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Next-Generation Electric Vehicle Charging System

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Summary

Southern Company has developed a low-cost, highly functional PEV charging micro-network that does not exist in the current market. Multiple electric vehicle chargers (EVSEs) are networked to a single kiosk to offer the full functionality of networked charging without the high costs. The solution will reduce barriers to multi-family dwelling and workplace charging, two critical elements in the electric vehicle ecosystem. By adding more chargers and higher functionality for lower cost, offering aesthetically pleasing design with user-friendly features and working with non-networked chargers, this next-generation EVSE will help move the electric vehicle market in the United States and beyond.

Keywords: charger, EVSE (Electric Vehicle Supply Equipment), infrastructure, load management, smart charging

1 Background

The electric vehicle market began surging in Atlanta — Southern Company’s headquarters — in 2014, quickly becoming the second-highest city in the United States for battery-electric vehicle adoption. The quick ascent brought a number of challenges to Southern Company, chiefly, providing the public and private electric vehicle charging infrastructure to serve the influx of vehicles. One particular challenge was identified: apartments seemed unwilling to give up already limited parking for EV parking. Collaboration with a company in the PEV charging space inspired the current solution.

1.1 Electric Vehicle Experience

Southern Company has a long history with PEVs and the associated infrastructure. In 1980, the CitiCar, affectionately known as the “Wedge,” was specifically designed by Southern Company subsidiary Georgia Power to be powered by electricity. The Wedge was powered by lead acid batteries, topped out at between 40 and 45 MPH and had about 25 miles of range. In 1993, the Consulier Electric sports car was the first vehicle to travel down the new Georgia 400 extension, carrying our then-company president and the state governor. When Atlanta hosted the 1996 Olympic games, Southern Company promoted its electric vehicles and new electric vehicle chargers, installed across the city during the EV1 boom.

Additionally, Southern Company was instrumental in the installation of PEV infrastructure across its territory. Charging stations were installed at area malls as part of a program that allowed those locations to add PEVs to their security and maintenance fleets. Additionally, the company surveyed customers and employees who drove PEVs about where they would like to see public charging stations, and worked to have them installed in those locations. Through this process, the company gained significant experience in workplace and public charging

1.2 Southern Company Current Activities

Southern Company has continued working to remove barriers to entry in the electric transportation market, accelerating adoption and meeting employee demand with initiatives that cover numerous elements of electric vehicle ownership.

Today, Southern Company has more than 560 PEVs in its company fleet. Southern Company has installed 270 electric vehicle chargers at approximately 75 company facilities across Georgia, Alabama, Mississippi and Florida to serve its fleet PEVs, as well the 340 company employees who drive electric vehicles. The company is part of the US Department of Energy's Workplace Charging Challenge, and encourages other companies to do the same. Nearly 1,200 business customers have received rebates for installing workplace charging stations, helping Atlanta rank No. 4 among U.S. metro areas in workplace charging [1].

In addition, Southern Company promotes charging in residential locations; more than 800 residents have received customer rebates for installing home charging stations in single-family dwellings. There are also programs and rebates in place to promote EVSE installations at multi-family-dwellings (MFDs) and mixed-use-buildings (MUDs), since it is evident that many potential PEV adopters live in MUDs in downtown locations. In Georgia, the company has made available 38 public community charging islands featuring Level 2 and DC fast charging ports, many of which are located near MFDs partially to provide charging for residents.

Southern Company also promotes general PEV awareness and education. More than 300,000 people attended its more than 100 plug-in electric vehicle education and readiness events in 2016, which include ride-and-drives both at Southern facilities and other workplaces. Southern helps customers understand the benefits of driving electric vehicles by identifying special rate options, providing information on vehicles and charging options and outlining the savings realized by using electricity as a transportation fuel.

1.3 PEV Adoption Barriers

It has been shown in [2] that there is a correlation between access to charging at home and PEV adoption. Even if current PEV drivers didn't currently use a level 2 EVSE at their home, they reported that on average, it was much easier to do so than potential Fast Followers did. In addition, it has often been show [3, 4] that there is a correlation to between access to charging and willingness to purchase a PEV. There is more information on this in Section 2.

Data from the US DOE Workplace Charging Challenge has shown [5] that individuals who work at locations with PEV charging are 20 times more likely to buy a PEV than others. This may be partially attributable to increased awareness from being exposed to EVSEs on a regular basis. Several studies have shown that there is a significant disparity in education and awareness between PEV drivers and those who have considered the technology but not purchased [6-9].

