ENGLISH

ELECTRIC VEHICLE

ITAIPU BINACIONAL | KWO GRIMSELSTROM

ITAIPU
BINACIONAL

SUMMARY

Itaipu and the Electric Vehicle

The EV Project is a result of the cooperation agreement signed by Itaipu Binacional with the Swiss company of KWO, which led to the signature of a covenant on research and development technologies addressing the means of transportation that are efficient and do not pollute the environment.

The construction of Itaipu, the largest generator of clean energy in the world, represented an unprecedented human, diplomatic and engineering challenge. It is a history that began in 1973 with the signature of the Itaipu Treaty by the governments of Brazil and Paraguay.

This is a history of success. In 2008, Itaipu produced 94,685 GWh; a world record in energy generation.

Nowadays, the company's challenges go beyond electric energy production, with quality and efficiency, from a clean and renewable resource. Itaipu enlarged its mission to boost the sustainable social, economic, technological and touristic development of Brazil and Paraguay. Various measures were launched to address this new mission. The Electric Vehicle Project (EV) is one of them.

The EV Project incorporates the concerns of Itaipu and of the majority of power companies in the electrical sector and reflects the urgency for actions to reduce the impact of dirty energy sources upon the environment.

This concern is shared by the firm of KWO – Kraftwerke Oberhasli AG, which controls nine hydroelectric power plants in the Alpine region of Switzerland. In November 2005, during the visit of the President of KWO, Gianni Biasiutti, and the President of his Administrative Council, Peter Schmid, Itaipu was invited to join efforts and assume coordination of the research and development works on electrically powered transportation alternatives that would be technically and economically viable.

The EV Project was formalized in May of 2006, with the signature of the 8226/2006, Itaipu/KWO Covenant. Itaipu considers it a sustainable project, of environmental character, capable of promoting the transfer of technology.

The EV Project objectives

Main objective

To contribute to the development of technology on electrically powered vehicles through the execution of lines of research in a coordinated and synergic manner, with the participation of educational institutions, public and private companies committed to socio-environmental responsibility.

Itaipu's motivation

Support the preservation of the environment, promote the rational and effective use of the energy resources of the planet and sponsor the sustainable social development of Brazil and Paraguay.

Project benefits

- Preservation of the environment;
- National research, development and technology;
- Improvement of the existing electric vehicle;
- Training of professionals;
- Acquisition of know-how;
- Creation of employment and incomes;
- Carbon credit use;
- Use of EVs in the company fleet;
- Cost reduction of the fuel account;
- Promote linearity in the load curve with consumption outside of peak hours (by charging batteries);
- Promote the local production of parts;
- Promote the production of EVs by the national industries.

PRINCIPAL GOALS

1. Nationalize all the components of electric vehicles.
2. Improve components by making them strong, reliable and of reduced cost.
3. Encourage the effective application of patents resulting from research developed within the project, for industry to feel commercially motivated to produce electric vehicles on an industrial scale.
4. Contribute with efficient and environmentally correct public transport solutions.
5. Create techniques and solutions to enable increasing the vehicle range as well as reducing the time expended in battery recharging.
6. Develop solutions for electric vehicles to take advantage of the benefits of integrating electric vehicles with the electric network by employing the smart grid concept.
7. Study the relationships and solutions to enhance compatibility of integrating the electrical sector with the new electric vehicle consumer market.
8. Study and apply EV recharging solutions using renewable sources.
9. Transfer knowledge and promote professional training, as well as the generation of jobs and income.
10. Promote the use of efficient vehicles that do not pollute the environment.

The largest assembly line in the Country

Just in the first five years of the EV Project, since 2006, more than 50 prototypes left the Center of Research, Development and Assembly of Electric Vehicles (CPDM-VE), built inside Itaipu in warehouse G5, with funds from Eletrobrás. Despite being on a laboratory scale, it is the largest assembly line for electric cars in the Country.

