# TRANSITIONING TO ELECTRIFICATION: CASE STUDIES

C2ES CENTER FOR CLIMATE AND ENERGY SOLUTIONS

Transportation is responsible for most air pollution in urban areas and produces the most greenhouse gases of any U.S. economic sector. To reduce these emissions, cities and businesses are considering deploying electric vehicles, which produce no tailpipe emissions that would otherwise impact public health in their immediate surroundings and have lower carbon footprints. Realizing the benefits of transportation electrification for all residents, including those in low-income communities, may require targeted policies and planning methods.

This paper draws out case studies or strategies described in "Electrified Transportation for All," a brief that encourages planners and fleet managers to consider the potential costs and benefits of different types of electrified transportation in low-income communities. The brief helps estimate and explain total cost of ownership (TCO) and the differences in air quality and greenhouse gas emissions of electrified light-duty passenger cars, school buses, and transit buses.

The adoption of EVs into fleets will not look the same for any city or region. Differences in funding streams, city or regional priorities, fuel prices, and community compositions make the process inherently unique for each project.

The brief "Electrified Transportation for All: How Electrification Can Benefit Low-Income Communities" provides considerations for planners and fleet managers interested in expanding EV benefits to their low-income communities, but the information provided is designed to be general and broadly applicable.

Real-world experiences and strategies are equally important to understanding how these technologies have been implemented. This fact sheet provides examples and resources to policy makers, planners, and fleet managers to help better demonstrate how some cities and agencies have identified project goals, obtained funding, and deployed electrified transportation to meet city and community goals.

## STRATEGIES TO INCREASE LOW-INCOME ACCESS TO EVS

To promote adoption of new electric passenger vehicles and deliver the identified air quality benefits to low-income communities, innovative strategies to overcome the higher purchase costs may be considered. Purchase incentives are typically administered at the state level, with the consequence being that cities may need to find alternate methods of facilitating low-income residents' access to EVs.

Cities across the country are experimenting with programs to encourage and facilitate EV adoption among low-income residents, but these programs are new, and performance data is not yet available. Strategies to expand low-income access to EVs include installing public charging in low-income neighborhoods, implementing car rental programs for low-income communities, and subsidizing ride-share companies such as Uber and Lyft to complete the "last mile" of journeys on public transit.

As technologies evolve and cities learn more about extending the benefits of electrification to low-income communities, new strategies and success stories will emerge.

## EXPANDING CHARGING ACCESS TO LOW-INCOME & DISADVANTAGED COMMUNITIES

Most notably, electric utilities in several California regions are installing charging stations to reduce harmful air pollution and greenhouse gas emissions in areas that the California Public Utilities Commission identifies as "disadvantaged communities." These charging efforts are elements of larger projects submitted by San Diego Gas & Electric (SDG&E), Southern California Edison (SCE), and Pacific Gas & Electric (PG&E) that were required by state law SB 350, which compels electric utilities to put forth EV charging project proposals. The utilities have already undertaken charging infrastructure programs to customers in disadvantaged communities and have additional charging infrastructure proposals in front of the Commission to collectively expand EV installations and access programs by more than $1 billion.

- SDG&E's Power Your Drive EV charging program has a minimum goal of installing 10 percent of a planned 3,500 charging stations in disadvantaged communities.
- PG&E's EV Charge Network has designated 15 percent of stations for disadvantaged communities from its 7,500-station pilot project. '
- SCE's Charge Ready program designated 10 percent of its planned 1,500 stations for disadvantaged communities.

Several of these utilities have already exceeded their goals for charging infrastructure deployment in disadvantaged communities—SDG&E reports 40 percent of station installations among these communities, while SCE's initial investments in disadvantaged communities accounted for 50 percent of installations. Nearby municipal utility Los Angeles Department of Water and Power is also installing charging stations and is exploring ways to reduce costs and rapidly expand EV infrastructure in low-income communities, such as using existing utility poles as charging stations, though a similar project in New York state did not produce significant cost savings. Seattle City Light is also exploring ways to reach low-income communities, such as installing DC fast charging stations that could rapidly serve many community members.

