plant producing the company's electric buses opened in August in Campinas (São Paulo State). BYD is one of the world's largest manufacturers of rechargeable batteries and electric buses. In 2015, the company introduced an electric double-decker bus in London, England. It plans to spend US\$400 million on three plants in Brazil by 2018. The Campinas plant will have the capacity to produce between 500 and 1,000 buses per year.

Through an agreement with SP-Trans, the authorities responsible for public transport management in the state capital, BYD began the first stage of performance testing of the K11 model in September. It is designed to operate in exclusive bus lanes and has a range of 260 km and a passenger capacity of 120. “BYD has sold electric buses and vehicles in more than 150 cities across 45 countries, and we are finding that, in addition to the environmental benefits, the electric buses are operating at a cost that is similar to or lower than conventional diesel vehicles,” says Adalberto Maluf, director of government relations for BYD. ■



Option in Europe: quick recharging of batteries at points of passenger entry or departure

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