The Palio Weekend prototypes, built in partnership with FIAT, possess a battery of 15 kW (20 cv) giving a range of 110 kilometers, a maximum speed of 110 km/h and demanding a recharge time of 8 hours.

The challenge for the EV Project is to enable a range of 450 km, a maximum speed of 150 km/h and a recharging time of only 20 minutes, with robustness and at prices compatible with those of the conventional market.

Test Track

In addition to its production, Itaipu transformed itself into a test track for the EV, transporting employees to and from the power plant. Today, the models leaving the CPDM-VE are already equipped with air conditioning and use more powerful motors and batteries. There are 120 recharging points (electric stations) spread throughout the Itaipu installations.

The prototypes also run in other partner companies of the electric power system and through the streets of cities like Rio de Janeiro, Niterói, Brasilia, Campinas and Curitiba. In addition to not polluting the environment with gas emissions that destroy the ozone layer, one detail draws the attention of the driver: the silence. The electric motor produces no noise.

After the success of the Electric Palio Weekend, one of the new models under development by the EV/Fiat partnership is the New Uno Ecology, in its purely electrical version. The prototypes of the electric New Uno, which weigh less than the Palio, will present enhanced performance since they will use a more powerful electric motor and battery.

Concepts that drive this idea

FUTURE

The energy matrix sustained by the fossil fuels now has its days numbered. If the current standards of growth are maintained, it is estimated that China alone will have 1.1 billion cars in 2031 and will require 99 million barrels of petroleum per day. This volume is greater than the current world production.

It is necessary to restructure the global economy with the intensive adoption of renewable energy sources and solutions making use of this energy. The electric vehicle is the contribution by Itaipu Binacional and its partners in the construction of a future with sustainable development. With research and technological advances, the cars powered by electricity are capable of being transformed into a viable alternative for public and individual urban transportation. For recharging, simply plug them into a power outlet.

CLEAN ENERGY

The widespread consumption of fossil fuels, obtained from petroleum by-products, is the principal cause of the phenomenon known as global warming. Vehicles powered by combustion engines release polluting gases such as carbon dioxide (CO_2) into the atmosphere. According to the Intergovernmental Panel on Climate Changes, 75% of the CO_2 emissions in the last 20 years arose from the combustion of fossil fuels.

The electric vehicle idea is to promote the substitution of petroleum by renewable and non polluting energy sources which offer a better quality of life in the cities. The entire world adds its efforts towards this goal. In Denmark, 20% of the electricity is generated by wind power (Aeolian). Brazil and Paraguay are countries holding generous natural resources, with a vocation for hydraulic energy and bio-fuels.

HYDROELECTRICITY

In order to power the worldwide fleet of 800 million vehicles, the current global petroleum production is 85 million barrels per day. The robust economic growth of the developing countries has increased the average price of the barrel, which in 2003 was US$ 31, to US$ 72 in 2007, reaching the incredible mark of US$ 99 during the year.

Hydroelectricity is an alternative source of clean and renewable energy instead of petroleum, and a solution that utilizes the force of running water without reducing its quantity and without generating toxic by-products. Although only 33% of the global hydroelectrical potential has been tapped, this percentage avoids the emission of gases corresponding to the combustion of 4.4 million barrels of petroleum/day.

Omnibus and truck: new possibilities of EV

In addition to individual transportation, the EV Project seeks solutions for the transportation of cargo and passengers. This provided the initiative for the first electrical truck in Latin America, which was developed in partnership with Iveco, a Fiat subsidiary company producing heavy vehicles.

The Electric Iveco Daily, double cab, was launched in August of 2009 and was awarded the Technological Eminence Prize at the Congress of the Society of Automotive Engineers (SAE).

The Electric Iveco Daily truck in use at Itaipu has a motor of 40 kW, a range of 100 kilometers and can reach a speed of 70 km/h. It can transport up to seven people and 2.5 tons of cargo. The vehicle uses three Zebra batteries weighing 165 kg each.

