

Is the Metro storing and reusing electric energy?



By Claudia Patricia Gil Salcedo / claudia.gil@upb.edu.co
Translation: Jean Paul Mejía Holguín
Photos: Natalia Botero

This is a project that aims to save energy lost by the Medellín Metro System, when trains stop to use it when they restart.

It is no secret that rational use of natural resources is imperative for the planet inhabitants. The climate change numbers show it, as well as extreme rainfalls and droughts. But this task is not only to individuals because the industry has greater responsibility.

Hence the Compañía Limitada de Transporte Masivo del Valle de Aburrá, Metro, was given the task of finding a way to save energy because it turns out that, when the trains slow down and restart at each station to pick up and drop off passengers, it happens something the experts call a voltage change. So that we understand it better as when at home you feel that the refrigerator starts and then you see how the lights lose luminosity,



On this project there are two international publications: IEEE in a conference paper and the Sustainable City Conference - Energy and Sustainability Conference organized by the University Of Wessex Institute Of Technology WIT, held in UPB in 2015.

the engineer of the Potifical Bolivarian University Andres Emiro Restrepo Díez explains. That same phenomenon, but at a higher scale, happens to Metro. With the aggravating circumstance that these voltage changes affect equipment of the mass transit system.

Electric traction systems, such as Metro, are regenerative. When the motor stop they become generators and part of the kinetic energy of trains can be recovered, to pass it on to another train that requires it, usually to start. But when there are no trains to take advantage of this energy, it should dissipate on heat because if it will return to the system it may damage the equipment.

Is here where the University – Industry and State start the task of finding a way to ensure that the energy lost in braking and voltage changes were saved and reused.

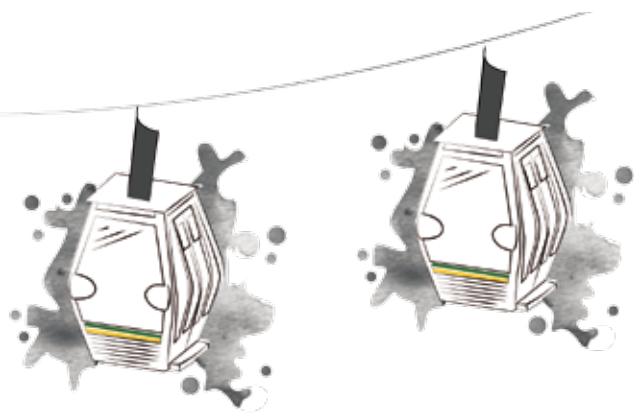
Partners for innovation

With the research leadership of the UPB, two engineers of the Metro, the UPB laboratory of Electrical Engineering and the company Muzca Technology, the task of finding a solution to this loss of energy, that is reflected in higher costs for the Company a higher price of service, which eventually is paid by the user.

And the solution was a system that saves energy to use it in another moment. The technology consists of three elements:

**There were two years of research
and the investment raised
to 1,200 million pesos.**





Via intellectual property some products of this research were protected as industrial designs and integrated circuits.

- An ultracapacitor, which is equipment that stores energy.
- A valve or converter developed at the UPB, which gives instructions for storage and power delivery, and it helps to maintain a stable voltage. This equipment works with power electronic boards, Díez Restrepo said.
- Intelligence: electronic boards made at the UPB, which task is to ensure that the equipment knows when to store and to deliver the energy, in the correct amounts and to the correct time.

The experts

The human talent behind this paper is organized as follows: UPB researchers with master's and doctoral studies, members of the Research Group Transmission and Distribution; two Metro engineers that articulated the project during their studies at the master's degree in Engineering at UPB, in the area of Energy Transmission and Distribution; three students from the University of Applied Sciences in Kempten - Germany, under the guidance of Professor Helmuth Biechel and a technology partner: Muzca Technology, an university graduated student's company, which was responsible for the physical installation of the system

Where is the innovation?

- Our system works at a frequency and voltage level higher than those found in the market, making it more efficient:
Voltage: 1500 V
Frequency: 3 Kilo Hertz



Programs like Nanotechnology Engineering will have a leading role in the development of technology such as carbon nanotubes in order to develop their own ultracapacitors.

