Aggregation and Control of Bidirectional Chargers in a Residential V2G Application

NEXTera ENERGY

BUSINESS PROBLEM

As electric vehicle (EV) ownership increases, utilities face a high strain on electricity demand when vehicles charge at peak hours. Companies are investing in various solutions, including stationary battery storage to power demand; however, the high cost of batteries can make it challenging to deploy at scale. Bidirectional charging is a system that allows vehicles to discharge their battery to another load. With many EVs coming to market, using vehicles for grid services, like bidirectional charging, could provide significant energy storage while being a lower-cost solution to improving grid resiliency.

APPROACH

There has been little work done in estimating the capacity of EVs for grid services. This thesis first focused on developing an algorithm to estimate capacity with residential EV charging data from FPL's Residential Charing Pilot. The thesis then proposed two algorithms for 1) choosing which vehicles should participate in a demand response event and 2) a managed charging algorithm for FPL's pilot.
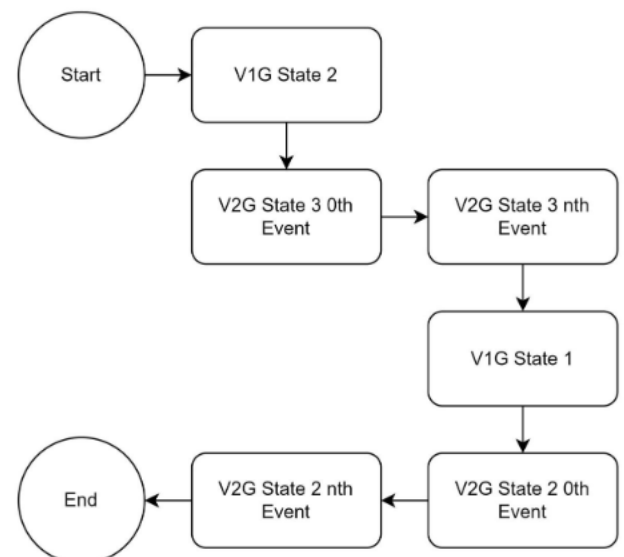
DATA SOURCES

Two databases were used to estimate capacity available from grid services: residential charging session data, residential charging meter data. Both data bases collected information from FPL's residential EV chargers. Session data gives an overview of each charging session while meter data gives a more granular view of how much power was consumed during each 15 seconds during a charging session.

Data Types and Format

Residential charging session data and meter data were exported from an OCPP 1.6 database

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IMPACT

The solution proposed in this thesis provides FPL with a process to estimate capacity available from grid services. This information will feed directly into shaping future programs and helping the utility plan for using EVs as a power source. The thesis lays out an algorithm to serve as a framework by which NextEra and FPL can develop a demand response program that uses both managed charging (V1G) and bidirectional charging (V2G) to meet an operator defined target load reduction. An additional managed charging algorithm is proposed as a feature for FPL's Residential Charging Program which can monitor total load from chargers to ensure the network of chargers does not exceed a maximum system load.

DRIVERS

In 2021, Ford announced their F-150 lightning would support bidirectional charging. This prompted many utilities to seriously consider using EVs in their grid operations. While Ford's announcement is exciting, there is still significant work to be done to connect EVs to the grid. The world highlighted in the thesis lays the groundwork for FPL integration EVs to the grid starting with a demand response program.

BARRIERS

The use of EVs for grid services is still a nascent field, This means there are limited vehicles and charging stations on sale today that support bidirectional charging, In the state of Florida there is currently no regulatory framework to launch a program. The work for this thesis needed to focus on first understanding the applications of EV grid services and quantifying the power capacity available.

ENABLERS

NextEra is a very innovative and forward looking energy company. They are willing to be early on exploring new technologies and making the requisite investments. This cultural feature of the company enabled early buy in from internal stakeholders that made this research gain traction.

ACTIONS

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Since hardware for bidirectional charging is not yet installed in FPL territory, there was a primary focus on first developing the capabilities to use V1G with existing EV charging stations. I worked with suppliers and the technical team to develop the managed charging capabilities in house. While this work was being completed I also worked on a discussions with an automaker to start exploring using EVs for V2H and V2G

INNOVATION

The most noteworthy part of the thesis is the work completed towards estimating capacity available. There has been little work done in the space and knowing the amount of power utilities can draw from EVs from a combination of V1G and V2G helps with future planning.

IMPROVEMENT

This thesis was a broad study of commercialization of EV grid services in FPL territory. Prior to starting this work, there was limited information on how to scale the technology internally. The thesis focused on showing that there is a real use case with the capacity planning work and provided a technical framework to build off.

BEST PRACTICES

Other utilities looking to conduct further studies should first invest in residential EV chargers. This was an innovation FPL recently launched that provided the data needed for this study, The charging program combined with a robust OCPP server, will be the backbone off which EV grid services starting with V1G can come to market.

OTHER APPLICATIONS

One of the future applications of this work is laid out in the thesis. It gives a plan for how to use the capacity available estimates to create a simulation of an EV grid services dispatch event. With the real data for chargers, it can create simulated data based on the probability of a charger being connected. It can then run for a set time period to determine how many vehicles would be required to meet a target load reduction.