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Simulation-based assessment of the installation of a reversible substation in a railway line, including a realistic model of large traffic perturbations

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Abstract— Improving the railway electrical infrastructure of DC railway systems with the installation of Reversible Substations (RSSs) or Energy Storage systems (ESSs) implies considerable investments that must be carefully studied. In this decision-making process, the use of electrical multi-train simulators is fundamental, in order to make accurate estimations about the potential energy savings that can be obtained. One of the main modules of these simulators is the traffic model, which represents the real operation conditions. Despite its importance, the majority of studies in the literature propose very simplified traffic models and only some recent research propose accurate models for traffic with small perturbations (being the perturbations the deviations with respect to the commercial timetable). Nevertheless, there is no research in the literature about traffic models with large perturbations, although this type of perturbations are common in certain moments of the day (usually in peak hours) and their impact in the energy consumption is high. Therefore, this paper proposes a traffic model for large perturbations and shows the impact that this traffic model may have in the estimations of the energy saving with an illustrative case study. The case study offers a comparison among the energy saving results associated with the installation of an RSS obtained with three different traffic models: the simplified traffic model more extended in the literature, the realistic traffic model for small perturbations proposed by recent research and the realistic traffic model for large perturbations of this paper. The results show that the differences in the energy saving estimations obtained with the different models are very significant.

Index Terms— Railway power systems; Railway electrical simulation; Traffic model; Perturbed operation; Reversible Substations

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