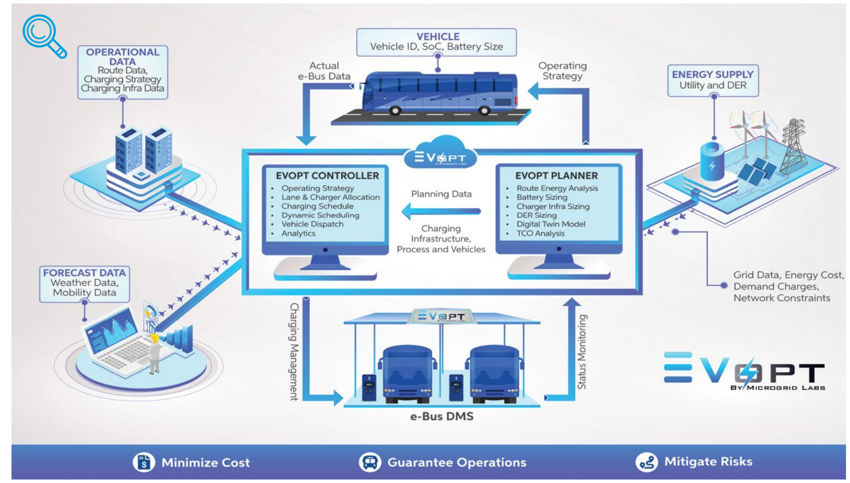
Zero-Emission Fleet Transition Planning and Simulation

Startup
Microgrid Labs
Boulder, CO

Host
Ameren

Technology Solution

Cost and complexity are two key factors standing in the way of a faster transition from conventional vehicle fleets to electric mobility. Electric school buses, for example, have much higher purchase prices than diesel buses and need additional investments in charging infrastructure, but they promise lower operations and maintenance (O&M) costs plus reduced emissions of pollutants and greenhouse gases. Myriad design, cost, and performance variables influence the appropriateness and the outcome of electrification projects. Planning is the first crucial step in fleet electrification, as early decisions can have significant impact.



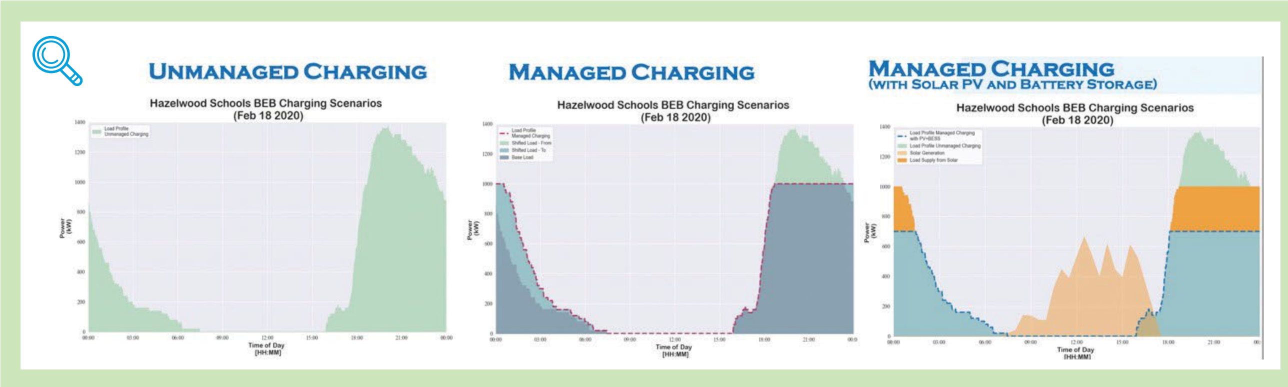
While this demonstration focused on planning applications, the EVOPT platform is also designed to support operational decision-making by customers and utilities.

This pilot project tested the EVOPT software platform developed by Microgrid Labs (MGL) for completing a feasibility study and system-level design for transitioning a diesel bus fleet into an all-electric fleet. The EVOPT platform is used to build a detailed digital twin of the application in question, addressing existing fleet vehicles and uses, charging and electrical support infrastructure, utility rates, and other factors. Simulation of the driving and charging process for an electrified fleet helps determine optimum capital and operating parameters for minimizing costs and achieving other goals. "What if" analysis functions support evaluation of alternative scenarios, helping reduce risks and costs while managing uncertainties.

Project Overview

The Hazelwood School District (HSD) in St. Louis, Missouri, is considering the possibility of transitioning its school bus fleet from diesel to zero-emission vehicles. As the local utility and electricity provider, Ameren is interested in understanding potential impacts on the distribution network and, more broadly, in exploring how to facilitate a faster transition toward zero-emission fleets. In this project, MGL, Ameren, and EPRI teamed up to provide HSD with planning services and support while determining the efficiencies and challenges associated with the use of EVOPT in a real-world setting.

