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ScienceDirect

Transportation Research Procedia 14 (2016) 655 – 664

Transportation Research Procedia

www.elsevier.com/locate/procedia

6th Transport Research Arena April 18-21, 2016

On the use of train braking energy regarding the electrical consumption optimization in railway station

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Abstract

Nowadays, many projects have been conducted in order to reduce CO_2 emissions, with the objective of reducing energy consumption. In the context of the urban railway area, the energy consumption is huge. It is respectively split into 70% for the traction and 30% for station consumers. Many works have already been carried out on traction systems, but very few of them were oriented towards the station energy problematic. This paper describes the project led by "Efficacity" Institute which concerns the use of the braking energy to manage and optimize the railway station energy consumption.
Efficacity investigates energetic concepts in order to store the braking energy of the trains with a stationary electrical saving system, and to reutilize it for the power supply of electric and thermal consumers or actuators in a railway station thanks to a microgrid. The idea is to store train braking energy in hybrid storage system (composed of batteries and super-capacitors cells) and to restate it judiciously at different moments of the day (during peak or low energy consumption hours) to various kind of station loads.

Peer-review under responsibility of Road and Bridge Research Institute (IBDiM)

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doi:10.1016/j.trpro.2016.05.321

Keywords: braking energy, storage system, train station, electrical grid, microgrid, braking electrical disturbance

1. Introduction

Efficacity is a research development institute specialized in the field of urban energy efficiency. The Efficacity Institute operates on the principle of action research:

- R&D work is carried out on the basis of a contractual program with the French National Research Agency (ANR) consisting of three research programs over the 2014–2016 period (linked to the 6 innovative projects);
- The Institute also supports public or private project owners seeking to develop innovations, experiments or demonstrators.

The project detailed in this paper is the "urban railway station" which aim to use all existing energy to reduce the daily energy consumption peak. Efficacity investigates energetic concepts in order to store the braking energy of the trains with a stationary electrical saving system, and to reutilize it for the power supply of electric and thermal consumers or actuators in a railway station thanks to a microgrid. The idea is to store train braking energy in hybrid storage system (composed of batteries and super-capacitors cells) and to restate it judiciously at different moments of the day (during peak or low energy consumption hours) to various kind of station loads.

2. Braking energy

Today, many projects are leaded to define how the braking energy can be used [F. Ciccarelli], [R. Teymourfar]. In this paper we focus on three recent projects which are close to the objectives of our work: OSIRIS, T2K and SEPTA.

2.1. Osiris

Osiris project [OSIRIS] started on the 1st of January and finished in December, 2014. Osiris has 17 project partners, including all major stakeholders: public transport operators, railway manufacturers and universities. Its aims at enabling a reduction of the overall energy consumption within Europe's urban rail systems of 10% compared to current levels by 2020.

In order to fulfill the objective above, the following specific objectives was addressed:

- Define the overall needs and operational requirements allowing for the development of a global approach for the simulation, optimization and benchmarking of the energy consumption of urban rail systems (i.e., Light Rail, Metro, Suburban);
- Define a series of standardized duty cycles and key performance indicators for urban rail systems to allow for direct performance comparisons and benchmarking of technologies;
- Develop a holistic model framework assembling existing proprietary traction and power network simulation modules into a complete urban rail system model (i.e., the OSIRIS tool). It will include all the primary parameters that influence energy consumption, as well as their inter-dependencies. As part of the project, a model of thermal energy exchanges within trains, tunnels and stations will be developed as well;
- Employ optimization methodologies for the identification of efficient, reconciled strategies for realizing low energy consuming urban rail systems, based on the use of the OSIRIS tool;
- Propose a Technical Recommendation (TecRec – a sector-wide voluntary standard) for the use of onboard energy storage systems, addressing the issue of assessment and mitigation of safety risks for the customer and operation staff;
- Evaluate specific railway technologies, operational strategies and the economic/political framework for the future reduction of energy consumption in urban rail systems;
- Assess and compare the overall energy saving potential when applying new technologies or operational modes; and implementing them over both existing and new equipment.