Logistics project description

Electrified Emergency Services Fleet Planning

A charging scheduling problem

Background

Emergency services are central to society's resilience against emergencies and disasters. Emergency services need to be quickly available anywhere, at any time. This puts high demand on emergency unit mobility and, hence, fleet capability and capacity. Replacing internal combustion engines with fossil free solutions will affect this capability. This calls for studies and concrete, quantitative decision support guiding the transition towards a fossil free emergency vehicle fleet. But there are also a set of challenges, including the uncertain factors, such as availability of electrical vehicles given their charging requirements, travel times that affect both response time and charging requirements.

Emergency services are in terms of transport work (kilometers traveled) small when compared to overall person and freight transportation. De-carbonization research has hence focused on the latter, which in their properties and requirements differ systematically from rescue service planning and operations. Emergency service agencies (e.g., fire and rescue services) are increasingly pressed to disposition their future vehicle fleet, and that they demand studies and decision support that confront fossil free fleet options with their operational needs.

There exist different decision-making problems from strategical to operational levels. For example, at strategic level, we have problems concerning the number of and position of each electrical vehicle type across different stations to maintain (or if possible, improve) response. At operational level, charging requirements and energy consumption (charging schedule) while considering the needs for charging infrastructure exists.

Aim

The aim is to propose a charging schedule for a fully electrified emergency fleet at each station such that RTÖG's response times (or coverage) is not affected given the needs and restrictions coming from electric vehicles.

Data for quantitative analysis, including positions of the RTÖG's stations, currently available types vehicles and number of each type at each station, OD matrices, and energy needs for each vehicle type under utilization and charging time and requirements as well as a proposed disposition of a fully electrified fleet will be made available.

Organization

Project supervisors: Niki Matinrad, niki.matinrad@liu.se and Martin Waldemarsson, martin.waldemarsson@liu.se

Project examiner: Tatiana Polishchuk, tatiana.polishchuk@liu.se

Project group

The project should be conducted by a group of 3-5 students.

Project description

The project covers the following steps:

- Make a literature survey of electrical fleet management and de-carbonization, with special focus on emergency services.
- Investigate and analyze the current (relevant) decision models concerning charging schedule of electrified (emergency) fleet, based on the surveyed literature.
- Survey and analyze the perspectives and potential needs of emergency services, by interviewing Räddningstjänsten Östra Götaland (RTÖG) personnel (contacts are already established) and investigating historical data.
- Construct a set of key indicators that should be considered when designing a decision model for charging schedule of electrified emergency fleet and the needs of charging infrastructure.
- Construct a mathematical model for charging schedule of (electrical) emergency vehicles at each station within RTÖG service area.
- Analyze the results. Validate these with RTÖG personnel.

Project grading

Each project can be graded, Fail, 3, 4 or 5, or the corresponding ECTS grade. Each step below will be evaluated regarding the complexity, realization, systematic treatment of input data, modeling and output data.

For the grade 3, at least the following steps have to be carried out:

- A detailed project specification and time plan, carefully written in English.
- A literature survey of electrical fleet management and de-carbonization, with special focus on emergency services and charging scheduling of electrified fleets.
- Construction of a deterministic mathematical model and examining the impact of different objective functions on the model (at least two different objective functions).
- An analysis of the results.
- A final report carefully written in English and an oral presentation of the project results.

For the grade 4, the grade 3 steps have to be carried out with very good results and the following steps have to be carried out:

- The mathematical model takes into account at least one stochastic factor.

For the grade 5, the grade 3 and 4 steps have to be carried out with extremely good results and the following steps have to be carried out:

- The mathematical model takes into account at least two stochastic factors.

Relevant literature

Elpustaty, H., Haidari, M., Hurynovich, P., Matinrad, N., & Sjölund, E. (2026, May). Electrified Emergency Services Fleet Planning. In *Proceedings of the International ISCRAM Conference* (Vol. 23). https://ojs.iscram.org/index.php/Proceedings/article/view/219

Haidari, M. (2026). *Decision Support for Strategic Planning and Optimal Fleet Dimensioning of an Electric Fire and Rescue Vehicle Fleet – A Case Study at Räddningstjänsten Östra Götaland*. Linköpings Universitet (Sweden). urn:nbn:se:liu:diva-226800