The first step was to document existing operations. This included gathering telematic data for 120 buses to understand daily routes, duty cycles, and other details, as well as data relating to fuel costs, maintenance charges, behind-the-meter electric



Operational simulations of EV charging load profiles illustrate peak shaving and load shaping opportunities achievable by managed charging and use of solar plus battery storage.

infrastructure, the localized distribution network, electricity pricing and tariffs, electrification and resiliency goals, etc. After integrating all the data in EVOPT, MGL conducted modeling and analysis to come up with recommended specifications for the electric bus (battery and motor size), charging infrastructure (number, type, and size of chargers), and electric infrastructure (transformer size, panel size, cable/conduit, etc.). In addition, technical and business factors such as load profiles, rate structures, vehicle-to-grid and vehicle-to-building integration, and on-site solar and battery storage were considered.

Results & Learnings

Working during the summer, during a pandemic, presented challenges not only in collaborating with HSD staff but also in applying EVOPT. In an ideal scenario, model development is based on the most recent 12 months of normal fleet operations. For this pilot, pre-shutdown (February 2020) and recent (May 2021) data were applied, with assumptions made to fill gaps. This did not impact the ability of the project team to generate important insights as introduced below.

Innovative fleet decision-making approach. Under a traditional approach for considering new technology, a few electric buses might be purchased and operated on a demonstration basis, easily costing upwards of $1 million and taking 18 to 24 months. The EVOPT-Planner tool combined with real-world telematic data provided a detailed, simulation-based analysis of a futuristic, all-electric fleet scenario at this location, supporting evidence-based decision-making for a fraction of the cost on a much shorter timeframe.

Fleet suitability for electrification. Based on telematic data, about 100 HSD buses are on route daily, averaging about 100 miles (160 km) with a maximum daily distance of about 270 miles (430 km). EVOPT modeling determined that about 80% of the fleet could be electrified using commercially available technology and that immediate operational savings could be realized by replacing the older vehicles that account for about half of the fleet.

Charging strategy. Armed with infrastructure and hourly pricing data from Ameren and as shown in the above figure, EVOPT provided insights on hosting capacity and peak load shapes for electric fleets under various charging scenarios. The existing 12 kV feeder has sufficient capacity to support electrification. Managed charging could reduce feeder peaks by more than 25% and HSD's electricity bill by about $2000/month at current rates. Integrating fleet charging with onsite solar and battery storage could provide additional benefits.

Capital and operating expense. An electric school bus, on average, costs about three times as much as a diesel bus and requires charging stations and upgrades to onsite and utility infrastructure. Electric buses also bring the promise of lower fuel and maintenance costs. For Hazelwood, EVOPT estimates a total cost of fleet electrification in the range of $50 million and a reduction in annual O&M costs of about $1 million.

Emission reduction. EVOPT estimates total annual CO_2 emissions from the current HSD fleet to be around 4000 tons. Electric buses could reduce tailpipe emissions to zero, and onsite solar could be installed to support a fleet with net-zero electricity consumption.

Utility infrastructure upgrades. According to EVOPT analysis, the much higher power levels needed for EV charging (1.5 to 2 MVA) would require an upgrade of the existing stepdown transformer (150 kVA at 12 kV-480 V). A separate but nearby 12 kV feeder could be tapped to increase resiliency for an all-electric fleet by having multiple connections to the local substation.

Implications & Next Steps

Consistent with its committment to net-zero carbon emissions by 2050, Ameren is working with MGL to identify other fleets in the utility's territory for which to perform detailed electrification planning studies. This will support system planning for huge EV charging loads coming online and the utility's goal of serving them with clean energy production sited at large EV fleet hubs or elsewhere on the grid.

The team also is exploring integration of MGL's digital twin model of the HSD fleet's charging depot with the capacity profile of the medium-voltage feeder serving this location. EVOPT models can provide load profile and power quality forecasting on a 24-hour basis and real-time forecasting on a rolling 15- or 5-minute basis. Detailed evaluation of this capability could provide further insight into the value of MGL's technology for both utility planning and operational purposes. MGL is considering a white-label version of EVOPT for use by utilities in helping customers evaluate fleet transition options.

Resources

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TESTIMONIAL: Microgrid Labs

Transitioning to zero-emission bus fleets gives school districts and other transportation providers the opportunity to reach sustainability goals and reduce costs but also poses challenges. Working with Ameren and EPRI allowed us to dig deeper into utility integration issues and created learnings that will be used to enhance EVOPT's features and support a faster transition to electric fleets.

TESTIMONIAL: Ameren

Collaborating with MGL, EPRI, and the Hazelwood School District on this EVOPT pilot has provided Ameren with hands-on experience in understanding our customers' general struggles and areas of focus in vehicle fleet management, as well as in analyzing the capital and O&M expenses and grid impacts associated with fleet electrification projects. As a result, Ameren is better equipped to discuss electrification strategies with customers and identify options for helping them manage risks, reduce costs, and maximize benefits.

TESTIMONIAL: EPRI

This demonstration generated unique insight into the potential impacts of electrifying a fleet of school buses, both for the school district and host utility. EVOPT modeling and analysis provided information needed to make decisions about this fleet electrification application and, when done at scale, could help quantify and guide utility planning along a key decarbonization pathway.

Resources

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