Southern Company sought a simple and low-cost method for increasing EVSE deployment at workplaces and MFDs.

2 Next-Generation Charging System Use Cases

More than 90% of charging occurs at home or the workplace and new construction is heavily trending toward multi-family dwellings over single-family dwellings with a detached garage. Current local, regional and national incentives are driving infrastructure development and adoption in workplace and residential settings.

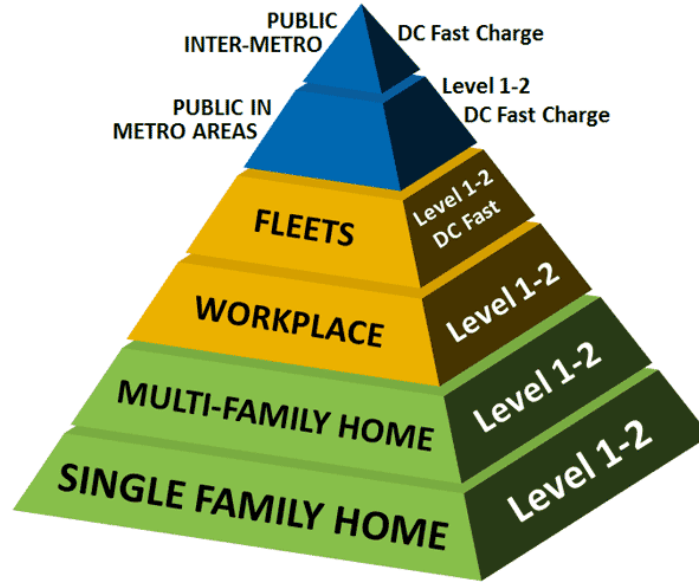


Figure 1: Charging use case pyramid based on market size. The next-generation electric vehicle charging station will address three of the largest use cases in the electric vehicle ecosystem [10].

2.1 Fleet

In the United States, an executive order by former President Barack Obama requires 20% of the federal sedan fleet to be electric by 2020 and 50% of the sedan fleet to be electric by 2025. The government's procuring agency, the General Services Administration (GSA), has signaled that it prefers a turnkey solution that can collect and report data at the vehicle level. GSA's stated challenge is the cost for multiple networked charging stations. Southern Company's next-generation charging station addresses the needs of the U.S. government.

2.2 Multi-Family Dwelling

Serving apartments and condominiums, a rapidly growing portion of housing in the United States, is a critical component for Southern Company's new charging solution. According to company data, nearly a third of new Southern Company electric customers live in multi-family dwellings (MUDs). Many MUDs in the U.S. are located in urban areas, where parking spots are at a premium. The beauty of the next-generation charging system is that a spot does not have to be designed for EV charging. Multiple plugs open up numerous potential parking spaces for EV drivers.

