THE CHALLENGES FACED IN BRAZIL

The use of electric models in Brazil depends on various obstacles being overcome

Battery-powered cars are already a reality on the streets of Europe, the USA, China, and Japan, but these vehicles are rarely seen in Brazil. Between 2011 and 2016, roughly 4,000 electric or hybrid cars were licensed in the country, including just 1,091 units last year, a number that pales in comparison to the 1.68 million total cars sold in Brazil. Since automakers in the country do not manufacture passenger cars that utilize this technology, all sales are from imports, which are much more expensive than domestically produced combustion cars. The Toyota Prius, one of the cheapest sold in the country, costs from R$120,000. There are around a dozen other models available to the Brazilian consumer.

"Measures that could stimulate widespread use of these vehicles by the public and encourage their production in Brazil include tax reductions, incentives for purchase, exemption from road space rationing, and access to exclusive bus lanes and restricted areas of the city," says Ricardo Guggisberg, CEO of ABVE. "Electric and hybrid vehicles are more expensive than traditional vehicles because of the technology they use, but high taxes lead to even higher final costs."

The motors used in electric cars are simpler and have far fewer parts than internal combustion engines

Some of ABVE's recommendations have already been adopted. In 2015, the government reduced the import tax for electric and hybrid cars from 35% to a maximum rate of 7%. Several states, including Ceará, Rio de Janeiro, Rio Grande do Sul, and São Paulo, have exempted or reduced motor vehicle taxes on these vehicles, and the city of São Paulo has exempted electric cars from road space rationing rules.

Experts, however, question the effectiveness of giving incentives to an industry that has always received help from the government. A study by the Montreal Economic Institute (MEI) in Canada has shown that incentivizing electric vehicles does not always add up. The Ontario government offers consumers a subsidy of up to CAN$14,000 (US$11,200) on hybrid or electric car purchases, while in Quebec they offer CAN$8,000 (US$6,400).

MEI researcher Germain Belzile and independent consultant Mark Milke did the math and found that the incentive in Ontario costs CAN$523 (US$418) per ton of CO_2 not emitted—which is essentially the total amount of greenhouse gases (GHG) not emitted—while in Que-

bec this figure drops to CAN$288 (US$230). To arrive at these figures, they considered that in a decade, electric models emit 30 tons of CO2 less than fossil fuel vehicles.

The price of every ton of eliminated GHG on the carbon market is CAN$18, meaning that by subsidizing electric cars, the Ontario and Quebec governments are spending up to 29 times and 16 times more than the carbon market price, respectively. Companies and countries use the carbon market to trade certificates equivalent to each ton of GHG not emitted or removed from the atmosphere.

Electric Vehicle Laboratory in Campinas run by the CPQD and CPFL Energia: evaluating recharging outlets

RECHARGING NETWORK

Another challenge to conquer is the need for battery-recharging infrastructure, involving the construction of electric vehicle recharging stations in urban centers and on major roads. "In a country of continental proportions like Brazil, this is a great challenge. What if a person wants to drive from São Paulo, in the south, to Belém, nearly 3,000 kilometers away in the north, in an electric car? They would need many recharging stations along the way," says mechanical engineer Marcelo Alves, from CEA/USP.

There is no official data, but it is estimated that there are currently less than 100 recharging stations nationwide. To solve this problem, there is a pending proposal in the Senate requiring the installation of electric vehicle recharging stations in all public parking lots and building garages. This measure, however, has even been questioned by proponents of electric vehicles. "Is it right to demand the installation of recharging stations when the number of electric vehicles is so low? The important thing is to ensure the growth of this market occurs naturally, and that its progress is accompanied by electricity stations where necessary," argues electrical engineer Ricardo Takahira, from ABVE.

