Advanced facility location models for the placement of charging stations in e-mobility

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In order to propagate reduction in environmental pollution, it is essential to stimulate the use of *electric vehicles* (*EV*s). Compared to conventional-fuel vehicles, nowadays EVs have a relatively small driving range. Thus a dense network of *charging stations* (*CS*s), guaranteeing that vehicles can reach their destinations without running out of fuel, is essential. This requirement usually contrasts with a limited CSs construction budget, which makes it necessary to choose their locations deliberately.

In the *deterministic flow refuelling location problem* (*DFRLP*), described by de Vries and Duijzer [1], the number of EVs, which can make their trip without running out of fuel, is maximized, while the number of CSs is given. In our talk four extensions considering different objectives and various constraints to the DFRLP are introduced and evaluated:

1. In the first extension we ask how many CSs are necessary to cover a pre-specified number of EVs and therefore exchange the original objective function for a minimizing cost function.

2. Further, our research shows that, when considering *location-dependent construction costs*, results heavily depend on the relations of said cost differences. Tests for different cost scenarios are carried out and policy implications are discussed.

3. The DFRLP assumes that the capacity of a charging station is sufficient to refuel all traffic flows, using it, regardless of the EVs number, which want to be refuelled there. In contrast, we believe that an increasing acceptance of EVs requires the consideration of a *restricted capacity* at each CS. This capacity is put into relation to the total sum of demands generated by all EVs, passing a particular CS, which means that our model determines the placement and the sizes of all CSs simultaneously.

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4. The last extension considers the probability of failures at potential facility locations while deploying an infrastructure in order to guarantee a so-called *minimum path reliability* for a certain number of EVs.

All model extensions are finally analysed using randomly generated problem instances based on test instances introduced for the DFRLP.

Keywords. Electric vehicles; recharging; facility location

References

[1] H. de Vries and E. Duijzer, Incorporating driving range variability in network design for refueling facilities, *Omega* **69**, 102–114, 2017.