MGL
Microgrid Labs
More than Renewable Energy

Planning and Operation of EV charging infrastructure

1. Introduction

Electric vehicles (EVs) are expected to comprise 30% of all cars globally by 2030. As the EV population surges, so must the population of EVSE. Given the long commute distances, driving habits, time taken to charge using home-based chargers and range anxiety there is a need for charging stations at locations like workplaces, hotels, car rental centers, parking garages etc. Simultaneous charging of several EVs at these locations will easily overload the facility electrical infrastructure. As more facilities start providing EV chargers at their locations, this will eventually overload the grid and threaten grid stability.

Many question must be answered in order to characterize the EVSE for a given facility. These include: how many charging stations are required – now, next year and in the coming years? Do we provide every EV owner access to a charging station as soon as they come in? What are the investments and operational costs? What is the impact on the electrical network? On the other hand, providing very few charging stations could result in long wait times, need to move the cars in and out, work disruption, customer inconvenience etc. The challenge is in arriving at the optimum solution that considers customer demand/ satisfaction, electrical limits and especially investment and operational costs.

2. Planning and Control Software for EVSE

To address this problem MGL is currently developing a software solution for intelligent planning and control of EV charging infrastructure. This is a joint development with University of California, Berkeley and is partially funded by NSF under a STTR award. As demonstrated by the earlier paper, MGL understand the side-effects of that will occur as EVSE rapidly expands, and we have the domain expertise and industry contacts to offer complete solutions for this market.

The proposed solution is a cloud-based software, provided under a Software as a Service (SaaS) model, for intelligent planning and control of EV charging infrastructure. The software has two parts, and each will fulfill different needs for different customers as described below.

3. Planning Software

The planning module of the software will help in designing an optimally sized EV infrastructure considering the following factors:

3.1. Mobility Behavior

The EVSE users could be any vehicles that are driven to the facility and parked for some minimum time. These could include vehicles used by employees, clients or other visitors. What are volumes of these today, what are abnormal events that could result in higher traffic and how are these factors likely to change in the future. Important factors affecting charger usage are the parking patterns, which are in turn affected by employee commute or customer transaction patterns. For vehicle host facilities (like parking

garages, rental car agencies, fleet-parking and similar facilities) arrival and departure patterns will strongly impact ESVE demand.

3.2. Access Policies and Management

Ideally when an EV driver needing to charge pulls into a parking lot/garage, a charger will be available. But at what cost? It is highly probably that at least under some circumstances these will be more incoming depleted EVs than chargers, thus policies must be defined for charger access, and there will need to be methods for establishing and updating queues for the chargers. These methods should include:

- Entry of a waiting EV into the queue
- Definition of the probable wait time and updating this time
- Notification of the availability of the charger
- Notification of the completion of the charge
- Transition time between completion of a charge and the start of a new charge

3.3. Electrical Network Limits

How many chargers can the current distribution network support without requiring major upgrades? Where should each charger cluster (adjacent parking spaces with a charger connection for each space) be placed? As EV's expand over time, at what point will additional investments need to be made to support them. Investments might include facility distribution system upgrades or using on-site electric generation and storage to mitigate the peak charging loads. The latter has several advantages, including:

- The use of renewable generation will reduce the facilities carbon footprint.
- Distributed solar (like parking-lot covers) plus battery energy storage can be located close to the chargers to mitigate any impact on the facility's existing distribution system.
- Distributed solar plus storage will greatly reduce demand charges and energy charges.
- Where vehicle parking facilities preclude distributed solar (like in garages), distributed battery energy storage can provide many of the economic benefits of solar plus storage, like reduction of peak charging impact on the facility distribution system and reduction of peak demand charges.

3.4. Pricing Strategies

Should the EVSE be installed and maintained by the target facility, or by a commercial EVSE network operator? What pricing should users be charged? What strategy should be used to avoid increased demand charges? What strategy should be used to avoid overloads? Can creative charge scheduling reduce overall power costs?

3.5. Budget considerations

What will be the budget for the initial (or next) phase of EV deployments? What will be the budgets for following phases? What will the operational costs be (including energy)? What are the income targets (from charging fees)?

3.6. Planning Software Users

Target users plan facility expansion, and include facility engineers, consultants, contractors, facility owners and managers, research institutes and academia. Currently, these customers do not have a software tool to optimize the design of the EV infrastructure considering the above factors.

4. Operational Control

Once a fleet of EV chargers are deployed control module of the software optimizes the operation of the entire system, including:

- EV fleet
- Onsite generation and storage
- Non-EV loads
- Waiting-time and queue length

The goal of the optimization will be tuned to specific facility and organizational requirements, and typically includes minimizing operational costs, achieving cost and income goals and satisfaction of the EV-owner.

4.1. Control Software Users

Target users manage a facility with charging stations. Examples are facility operators of hotels, car rental centers, parking garages, office complexes and other facilities with a large number of clients and/or employees that arrive via user-owned automobile, and facilities that host a large number of organizationally-owned vehicles. Summary

The Microgrid Labs (MGL) solution offers specific, targeted value to customers in different groups with different needs. It will allow EVSE owners to add an optimized revenue stream from EV charging services while keeping capital investment to a minimum. It will allow facility operators to keep EV owners satisfied and reduce complaints regarding undercharged EVs, while reducing energy costs by optimizing energy demand from the grid. It will allow the utility to continue stable operations without expensive upgrades. It will also empower small consulting businesses and electrical contractors - they will be to design and build EV infrastructure without any specialized knowledge of optimization or modeling.

MGL and our partners have developed a set of tentative requirements and a prototype planning application. We are at the point in our development where we need to interact with potential users and other stake-holders to verify that we fully understand their requirements and priorities.

We are keen to talk to your organization to get your perspectives on electric vehicle charging infrastructure a key component in the emerging EV revolution.