

# THE GROWTH ENERGY EFFICIENCY IN METRO TRANSPORT THROUGH THE USE OF RECOVERY ENERGY AND CORRELATION OF TRAFFIC GRAPHS

Key words: kinetic energy, underground transport, recuperative braking

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### Summary

Underground transport in large cities can provide, using the process of energy recovery by braking a significant amount of energy. Given the fact that the electric subway frames run on galleries with many stations, generating many brakes, a technical and economical solution is needed to recover the braking energy. The research carried out by the author has demonstrated, both theoretically and practically, the possibility of increasing the degree of recovery of traction energy during the braking stage.

The paper proposes two technical solutions by correlating traffic graphs and by building an electrical network for the recovery of braking energy and its use for other electrical systems located in subway stations. The experiments performed by the author in the "in situ" conditions on the electric subway frames showed that the recovered electricity has a lower quality than that provided by the contracting distributor in SEN, but can be used in certain power systems in those subway stations. The proposals refer to the subway frames with electric drive motors, powered by power converters whose digital control allows the flow of energy in both directions. The determination of the experimental values proved the quality of the electricity recovered by braking is weaker (voltage, frequency).

Considering that the price of electricity on the electricity market is about 100 € / MWh, it results that the company METROREX S.A., in the analyzed case, can make a monthly saving of 18430 €. As the gaskets are not always fully charged or fully discharged it can be considered that the average  $E_{rm}$  energy per month recovered per month is:

$$E_{rm \text{ lună}} = \frac{E_{r \text{ lună}} + E_{ri \text{ lună}}}{2} = 184,3 \text{ MWh},$$

Which corresponds to a monthly saving of 18430 €.

Chapter 1 presents in the introduction the object of the thesis, its structure, aspect of the study areas and general considerations on the general issue of subway operation.

Chapter 2 describes the stages of the history of METROREX, completing with images of the construction stages of the metro galleries and with the technical characteristics of the underground passenger transport network in Bucharest.

Chapter 3 presents the current state of international and national braking energy recovery, highlighting the advantages and disadvantages of the recovered braking process.

Chapter 4 is intended to present the results of research in the cab and monitoring of the electric subway frame on the dynamics of the sole, on bus 2 (subway 2 being from the underground transport network that has no stations for boarding / quays).

Chapter 5 is intended to present the principles and ways of determining the available energy to be captured to be converted into electricity. The calculation of this available energy to be captured and transformed into electricity was developed for the situation when the subway frames are full of passengers, as well as for the situation when the subway electric frames are without passengers.

Chapter 6 of the financial proposal proposes the one recommended both from a technical point of view and from a point of view, for the efficient use of the recovered electricity in the recovery braking process.

Chapter 7 of the thesis presents original contributions, final conclusions and proposals for future research directions.

Chapter 8 details the 54 bibliographical references, with Romanian and foreign authors, that helped to elaborate this doctoral thesis.