Electric Vehicle Fleets – The Distribution Planning Process

Distribution Operations and Planning in collaboration with Electric Transportation

Introduction

Traditional distribution planning ensures that capacity is sufficient to reliably meet annual peak load everywhere on the distribution system. The normal annual planning process has proven effective at preparing for load growth through:

- Forecasting annual peak load,
- Allocation of peak load to distribution planning areas,
- Identification of areas with constrained capacity,
- Selection of low-cost mitigation solutions, and
- Construction of new capacity when necessary.

However, the electrification of transportation fleets creates forecasting and mitigation challenges not seen since air conditioners spiked demand more than a half century ago. Electric Vehicle (EV) fleets will potentially be very large loads, causing sudden regional challenges with little advance notice. One fleet charging facility could exceed the capacity of a single feeder. Utilities will initially be able to serve them as they would any new, large customer, but the high numbers of vehicle fleets, along with other electrification trends, are likely to overwhelm utilities as the adoption curve accelerates.

Anticipating this situation, many planners are struggling with how to forecast when and where vehicle fleets are going to appear on the system in addition to the impact of their load. They are also being asked to consider new mitigation solutions, such as solar with storage, demand response (DR), and customer incentive programs when resolving distribution system constraints. They find themselves asking, "Where are the vehicle fleets; which ones will transition to electric first; and when they do, what will the load look like?"

Figure 1: Fleet managers are quickly becoming important partners as utilities prepare to serve their electric fleets.

To answer the questions above, this whitepaper proposes several techniques where EV fleet loads can be forecasted and incorporated into a utility's annual planning process. In addition, with some minor modifications, the processes could also be used to address specific customer requests for fleet electrification. Finally, several new EPRI analytical tools are introduced to aid planners with key steps along the way.

Combined, these processes and tools will help distribution planners engage fleet customers in more depth to resolve much of the uncertainty of fleet electrification whether it is:

- Strategic, where utilities proactively engage customers and gather information as part of their annual planning process, or
- Responsive, where a customer is contemplating the electrification of their fleet and reaches out to their utility for help.

The subtle difference between most commercial/industrial loads and an EV fleet is that the EV fleet may have more flexibility on when and where it charges, so a more in-depth understanding of these requirements helps both the customer and the utility make mutually beneficial decisions.

In the latter situation, planning engineers will be able to treat EV fleets as they do any growing commercial or industrial load, but they may need the tools and capability to handle larger volumes of requests. Through consultations with the customer and new analytical tools, planners will develop a better understanding of their customer's business needs and plans, and together evaluate what types of services will best accommodate them. The subtle difference between most commercial/industrial loads and an EV fleet is that the EV fleet may have more flexibility on when and where it charges, so a more in-depth understanding of these requirements helps both the customer and the utility make mutually beneficial decisions.

Advanced Distribution Planning for EV Fleets

Advanced distribution planning introduces new capabilities to enable planners to prepare for vehicle fleet electrification in an increasingly complex grid, while maintaining overall grid integrity. We use the term grid integrity because it considers more than reliability. It also includes resilience, power quality, safety, security (including cyber security), and agility. Each of these attributes should be considered when planning a distribution system. However, this paper addresses primarily reliability and resiliency when planning for EV fleets, which are the immediate concerns for planners.

Advanced distribution planning is a vast subject, but it is useful to outline the framework here because we will be using some of the capabilities to plan for EV fleets, especially the first two elements of advanced planning:

- Unique Planning Area Demographics, and
- Location Forecasts for Every Hour.

There are seven capabilities shown in Figure 2, along with a short description explaining each capability. The last one, System Performance, is similar to a feedback loop that provides planners and management ongoing indication about the process and whether it is working as intended. We will discuss this more towards the end of this paper. In the next several sections, we will examine how these capabilities help us plan for EV fleets. Our focus on the first two capabilities sets the stage and enables the collection of information that planners can use to inform their own planning processes.

Unique Planning Area Demographics

Planning Areas

Distribution systems are often so vast that planning an entire system at the same time would be inefficient and daunting. Instead, planners divide the distribution system into planning areas to help manage the work. Planning areas are predefined geographic areas that can be defined by a 5 to 50 square mile border, a substation service area, or even an area served by a single feeder. As planning tools develop more capabilities over time, it may be useful to make planning areas more granular. This is best determined by each utility, their needs, and their capabilities. Regardless, it is important to define these areas because each will have unique demographics associated with it including the number of customers, the type of customers, the number of vehicle fleets, the load shape, and the timing of the peak. Some areas will be capacity constrained, while others will have an abundance of capacity. All these attributes influence the analysis and the mitigation plan for each planning area.