## SITING EV CAR SHARES IN LOW-INCOME COMMUNITIES

Rather than focus on encouraging new vehicle adoption, which may be expensive for low-income residents, Los Angeles is implementing a car-share program in low-income communities. The program, which was announced at the end of 2016, is funded with nearly $1.7 million from California's cap-and-trade program and a $10 million contribution from the supplier of the vehicles, Blue California. Los Angeles' program will provide 100 all-electric sedans at 200 public stations in targeted low-income communities. The Los Angeles program was inspired by a program partially funded by the New York State Energy Research and Development Authority and state DOT that placed four all-electric vehicles into a low-income community car share program in Buffalo, NY. A review of the community car share program found that the EVs were not adequately used to be cost-effective due to long charging times and limited range due to heat and cold impacts. However, an analysis of the project found that EV car-share programs could have strong regional economic potential and are valuable for promoting electric technologies.

## IMPROVED MOBILITY SERVICES

On-demand mobility options such as autonomous vehicle adoption and subsidized ride-sharing are new strategies to promote clean, equitable transportation solutions that reduce the need to own a vehicle. Columbus, Ohio's winning Smart Cities application establishes a bus rapid transit corridor that will target low-income and vulnerable populations to improve economic opportunities—the plan also calls for a small fleet of autonomous EVs that will extend the reach of the bus system to additional retail and employment centers.

A few cities are subsidizing the costs of ride-share program. Summit, New Jersey is running a pilot program that allows 100 commuters to take an Uber to the train station for the cost of the standard $4 parking fee. The program, which is estimated to cost $167,000 annually, may help avoid the cost of building a $10 million parking garage or $5 million surface lot. The city of Los Angeles is planning to incorporate a ride-hailing "MicroTransit"

pilot project into its transit program to improve mobility and access to standard transit options. With improvements to autonomous vehicle technology and longer-range, lower-cost vehicles entering the market, car share and ride-hailing programs will have greater access to EVs. The flexibility provided by car-share programs helps low-income residents who cannot use public transportation due to schedule constraints or a lack of nearby transportation options.

## KING COUNTY, WASHINGTON, REVIEWS COSTS AND ADOPTS ELECTRIC TRANSIT BUSES

The electric transit bus market is young, but growing quickly, in part because of the emissions benefits identified above. Two notable manufacturers, BYD and Proterra, have been active in the electric transit bus market for years. Proterra sold its first three buses in 2009 to Foothill Transit in Pomona, California. BYD is a Chinese-based company that has sold electrified buses since 2010, recently expanding to the U.S. market with a manufacturing plant in Lancaster, California. All-electric transit buses represent a tested and market-ready technology.

King County Transit, the public transit operator in Seattle, has tested a small fleet of all-electric Proterra transit buses since early 2016. Three 40-foot buses with a range of 23 miles cost King County Transit $4.7 million, which was funded in part by a grant from the Federal Transit Authority. The tests were successful enough to compel King County Transit to conduct a feasibility study on adopting all-electric buses at a much larger scale. The feasibility study drew contributions from more than 20 experts from local utilities, vehicle maintenance technicians and operators, route planners, and individual operations bases. The study compared the costs and benefits of all-electric bus adoption compared to the transit agency's standard purchase of diesel-hybrid buses.

The most notable finding is that all-electric transit buses can be purchased at scale for a two percent TCO increase when including societal costs, such as air quality health impacts, noise pollution, and greenhouse gas emissions. The projected total costs of ownership increase to six percent over business as usual when not accounting for societal costs. The valuation benefits from a gap in fuel prices - one of the largest in the nation - between diesel prices and electricity prices, which are very low in Seattle. The study also scored bus routes for equity, finding that all-electric buses can be prioritized to serve vulnerable populations that are defined by poor health indicators, low education and income levels, and racial composition.

King County Transit plans to purchase 73 of the same all-electric 40-foot Proterra transit buses that have been tested over the past year and may purchase as many as 120 all-electric buses within the next few years. The planning process also helped inform a city decision to join eleven other major international cities to purchase only all-electric transit buses by 2025. The county estimates that each bus will cost approximately $750,000 and will require access to very high-speed charging equipment that can power a bus at 500-600 kilowatts. Cost estimates for high-speed charging equipment project between $300,000 and $350,000 for charging equipment and an average of $360,000 to install the equipment and facility upgrades. Each station is projected to service four buses, bringing the per-vehicle cost of charging equipment to slightly under $150,000 (these costs reflect the costs of new technologies and techniques and should be reduced as high-powered charging becomes standardized). The high rate of energy consumption required to fuel these buses also creates significant demand charges. King County, with the help of the Electric Power Research Institute, estimates that the additional costs of demand charges will increase electricity prices per mile from 8-9 cents to 15 cents.

