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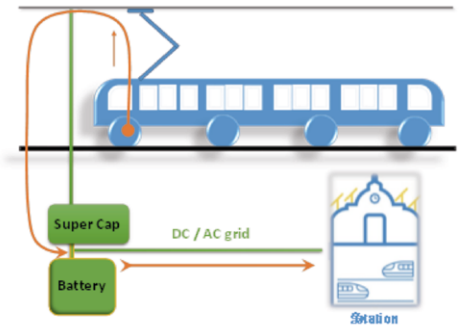
STATIONS ENERGY OPTIMIZATION: DESIGN AND CONTROL OF A SMART MICROGRID

A NEW POTENTIAL FOR WASTE ENERGY RECOVERY IN THE URBAN TRANSPORT SECTOR, USING REAL-TIME SMART ENERGY MANAGEMENT

Underground subway stations present unexploited energy resources. A microgrid, smart small scale electrical network, integrating harvest and storage of these currently wasted energies, could allow load shedding/shifting, eventually improving air quality through reductions in trains mechanical braking. These important potentials require numerous innovations in multiple fields: electrical engineering, building energy efficiency, mathematical optimization, modelling, energy economy as well as implementation of real test beds.



INNOVATIONS

▶ The sporadic and unforeseeable behaviour of renewable and recoverable energies, is a major stake for the energy transition. The electrical current created by a subway regenerative braking is characterized by a large amplitude and a very short time (few seconds). Technological innovations in power electronics have a key role to play to recover this energy with a hybrid storage system.

▶ In order to maximize the energy benefits, cutting-edge optimization methods allow an optimal sizing and a real time management taking into account the devices' diversity, the actors' multiplicity and the randomness related to energy and urban transport.

STAKEHOLDERS

▶ These innovative concepts specific to stations are related to the railway operators and the public transport institutions.

▶ On one hand, a microgrid installation inside a station implies operational changes. Railway operators must be trained to new practices. On the other hand, the real time optimized energy management and storage of renewable and recoverable energies, can benefit to other station services. A complete ecosystem can be developed around a station, such as an electrical buses' service, electric vehicles and bicycles charging stations. Therefore these potential eventual actors may become interested stakeholders in Efficacity's R&D projects.

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IMPLEMENTATION

- One of the solution studied by Efficacity is the hybrid storage, with a high capacity electrochemical capacitor, which stores energy much faster than batteries (supercapacitor) combined with a battery with a low capacity but a slower discharge. This hybrid storage is associated to a voltage converter to adapt the catenary voltage to the station's electrical network.
- This recoverable and renewable energy storage system is very expensive. Its profitability increases using a charge and discharge smart management of the electrical storage associated to a technical and economical sizing of the most expensive equipment.
- The aim of this project is also to realize a decision-making and design assisting tool to improve the energy efficiency of a station.

André Pény, Innovations Manager, RATP

"RATP is an important energy consumer, due to the trains and subways operation, but also due to the stations whose consumption is increasing. Efficacity's scientific progress provided by its innovative solutions are of paramount importance. Trains regenerative braking energy recovery, microgrids connecting trains to stations and districts, adapted energy storage researches, electrical grids modelling and optimal control bring multiple technical enhancements to Efficacity's skills base in the public transportation field."

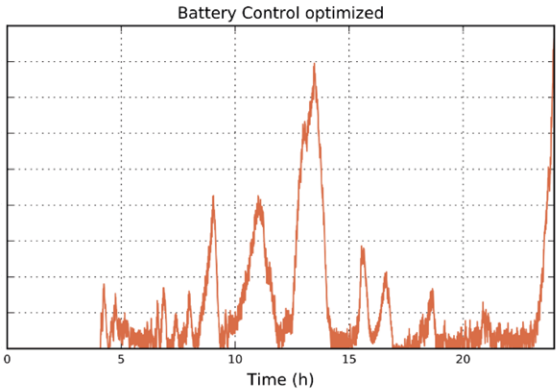
RESULTS

/// Energy benefits

Real-time control of a station electrical network and its eventual electrical storage could bring a significant energy economy, which represents a great deal for a railway operator.

/// Indoor air quality improvements

Following the electrical devices' technological improvements, the most important profits are generated by trains regenerative braking. This project could reduce significantly mechanical braking generating less particulate matters.



Battery optimal management simulation

A MICROGRIDS OPTIMAL SIZING AND MANAGEMENT TOOL

/// Efficacity develops a tool based on generic subway stations' models. These models provide a tool to realize a technical study to size the least energy-friendly devices and propose operation strategies. This tool associated to sensors' measures and to actuators will allow devices' real-time optimal control.

VALIDATION METHOD

- → Simulation model development
- → Laboratory demonstrator and Real-size demonstrator

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