VISUALIZATION TOOL FOR ELECTRIC VEHICLE CHARGE AND RANGE ANALYSIS

Electric vehicles (EVs) are widely promoted as clean alternatives to conventional vehicles for reducing greenhouse gas (GHG) emissions from ground transportation. However, the battery undergoes a sophisticated degradation process during EV operations and its effects on EV energy consumption and GHG emissions are unknown. Here we show on a typical 24 kWh lithium-manganese-oxide–graphite battery pack that the degradation of EV battery can be mathematically modeled to predict battery life and to study its effects on energy consumption and GHG emissions from EV operations. We found that under US state-level average driving conditions, the battery life is ranging between 5.2 years in Florida and 13.3 years in Alaska under 30% battery degradation limit. The battery degradation will cause a 11.5–16.2% increase in energy consumption and GHG emissions per km driven at 30% capacity loss. This study provides a robust analytical approach and results for supporting policy making in prioritizing EV deployment in the U.S.

In general, EV battery degradation undergoes two processes:
one is the cycling capacity loss due to the internal solid-electrolyte interphase (SEI) layer growth, structure degradation of the electrodes and cyclable lithium loss during the battery charging/discharging process, as mainly dictated by the number of battery charging/discharging cycles; the other is the calendar capacity loss due to battery self-discharge and side reactions during energy storage period, as mainly determined by the state of charge, aging time, and ambient temperature, particularly the high temperatures to which the battery is exposed16–18. Due to the largely different operating conditions across the U.S., the EV battery degradation, electricity consumptions, and GHG emissions in each state are largely different.

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The advances in electric mobility, motivated by current sustainability issues, have led public and private organizations to invest in the electrification of their corporate fleets. To succeed in this transition, companies must mitigate the impacts of electrification on their fleet operation, in particular the ones on vehicle recharging. The increase in energy demand caused by electrification may require changes in the company electrical infrastructure, the installation of charging stations,and the proper planning of the recharging schedule considering the particularities of each fleet and operation. In this context, data analytics is seen as an important tool to help companies to understandtheir charging fleet profile, supporting decision makers in making data-driven decisions regarding their charging infrastructure.