With such heavy electric demand, King County Transit has emphasized the importance of working with utilities to develop electrified transportation. Both Seattle City Light and Puget Sound Energy have been consulted to ensure that the necessary power supply will be available and the infrastructure will be ready to deliver large electric loads. Utilities can be more proactive when cost recovery is permitted. Seattle City Light is permitted to rate base EV infrastructure investments and has been very responsive, whereas Puget Sound Energy needs to identify a break-even proposition on projects.

## CALIFORNIA SCHOOL DISTRICTS PLUG IN

Three school districts in California signed on to a September 2015 agreement to deploy two all-electric

school buses each. Torrance, Edison, and Napa Valley school districts will undertake a demonstration project intended to reduce air pollution and incorporate vehicle-to-grid (V2G) technologies that will provide a new revenue stream and reduce operating costs for the rest of the bus fleet. All six buses repowered by California-based Transpower have been built, and five have been delivered. The "repowered" vehicles are converted 1996 diesel school buses that have had their original engine components stripped and replaced with electric motors, regenerative brakes, V2G technologies, and other equipment specific to electric drive.

The consulting group National Strategies is overseeing the project in each of the school districts and has helped the school districts secure funding for the project. The projects were made possible with grants from the California Energy Commission and the South Coast Air Quality Management Districts, state agencies responsible for managing air pollution within a specified geographic area. Funding was made also available through grants created by the state's cap-and-trade program and DERA funding. Electric utility NRG's eVgo program also contributed funding and expertise. eVgo helped the school districts to upgrade their electric supply and install electric inverters and charging equipment. Because the program uses new technologies, National Strategies sought buy-in from partners at many levels from large investor-owned utilities to school boards and vehicle operators.

The project utilizes converted diesel buses because commercially available all-electric school buses were not available when it began. Purpose-built all-electric school bus technology is still quite new, but the field of manufacturers is growing. Quebec company eLion produces all-electric buses that have been commercially available for over a year and has deployed its vehicles in schools in Quebec and Massachusetts. National Strategies, the consultancy leading the project, will build on its experience with this project to develop purpose-built all-electric buses from Blue Bird for a pilot project in California that is scheduled for 2019. Blue Bird expects to offer two types of all-electric school buses that should be available to all school districts in 2018.

Though state grants paid for the project's upfront costs, the project intends to demonstrate the value of V2G and V2B technologies in making all-electric school buses commercially viable. Reducing operating costs and forging new revenue streams is critical to demonstrating that the all-electric vehicles can overcome higher purchase costs and compete with diesel or CNG buses. National Strategies estimates the cost of a purpose-built all-electric bus at $300,000 and the associated bi-directional infrastructure up to $50,000. The Vermont Energy Investment Corporation also estimates costs of a new bus with infrastructure and dedicated management at $350,000 in a feasibility study of electric school buses. However, with added value from the buses' V2G and V2B capabilities (see box on "Cutting EV School Bus Costs with Technology"), National Strategies estimates that the price premium of the buses and the charging infrastructure could be reduced to approximately $200,000 and $30,000, respectively. At this price point, the electric buses may equal diesel buses in TCO calculations due to reduced fuel and maintenance costs.

## Other C2ES Resources:

*Electrified Transportation for All:* https://www.c2es.org/document/electrified-transportation-for-all-how-electrified-transportation-can-benefit-low-income-communities

*Transitioning to Electrification: Funding Resources:* https://www.c2es.org/document/transitioning-to-electrification-funding-resources

*Feasibility of Achieving a Carbon-Neutral or Zero-Emission Fleet:* http://kingcounty.gov/~/media/elected/executive/constantine/news/documents/Zero_Emission_Fleet.ashx?la=en

*Electric School Buses: Feasibility in Vermont:* https://www.veic.org/docs/resourcelibrary/veic-electric-school-bus-feasibility-study.pdf

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