Today, technology enables us to plan with more precision, which will lead to better applications of solutions and improve the utilization of infrastructure. The last point is key, because better utilization of infrastructure leads to lower costs and puts downward pressure on electric rates. Since some electric vehicle fleets may have flexibility on when and where they charge, this is an important characteristic that we will leverage later in the process.

Planning Area Demographics – Vehicle Fleets

When planning for electric vehicle fleets, we will need to address the following questions for each planning area. All are related to forecasting load for each planning area, and they help us to understand the unique characteristics associated with the vehicle fleets within each area:

1. How many vehicle fleets are in the planning area, where are they, and how big are they?
2. When will they make the transition to electricity? Which ones are likely to transition first, and how fast will they transition?
3. When they are electrified, what will the load shape be, and are they flexible about when and where they charge? (How do the fleets operate? Can they charge off peak or at different locations?)

Let's start by identifying where the vehicle fleets are and how big they are. EPRI is developing new capabilities to locate and assess vehicle fleets. Although the new capabilities won't forecast new EV fleet loads and load shapes, they will help locate the fleets and estimate their potential for grid impact. Using aerial imagery and location, these tools will identify probable fleet locations as well as their relative size, and consequently, their potential impact on the grid. By combining this information with internal customer data, the locations can be pinpointed, which begins to answer question number 1. This also provides the first essential data that planners and customer representatives will use to prioritize which customers to engage first. It also begins the process to learn specifics about the fleets and the answers to questions 2 and 3 .

Evaluation of Standards | System Performance

Capability	Unique Planning Area Demographics	Locational Forecasts for Every Hour	Multiple Scenario Development	Locational Impacts for Any Hour	Optimal Mitigation Solutions	Operational Planning
Short Description	Local plan based on the unique demographics of the planning area	Locational and temporal (8760) forecasting of customer's load shape	Evaluation of multiple planning scenarios	Locational and temporal analysis of impacts	Readily identify optimal mitigation combinations	Distribution planning on the fly integrated into the control room

Figure 2. Advanced Distribution Planning Capabilities. The first two are most applicable to planning for EV fleets.

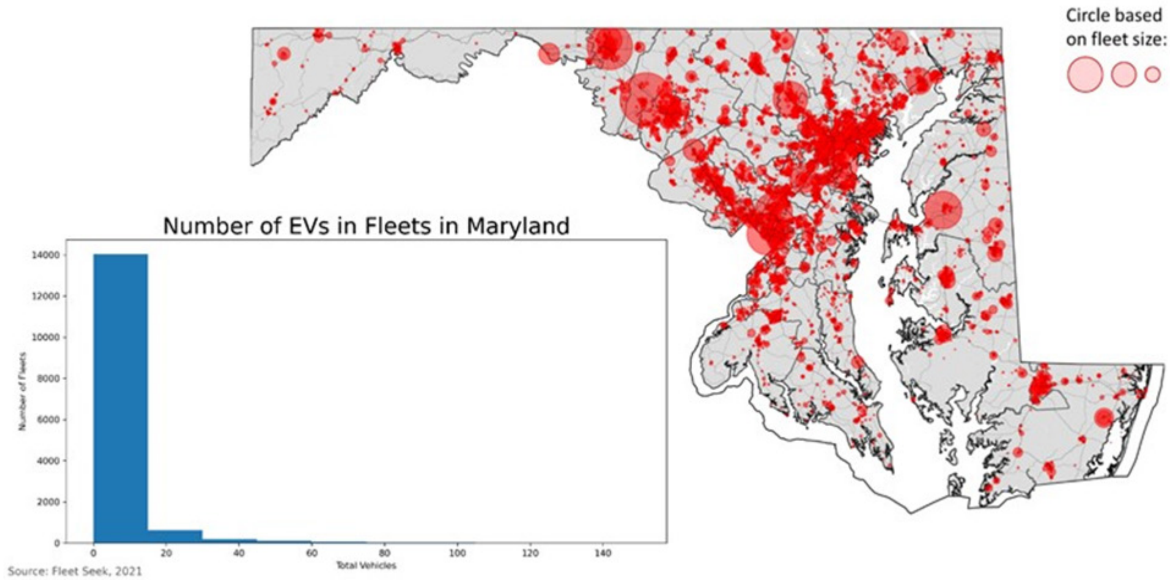

Figure 3. Locating vehicle fleets size and location.