Passenger transportation

Following the electric car and truck, the EV Project has developed the first 100% electric micro-omnibus in the Country, in partnership with the Iveco and Mascarello companies, plus the special participation of the Euroar company in the air conditioning project. The micro-omnibus prototype has capacity for 17 passengers and is endowed with high technology, such as LED illumination, and a special table with power outlets for notebook recharge, among other innovations.

Itaipu's pioneering created a new demand from the Brazilian government: utilize the know how obtained throughout the EV Project to produce the first hybrid electric omnibus powered by ethanol.

One of the objectives is that this vehicle could serve as a model for those to be used for passenger transportation during the World Cup in 2014 and the Rio de Janeiro Olympic Games in 2016.

It involves a modern omnibus prototype, of 13 meters, low floor, capacity for 34 seated passengers and 54 standing. It was developed under Itaipu coordination, with a consortium of several Brazilian companies, such as, Eletra, Weg, Mascarello, Tutto Trasporti, Mitsubishi and Euroar, and the special participation of Magneti Marelli in the adjustment of the control software for the ethanol engine

The contribution of the partners

The range and technological complexity of the EV Project demanded from Itaipu and KWO the establishment of partnerships with Brazilian, Paraguayan and European companies. The lines of business identified as essential in the partnerships include:

- Battery manufacturers;
- Electronic accessories manufacturers;
- Automotive assemblers;
- Electric motor and control system manufacturers;
- Electric energy concessionaires;
- Research institutes;
- Universities.

With the dissemination of the EV Project, entities committed to the preservation of the environment and the rational and efficient use of natural resources became interested in investing in the research and development activities of this project and, therefore, they contacted Itaipu. They are: Fiat, Eletrobrás, Cepel, Copel, Lactec, ANDE, Cemig, CPFL, Chesf, WEG, Correios, Iveco, Mascarello, Petrobras, Euroar, Moura Group, Agrale and Light, as well as KWO's affiliated companies.

The important role of Fiat in the EV Project

The Fiat assembler is constantly monitoring and interacting in each stage of the EV Project, turning the prototypes robust and safe and ensuring attention to the necessary basic requirements.

Fiat also leads the principal lines of research and technological development, as well as the tests established for evaluating the assembly.

Fiat's team, furthermore, uses its knowledge of the conventional processes to evaluate the corrections and adjustments required in the prototypes, also considering the diverse market niches that could be exploited.

Thus, Fiat can determine the most suitable moment to produce a vehicle of purely electrical conception, as well as to define the economic feasibility of the large scale production of EVs, which is planned to occur at the end of the EV Project.