Regulating the sale of electricity for recharging batteries is another subject under discussion. The legislation prohibits charging money to use public recharging stations, because only energy suppliers registered with the Brazilian Electricity Regulatory Agency (ANEEL) are allowed to sell electricity. "ANEEL held a public hearing this year to discuss the issue, as the regulatory framework imposes restrictions on the public recharging of electric vehicles by agencies and companies other than energy providers," says electrical engineer Danilo do Nascimento Leite, coordinator of CPFL Energia's Electric Vehicle Program (called Emotive). One of the ideas under debate is to charge electric car owners through their electricity accounts for kilowatts consumed recharging their vehicle. "The driver would use a card to authorize recharging, and the cost would be added to their electricity bill," suggests Takahira.

Different types of rapid recharge plugs and connectors at an electric vehicle recharging station

PHOTOS LÉO RAMOS CHAVES

RECHARGING SPEED

The industry is also working on speeding up recharge times. While gasoline and ethanol vehicles can be refueled in minutes, electric cars need at least an hour. There are three main charging systems: rapid charging restores 80% of the battery's power in 30 minutes, and needs 30 minutes more to complete the remaining 20%; fast charging takes up to three hours; and slow charging takes 6–22 hours to fully recharge the battery.

"The idea is that rapid and fast chargers are installed in public places, such as shopping malls, so that drivers can recharge their car while they shop, and slow chargers are used at home to recharge the batteries overnight," explains electrical engineer Vitor Torquato Arioli, a researcher from the Energy Systems department of the Telecommunications Research and Development Center (CPQD).

In partnership with CPFL Energia, the CPQD runs a research unit called the Electric Vehicle Laboratory, which studies electric vehicle recharging stations and outlets commercially used

CPFL Energia study indicates that battery-powered vehicles have a low impact on the electricity grid

A technician from the Itaipu Binacional R&D center works on a battery for electric cars (above). More than 80 electric prototypes have already been assembled by the plant (right)

Small-scale model of the Electric Dreams supercar: tests are conducted in a wind tunnel

around the world. Like the plugs on other electrical devices, standards vary by country and recharging outlets have a variety of connectors. "There are several recharging station manufacturers around the world, such as Chinese company BYD, and Siemens, from Germany, but it is important that Brazil develops recharging outlets in a way that we are not dependent on this international equipment," says Arioli. There is a global discussion about standardizing the connectors to simplify the recharging process for existing car models, and to avoid the need for duplicate infrastructure.

The Electric Vehicle Laboratory also researches the impact of battery-powered vehicles on the power grid. Two years ago, CPFL Energia conducted a study into the effects of the mass use of electric vehicles on energy consumption in Brazil. "We estimate that the increased use of electric cars would have a limited impact on energy demand," says Danilo Leite. "Our initial projections suggest that the use of this technology will increase energy consumption from the national grid by 0.6% to 1.7% by 2030, when forecasts indicate that there could be between 5 million and 13 million electric vehicles in the country."

According to experts, as well as having a low impact on the grid, battery-powered cars could be used to balance the national electricity system. "It is the concept of a smart grid. Although electric vehicles do not produce energy, they have the potential to function as an input at peak times, such as late afternoon. While connected to a charging outlet, they could return unused power to the grid, supplying the system," suggests electrical engineer Celso Novais, coordinator of the Electric Vehicle Program at Itaipu Binacional, one of the main centers studying electric vehicles in Brazil.

Created in 2006, the program researches electric vehicle solutions. More than 80 electrical prototypes have already been built at its Center for Research, Development, and Assembly of Electric Vehicles (CPDM-VE). "In the beginning, we attained know-how about converting cars powered by combustion engines into electric vehicles through a partnership with Swiss company Kraftwerke Oberhasli AG, which operates several hydroelectric power plants in the Alps. At the time, many of the components were imported. Today, about 60% are produced in Brazil," says Novais.

In 2014, Itaipu started assembling the Renault Twizy after reaching an agreement with the French automobile manufacturer. The electric car comes partially disassembled, comprising about 90 parts, and the technicians put together the traction system, batteries, and electric motor. The purpose of the initiative is to further study the Brazilian production of components and prepare auto parts suppliers for the market. "We do not intend to become an electric vehicle factory—that is the role of automobile manu-

PHOTOS 1 ALEXANDRE MARCHETTI / ITAIPU BINACIONAL 2 ELETRIC DREAMS 3 CAIO CORONEL / ITAIPU BINACIONAL

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facturers—but we want to master this technology," says Novais. "When there is demand, the local industry will be able to produce the main systems, such as electric motors and inverters." The Itaipu program is partnered with automotive components manufacturers such as Weg, which produces electric motors, and Moura, a battery company, as well as research institutes and energy suppliers.