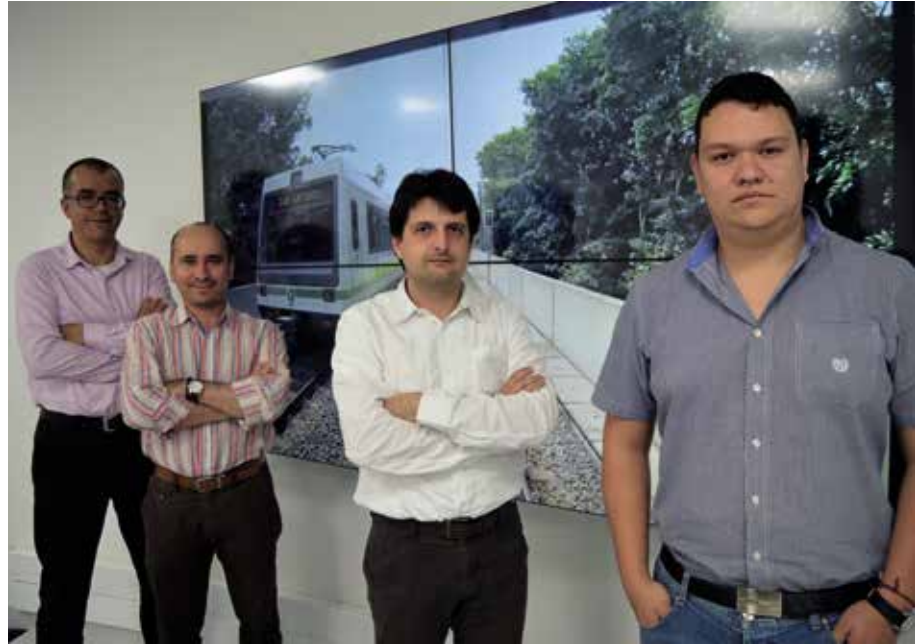
- The saving or profiting algorithm makes it highly effective because, in the words of Engineer Díez: "it learned the nature of the train to exploit its energy". This element becomes one of the strongest innovations of this exercise, which will be protected via intellectual property.

In a typical working day of the Mass Transportation System, it was measured a saving of 111 kWh, with a 1 kWh storage system, the engineer Luis Eduardo Castrillón Agudelo explains, from the Research, Development and Innovation area of the Metro.

Other differentiators are also working frequency and the cost of equipment. Although the development work at more tension (higher voltage), its cost is the equivalent to the third part of an available equipment there is in the market, but they are also made to work with lower voltage levels.



Project leader Andres Emiro Díez Restrepo.



Research: Edison Manrique Ospina, Idi Amín Isaac Millán, José Valentín Restrepo Laverde y Daniel Arroyave Molina.

Since July 2015, the date on which the investigation was completed, the equipment was installed in the Niquía Station, line A of the Metro. The point was chosen strategically because there the system is weak, in energy terms. When a train arrives at the station and it will waste energy as heat, the equipment saves it. When that same train, or other, will start moving, the computer returns the stored heat. It is approximately 10% of the power needed to start.

Castrillón Agudelo said ... "measurements and follow-ups can conclude that the technology is viable not only from the technical point of view but also economically. The prototype left verify voltage stability in the range between 1400 V and 1800 V and financial year established 30-year savings of nearly \$ 100 million COP annually".

The equipment is programmed to take power only when it is losing heat. It does not compete with the power going in another train.

Scan the QR code to watch the video.



In this type of project learning is meaningful for all participants, especially in the field of Engineering: design of compensation systems, bidirectional converter in direct current, functional management of ultracapacitors and many others, but the most significant is this exercise puts to the forefront of technology to local industry and academia, as stated Castrillón Agudelo.

A development achieved through the partnership University-Enterprise - State, ensuring energy efficiency and environmental sustainability and is a very important news during these days in which the world energy scene is stressed, in terms of experts.

Data sheet:

Project Name: System of direct current compensation for the use of regenerative braking based on ultracapacitors
Keywords: Energy; Voltage; reuse; Losses; ultracapacitor
Research Groups: Transmission and Distribution and Energy and Thermodynamics
School: Engineering
Project leader: Andres Emiro Díez Restrepo
Email: andres.diez@upb.edu.co