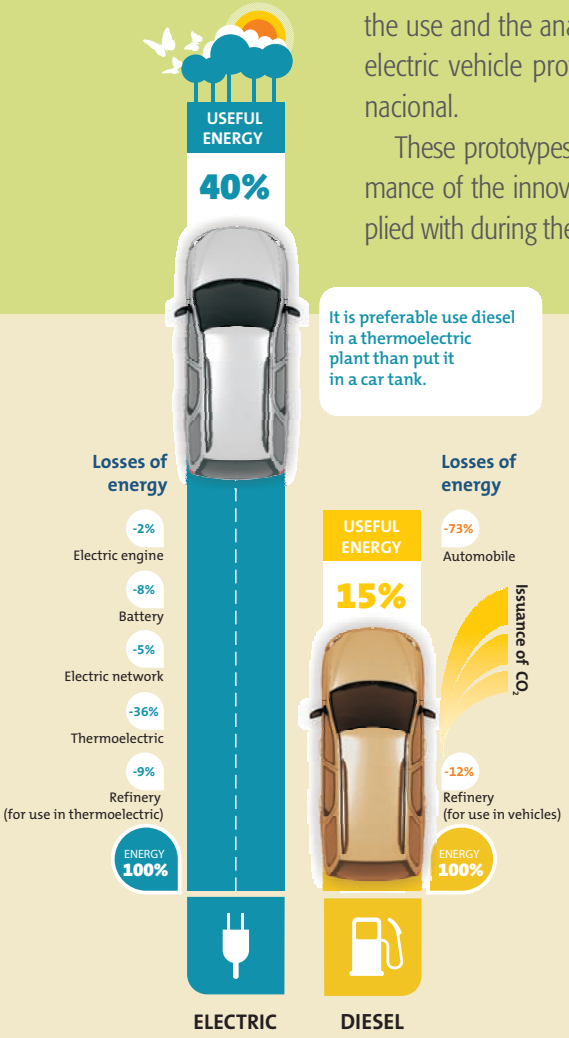
The purpose of the prototypes

The verification of the robustness and the results of the technological improvement provided by the lines of research of the EV Project is performed by the use and the analyses of the performance of the electric vehicle prototypes assembled by Itaipu Binacional.

These prototypes are also used to test the performance of the innovations. This stage has been complied with during the entire evolution of the project.

Since the prototypes are not yet totally robust, they must preferably be used under supervision of trained professionals to detect any incipient faults and adopt corrective actions.

To this effect, it has been planned that the delivery of prototypes is to be made after training the representatives of the partner entities due to receive an EV.



1- Estimate based on Brazil's taxation.

Compare the energetic effectiveness (well-to-wheel) between the car powered by diesel and the electric car

Energy efficiency: the power of the EV

Whoever compares an EV with an ordinary vehicle powered by fossil fuels has no doubts: the vehicle powered by electricity is clearly superior as regards energy efficiency.

In an analysis considering the well-to-wheel losses, if we use petroleum transformed into diesel fuel and applied in a conventional vehicle, only 15% of the energy in this process will be converted into motion, that is, 85% of the energy is lost. However, if the same amount of petroleum is used in a thermoelectric plant to produce energy to be used in an EV, the efficiency of the process reaches 40%.

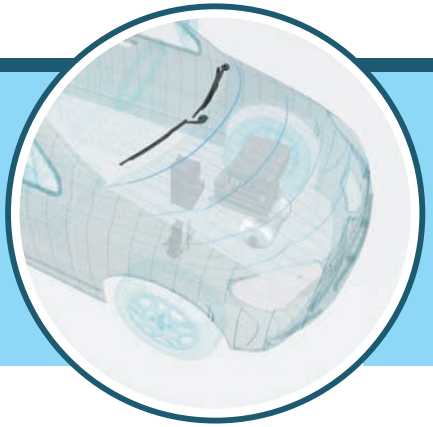
Therefore, for the means of transportation, even in countries where the main source of energy depends on petroleum, the use of electric vehicles is at least twice as efficient as the use of combustion vehicles.

Inside the EV

In the EV Project, the engineering process for production of prototypes was divided into two sets of components – the **mechanical kit** and the **electro-electronic kit**:

1) The **mechanical kit** comprises the chassis, body, suspension and other lesser mechanical parts.

2) The **electro-electronic kit** comprises the electric motor, battery, traction inverter module and other digital control systems.



The battery

The EV under development at Itaipu uses a ZEBRA battery (Zero Emission Battery Research Activity). This type of battery is used in general applications that demand high density of energy and power, which are fundamental characteristics of electric vehicles.

The principal chemical components are salts (sodium chloride and nickel) and metals, which make the battery practically 100% recyclable.

The battery works while heated to 270ºC but, due to the vacuum insulation, the external temperature remains at from 5ºC to 10ºC above the ambient temperature. In order to keep it heated, the battery consumes approximately 10% of its charge per day while the vehicle is not connected to the electric network.

Itaipu has commenced tests with other batteries and has developed a technology transfer project with the University of Bern, Switzerland, and new interactions are in progress in the motor and hydrogen fuel cell sector.