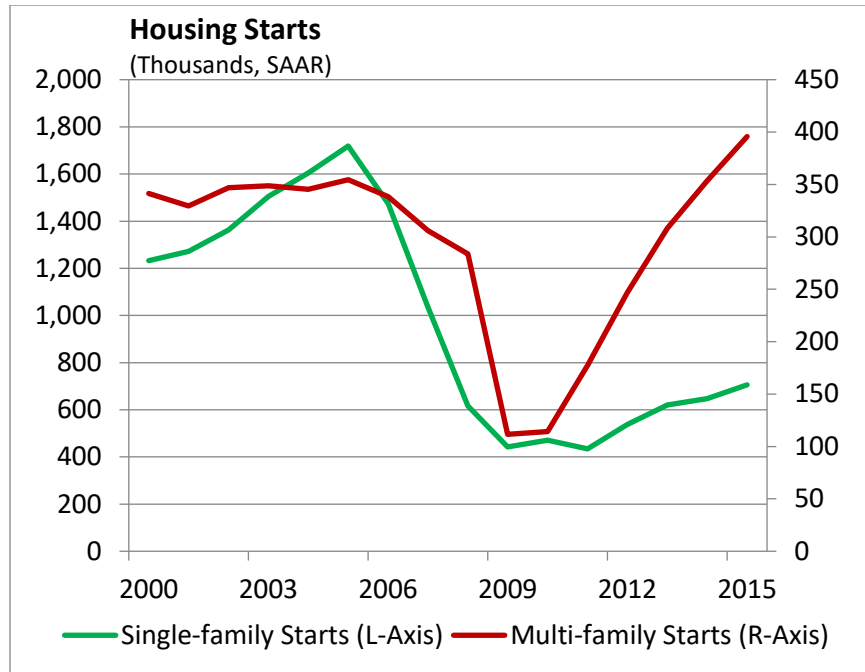


Figure 2: United States housing starts

Additionally, property managers are under pressure from cities to reduce parking spots. Eliminating parking spots earns apartment companies more favorable rankings in the widely-recognized Global Real Estate Sustainability Benchmark. This trend favors the Southern Company solution over standalone chargers, since the kiosk can support more cars than spots available.

Southern Company surveyed property managers across the country to gauge interest for the next-generation charging system. Nearly three-fourths of respondents indicated an interest in the system.

2.3 Workplace

Southern Company's charging solution offers employers a low-cost option to provide PEV charging to employees at the workplace, the second-most important place for charging behind home charging. Additionally, this solution will leave workplaces the flexibility to adjust EV network use after installing hardware, and to incorporate employee charging and fleet charging in the same location with different rules.

3 Current Market

Current market offerings are either low cost/low feature ports or high cost/high feature ports. Low cost/low feature ports, while typically very reliable, do not offer sleek design, access control, load management queuing, data tracking and a local site host interface. The high feature ports currently in the market are usually sold at a premium, deterring some cost-conscious property managers who are hesitant to make a large capital investment into a nascent market. The next-generation electric vehicle charging system takes reliable, low-cost electric vehicle charging equipment and integrates it with an OCPP-compliant, feature-rich kiosk to yield a system that is lower cost per port.

3.1 Market size

According to Navigant Research, charging station and related equipment will be a \$2.9 billion market by 2023. Sales of charging units will grow from 425,000 globally in 2016 to 2.5 million in 2025 [11]. The market is

particularly robust for workplace, fleet and multi-unit dwelling charging. Navigant Research projects sales of nearly 200,000 workplace chargers between 2016-2020.

For fleets, the use cases are wide ranging. Nearly 80 utility operating companies and 38 utility holding companies in the U.S. agreed to invest at least 5% of their annual fleet expenditures to electric transportation and supporting technologies as part of the Edison Electric Institute electrification initiative. Additionally, more cities, states and counties are considering electric vehicles as part of their fleet due to the lower total cost of ownership. In the state of Georgia alone, where Southern Company is headquartered, there are more than 58,000 fleet vehicles.

While the size of the multi-unit dwelling charging market is difficult to gauge due to wide-ranging parking situations at apartments and condos, an Accenture study stated that 59% of American urban dwellers were considering an electric vehicle for their next car compared to just 48% of suburban residents and 39% of rural residents [12].

4 Functionality

Due to an ongoing patent submittal process, the functional details of the next-generation electric vehicle charging system will not be fully revealed in this paper. Additionally, as this is a system currently under development, some of this functionality is part of a long-term plan. In general, the cost of this charger will be competitive per port due to local networking with a central gateway—as the number of ports increases, the cost per port decreases exponentially. A multi-standard RFID reader will allow for integration with workplace/apartment access cards and existing fleet management systems and offer a local site host interface. The network will be able to capture vehicle data for tracking and offer a queueing functionality. Metering capability will allow the charging solution to support more stations than available capacity by utilizing local load management.

The charging system will also support real-time pricing of electricity and enable users to enter their charging preferences in reaction to current and anticipated grid conditions. This allows the overall charging system to be responsive to not only local load conditions, but help reduce the impact of increasing electric vehicle charging on the grid.

5 Partnerships

Development of the next-generation electric vehicle charger would not be possible without partnerships with the research and development community, major apartment companies, other utilities, EV software providers and EV hardware companies. Through this community, Southern Company is able to offer a product aimed at revolutionizing the charging industry and encouraging more drivers to choose sustainable, electric vehicles.

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Blair Farley is a research engineer focusing on electric transportation. Throughout her five years at Southern Company, her transportation research has been centered on the movement of people and goods in the residential, commercial and industrial segments. Research topics include vehicle efficiency, vehicle-to-grid integration, advanced charging methods and alternative fuel options. In addition to her research activities, Farley is active in several programs promoting females in STEM fields. Blair holds a bachelor's degree in mechanical engineering from the University of Alabama at Birmingham.