H.F.R.I.
Hellenic Foundation for Research & Innovation

Description of the funded research project

1st Call for H.F.R.I. Research Projects to Support Faculty Members & Researchers and Procure High-Value Research Equipment

Title of the research project: Zero Emission Public Transport: Design Models and Decision Support System

Principal Investigator: Konstantinos Kepaptsoglou

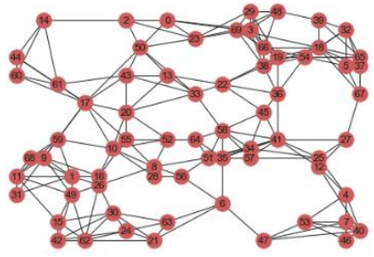
Reader-friendly title: ZEPHYR

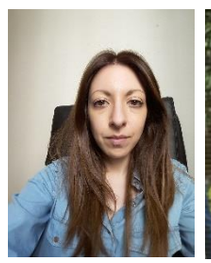
Scientific Area: Engineering Sciences & Technology

Institution and Country: NTUA, GREECE

Host Institution: NTUA

Project webpage: lte.survey.ntua.gr/zephyr





Budget: 184,775.00 €

Duration: 30 months

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Research Project Synopsis

The adverse environmental and public health effects associated with motorized transport and fossil fuels call for the re-design of urban transportation systems under α sustainable mobility paradigm. In this direction, effective planning and operation of public transport is crucial in order to reduce emissions as well as increase its attractiveness and financial viability. Electro mobility in urban surface public transport systems (electric bus fleets) has long been recognized as a promising direction for sustainable development. While range and battery performance constraints have hindered the widespread adoption of electric buses in the past, technological advances make them a prominent and attractive option for public transportation in the future. Still, operational constraints and the need for additional (charging) infrastructures highlight the need for introducing appropriate decision-making tools, tailor-made for supporting the design of transit networks operated by electric buses. Common ground in the literature and practice is the scarcity of approaches for the design of a fully electric public transportation network. In this context, this project proposes the joint consideration of route and infrastructure design stages, setting the ground for the efficient implementation of electric bus networks and charging infrastructures by offering a decision support tool for optimally designing electric public transport networks.

Project originality

Electro-mobility in public transportation is a novel scientific field, linked to several so far underexplored aspects. For this reason, this project aims to fill the gaps in the literature, especially when it comes to technological attributes such as vehicle engines and batteries as well as environmental and energy-related aspects such as carbon footprint in urban areas. It is noted that there is no commercially available decision support tool for the design of fully electric public transportation networks, considering new charging infrastructure technologies. The proposed research will contribute in multiple fronts, as introduction of electro-mobility creates new challenges for all stages of public transportation planning. More specifically, the project is expected to fill the research gap related to the incorporation of environmental considerations in the design of public transportation systems. Indeed, energy consumption will be optimized through introducing zero-emission vehicles. Furthermore, optimal charging configurations featuring different technologies at the route network level will be investigated. Moreover, the impact of recharging durations on passenger travel times will be estimated and a realistic passenger assignment process for route networks with recharging requirements will be devised. Finally, the use of heuristic and meta-heuristic algorithms for solving the problem will contribute to the general know-how on solving similar large-scale design and multi-objective optimization problems.

Expected results & Research Project Impact

The proposed project enhances the general status of electro-mobility in Greece while research findings can assist in the associated strategic policy decisions on the deployment of charging infrastructure and the purchase of Battery Electric Buses (BEBs) by the Athens Urban Transport Organization (OASA). In particular, the project aims at developing the necessary conceptual and methodological frameworks and the appropriate mathematical models and solution algorithms for handling the associated problem. A Decision Support System will also be developed to help the authorities and stakeholders during electric bus network design with a powerful yet user-friendly tool. The ultimate goal of the project is to provide the necessary background for an in-depth discussion on introducing electro-mobility in public transportation networks; project results will act as a benchmark for both academics and engineers, extending the derived knowledge from research to real-world application. Conclusively, the proposed project aims at setting the stepping stone for the transition of public transport to the new era sustainable mobility, promoting transit electrification and embracing the vision of improved life quality.

The importance of this funding

The H.F.R.I. funding of the ZEPHYR research project has allowed us to investigate this emerging and relevant topic, and create a strong, diverse team of qualified researchers with distinct qualifications. Based on this project, we plan to further expand our research activities in the fields of electromobility and sustainable public transport.

Furthermore, this funding allows us to purchase adequate equipment and software which is an indispensable asset for the computationally complex problems arising in our project, as well as future research activities of our team.

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