Slow recharge

In order to refuel the EV (recharge the battery), just connect it to a domestic power outlet of 110-220 V/50-60Hz common to any residential electric installation, and equipped with a capacity of 16 A. When a vehicle is totally discharged, eight hours are necessary for a complete recharge.

Since the battery does not possess the memory effect, it can be recharged at any time. When the vehicle is not in use it should preferably be kept connected to a power outlet. Thus the vehicle will always be completely charged and ready to provide its maximum range when required.

Fast recharge

Studies are in progress concerning the performance of a fast recharge, although to ensure the great power transfer in a brief space of time, it is necessary to employ higher feed voltages.

Fast coupling

In order to verify the feasibility of longer runs with batteries that use the current technology, Itaipu has developed the fast coupling.

The test performed by Itaipu involved covering a round trip distance of 700 km from the Itaipu power plant in Foz do Iguaçu, to the Itaipu offices in Asunción, Paraguay, and back.

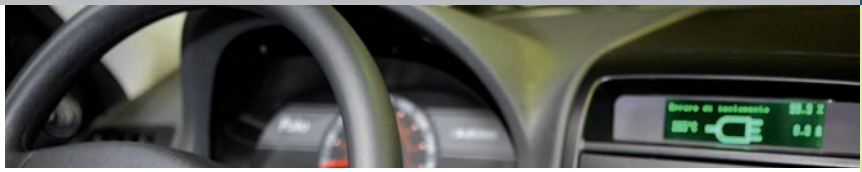
Approximately every 120 km, the team substituted the discharged battery with another fully charged replacement. Six exchanges were carried out during this journey, requiring approximately 2 minutes each.

BATTERIES WILL BE NATIONALIZED

The high cost of the batteries, currently imported from Switzerland, is considered one of the principal barriers to the popularization of electric vehicles. To overcome this difficulty, the EV Project obtained R$ 32 million from Financiadora de Estudos e Projetos (Finep), a fund supplier linked to the Ministry of Science and Technology.

The idea is to develop a national battery similar to those currently used in the EV Project. The Fundação Parque Tecnológico Itaipu – FPTI shall manage the project, with technical coordination by Itaipu.

Technical features of the prototype *Electric Palio Weekend*



Electric motor

Type: Three-phase asynchronous (induction motor)
Rated power: 15 kW (20 hp)
Rated torque: 50 N.m (5.1 kgf.m)
Maximum power: 28 kW (37.8 hp)
Maximum torque: 124 N.m (12.6 kgf.m)

Power supply

Fuel: Electric energy (127/220 V – 50/60 Hz)

Traction battery

Type: Sodium-Nickel-Chlorine
Voltage: 253 V
Energy: 19.2 kWh
Recharge time: 8 hours
Weight: 165 kg (*)
(*) An ordinary car battery (lead-acid) with the same energy storage capacity would have three times the weight.

Brake system

Service: Hydraulic with pedal command
Front: Ventilated disc (Ø 257 mm) with floating calipers
Rear: Drum brake (Ø 185 mm) with self-centering shoes and automatic adjustment

Gear shift

Speeds: Front, Neutral and Reverse
Traction: Front

Front suspension

Type: MacPherson with independent wheels, transversal lower oscillatory arms
Shock absorbers: Hydraulics, telescopic double acting
Elastic element: Helical springs

Rear suspension

Type: With independent wheels, longitudinal oscillatory arms and stabilizer bar
Shock absorbers: Hydraulics, telescopic double acting, WET type
Elastic element: Helical springs

Performance

Maximum speed: 110 km/h
0 to 100 km/h: 28 s
Range: 100 km

Parked: EV recharges its battery from electric network or other energy sources.

Peak time: the electrical vehicle provides energy to the network, helping in the offer to the consumers.

Lack of network: the EV works with a no-break that ensures energy supply.

Electric vehicle and the smart grid concept

The electric vehicle could be fueled from alternative energy sources, such as solar panels connected to the electric network. In Itaipu, there are solar panels installed at the Center of Research, Development and Assembly of Electric Vehicles – CPDM-VE, where EVs are produced.