NATIONAL MODEL

In recent years, several initiatives in Brazil have tried to encourage the large-scale domestic production of an electric vehicle, but none have succeeded. Electric Dreams, a small company from São José dos Campos, SP, is pursuing this goal. It has spent six years designing a supercar capable of accelerating from 0 to 100 km/hour in just 2.7 seconds. With four motors—one for each wheel—the model was developed based on computational simulations and tests run in wind tunnels used by the aeronautics industry.

"We developed the car from scratch. We created all its systems, control algorithms, and embedded software, and we already have a small-scale model. Our aim is for our supercar to serve as an experimental model, on which simpler electric cars, buses, and trucks can be based," says aeronautical engineer Fábio Zilse Guillaumon, a former Embraer employee who left the aircraft manufacturer to set up Electric Dreams.

The project is funded by the FAPESP Technological Innovation in Small Businesses program (PIPE) and the Brazilian Development Bank's Technological Fund (BNDES-FUNTEC). The CPQD helped to develop the battery. "The energy storage system is the heart of the car and one of the great technical challenges," says Guillaumon. "The solution was a battery with two types of lithium cells that powers the engines and provides a range of 400 kilometers, similar to cars with combustion engines," he says. A finished prototype is expected within the next year.

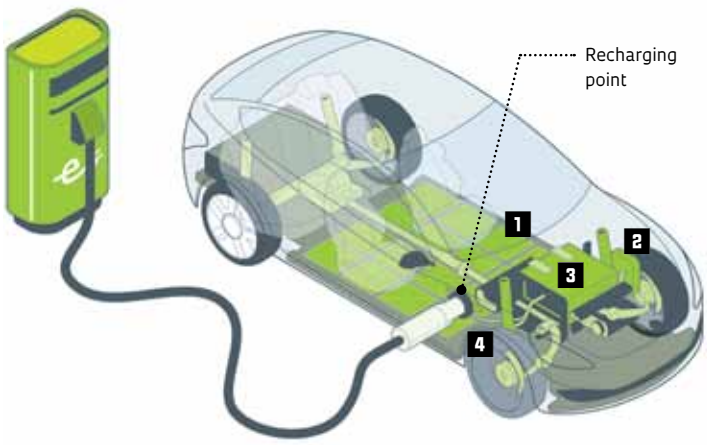
Despite research efforts, it may still take some time for Brazil to enter the global electric vehicle production chain, whether by building cars locally or supplying components to international manufacturers. "Brazil has a clean energy mix and a beneficial renewable liquid fuel: ethanol," says Francisco Nigro of POLI-USP. "We do not have the same impetus to stimulate the electric vehicle market as Europe, China, and the United States." ■

Inside an electric car

With no noise combustion and exhaust noise, battery-powered cars are smooth and quiet to drive

1 BATTERY

The battery pack stores the energy used by the electric motor, weighs 250 kilograms or more, and is often located in the vehicle chassis



2 INVERTER

Also called a control module, the inverter manages the electrical energy generated by the battery and sent to the motor

3 ELECTRIC MOTOR

The motor converts electricity from the batteries into motion, which rotates the wheel axles, causing the vehicle to move

4 REGENERATIVE BRAKE

Transforms the kinetic energy of the car's movement into electrical energy, which recharges the batteries

INFOGRAPHIC ANA PAULA CAMPOS **ILLUSTRATION** ALEXANDRE AFFONSO

Project

Development of the chassis of a fully electric vehicle based on its aerodynamic, thermal, and mechanical characteristics (No. 12/51376-8); **Grant Mechanism** Technological Innovation in Small Businesses (PIPE); **Principal Investigator** Fábio Zilse Guillaumon (Electric Dreams); **Investment** R$152,690.00.