

Technical and Economic Potential of Partial Electrification of Railway Lines

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Abstract : Electrification of railway lines allows to increase speed, power, capacity and energetic efficiency of rolling stocks. However, this process of electrification is complex and costly. An electrification project is not just about design of catenary. It also includes installation of structures around electrification, as substation installation, electrical isolation, signalling, telecommunication and civil engineering structures. France has more than 30,000 km of railways, whose only 53% are electrified. The others 47% of railways use diesel locomotive and represent only 10% of the circulation (tons.km). For this reason, a new type of electrification, less expensive than the usual, is requested to enable the modernization of these railways. One solution could be the use of hybrids trains. This technology opens up new opportunities for less expensive infrastructure development such as the partial electrification of railway lines. In a partially electrified railway, the power supply of these hybrid trains could be made either by the catenary or by the on-board energy storage system (ESS). Thus, the on-board ESS would feed the energetic needs of the train along the non-electrified zones while in electrified zones, the catenary would feed the train and recharge the on-board ESS. This paper's objective deals with the technical and economic potential identification of partial electrification of railway lines. This study provides different scenarios of electrification by replacing the most expensive places to electrify using on-board ESS. The target is to reduce the cost of new electrification projects, i.e. reduce the cost of electrification infrastructures while not increasing the cost of rolling stocks. In this study, scenarios are constructed in function of the electrification's cost of each structure. The electrification's cost varies considerably because of the installation of catenary support in tunnels, bridges and viaducts is much more expensive than in others zones of the railway. These scenarios will be used to describe the power supply system and to choose between the catenary and the on-board energy storage depending on the position of the train on the railway. To identify the influence of each partial electrification scenario in the sizing of the on-board ESS, a model of the railway line and of the rolling stock is developed for a real case. This real case concerns a railway line located in the south of France. The energy consumption and the power demanded at each point of the line for each power supply (catenary or on-board ESS) are provided at the end of the simulation. Finally, the cost of a partial electrification is obtained by adding the civil engineering costs of the zones to be electrified plus the cost of the on-board ESS. The study of the technical and economic potential ends with the identification of the most economically interesting scenario of electrification.

Keywords : electrification, hybrid, railway, storage

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