This type of solution addresses the smart grid or intelligent network concept. With this concept, the EV could act as a residential no-break in the case of a power failure. In the future, when the quantity of electric vehicles is significant, many of them could assist with the energy supply to the network during hours of peak demand, recharging their batteries during the times of low consumption.

The technological innovations and the products of the EV Project were determinant factors for Eletrobrás to invite Itaipu representatives to participate in the E8 meetings for the electric vehicle and smart grid themes. The E8 is a subgroup of G8 that congregates the largest energy firms in the world. In 2010, Eletrobrás was designated a permanent chair in this group.

Pilot project in a natural paradise

In addition to the vehicular use, sodium batteries in their stationary version could, in the future, be used for the electric supply to homes, companies and even entire communities. The stationary battery banks work as a type of lung, storing energy when production is intense and consumption is low, and becoming available to consumers at the moment of demand.

A pilot project is being developed by Itaipu, with provisions for its application in the Fernando de Noronha archipelago. Energy production by the combustion of fossil fuel will be replaced by renewable sources that are presently not available, such as energy from the wind, the tides and the sun. This energy is to be stored in a bank of 80 batteries of 80 kWh each; sufficient to supply the demand of the island when the alternative sources are not available.

At the conclusion of the project, Fernando de Noronha will be self-supplying in energy and become the first natural paradise totally free of polluting sources.

Main stages of the EV Project

Concluded Phases

- Preliminary study to gain knowledge of the EV technology;
- Training Itaipu professionals for maintenance of the EVs;
- Inclusion of the Fiat automotive assembler in the Project;
- Inclusion of the first partner entities;
- Drafting the basic technical documentation of Fiat and Itaipu vehicle;
- Transformation project of the Palio Weekend into an electric vehicle (prototype), prepared by Fiat;
- Creation of the Center of Research, Development and Assembly of Electric Vehicles (CPDM-VE) in the Itaipu premises;
- Testing with Fiat and Itaipu prototypes for homologation;
- Recognition and homologation by Denatran of the Fiat prototype;
- Assembly of the first prototypes at CPDM-VE by the Fiat/ISVOR team;
- Constitution of the Management Committee and the Technical Committee.

Stages of cyclical execution throughout the Project

- Inclusion of strategic partner entities;
- Identification of the lines of research and development;
- Creation of multi-corporate groups to execute the lines of research;
- Execution and follow-up of the lines of research;
- Basic training for the partner companies;
- Nationalization of the imported parts;
- Assembly of new prototypes to certify the technical feasibility and authorize the training;
- Testing the products resulting from the lines of research on prototypes;
- Actions with the government to promote tax reduction for vehicles that do not pollute the environment.

Final stages

- Command over the electric vehicle technology;
- Integration of the electric vehicles into the electric network in an intelligent manner;
- Development of the electric vehicle prototypes in the light, heavy and passenger transportation sectors;
- Study of the new business for the energy sector;
- Feasibility of the domestic production of components;
- Draw-up infrastructure solutions to enhance the feasibility of EV use;
- Incentives to the large scale production of EVs

Principal activities of the Technical Committee and Management Committee

Technical Committee

- Follow-up and execution of research lines;
- Evaluation and analysis of results;
- Identification of new lines of research.

Management Committee

- Definition of global guidelines for the project;
- Analysis and approval of Technical Committee proposals;
- Support for parts production in the national territory;
- Governmental actions to obtain resources to stimulate activities of R&D related to energy efficiency and environmental preservation.

GALLERY


Tecnologia

O CARRO ELÉTRICO BRASILEIRO

VEJA andou num protótipo do primeiro automóvel movido a eletricidade a ser fabricado no país. A Fiat o lançará em 2011

CS.GB - 01/2011

ELECTRIC VEHICLE

ITAIPU BINACIONAL | KWO GRIMSELSTROM

www.itaipu.gov.br/ve