Incorporating Charger Efficiency into Electric Vehicle Charging Optimization

Constance Crozier, Matthew Deakin, Thomas Morstyn, and Malcolm McCulloch
Department of Engineering Science
University of Oxford
Oxford UK, OX1 3PJ
Email: {constance.crozier, matthew.deakin, thomas.morstyn, malcolm.mcculloch}@eng.ox.ac.uk

***Abstract*—Optimization of electric vehicle (EV) charging will allow network operators to improve power quality and avoid costly reinforcements. Existing problem formulations allow EV charging power to vary continuously in order to achieve convexity and a tractable solution. However, at low powers EV chargers become inefficient and this inefficiency is not taken into account in these formulations. Here, we use real charger efficiency data to demonstrate how including this relationship alters the optimal action. For managing network power flows, we are often only concerned with the network behaviour at lower time resolutions. In this case, we suggest a heuristic method of altering the results of convex optimizations such that low charging efficiency is avoided without altering the behaviour at lower resolution.**

***Keywords*—Demand-side management, Charger efficiency, Electric vehicles, Optimization**

It is typical for smart charing formulations to define charging power as a continuous variable (e.g. [1]–[4]). This approximation admits a convex problem formulation which can be efficiently solved using standard numerical techniques. However convexity also requires the assumption of constant efficiency, which is not valid when power is allowed to vary continuously. If charging power is constrained to be near the rated power or zero then constant efficiency is a more reasonable assumption, however this results in a non-convex discrete problem. While some formulations attempt to tackle non-convex problems (e.g. [5], [6]) the computational complexity grows exponentially with the number of vehicles considered. While these can provide insight about what the optimal action might look like, they could not be used to