To get the complete picture and fully answer our questions, we will need to visit the customer. Customer engagement is a key to successfully finding the optimal solutions that fit the customer's needs as well as leveraging available capacity at the right location and time on the grid. However, before making a visit, it is important the team prepare by gathering some additional information to fuel useful dialog with the customer. Therefore, we will come back to this part of the discussion later in the paper.

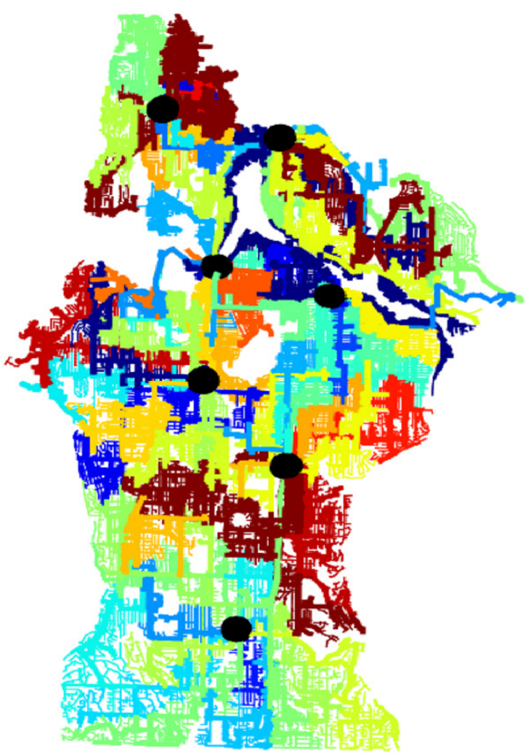

Figure 4: Feeder capacity visualization using EPRI DRIVE.

Planning Area Valuation

As the complexity of the distribution system increases, and more techniques are at our disposal to mitigate constraints on the systems, we will need to come up with methods to analyze multiple scenarios and point to the best combination of solutions. No longer will planners focus only on new infrastructure to address load growth. For EV fleets, our mitigation choices also include managed charging (i.e. demand response, time-of-use), solar with storage, and other methods to minimize the added demand during peak periods. These same programs may be used to enhance system reliability and resilience, and further in the future, these programs may create additional value through ancillary services.

To help inform this process of finding the right EV fleet solutions, distribution planners need to evaluate each area with respect to available capacity. As load increases, normally planners are focused on the areas that are capacity constrained so they can determine if upgrades are necessary to keep the lights on. However, when working with EV fleet customers, they will want to identify areas with an abundance of capacity to incentivize fleet electrification in the short term. These areas have higher value to EV fleets, so targeting these areas first creates growth in areas where the infrastructure is otherwise underutilized. It is also common that commercial service transformers and the secondaries have significant room for growth. With these opportunities in mind, it will be possible for some fleet customers to electrify without any service upgrade investments.

This strategy of encouraging EV fleet charging in certain areas where capacity is available first, is appropriate during the early phases of electrification because it would increase asset utilization with minimal capital investment. This leads to higher returns, which helps to fund more renewable resources and storage. More importantly, this leads to downward pressure on electric rates for all customers. It also helps the planning and customer teams manage their workload as they initiate the deployment of EV fleet customer programs and pricing programs by targeting marketing programs first to a selection of customers. It is analogous with the age-old strategy of picking low hanging fruit first.

Delivery fleets and vehicle fleets that can charge during off-peak periods are of particular interest for utilities. They can be easily influenced to charge when capacity is available, even after growth begins to fill in the available capacity at peak. This approach takes advantage of the variability in real-time hosting capacity at any location on the system. The ability to manage a fleet's charging profile means that their demand is adaptable to take advantage of the shifting load profiles over time, further prolonging the need for grid investments. However, this improved utilization requires planners to assess the regional distribution system's ability to support the fleet during shoulder and off-peak periods as well. The diagram shown in Figure 5 illustrates how managed charging enables the distribution system to serve the load without upgrades. Another way to consider this is that managed charging can improve the system's hosting capacity at any location. Figure 6 illustrates a before and after view of hosting capacity after applying managed charging.

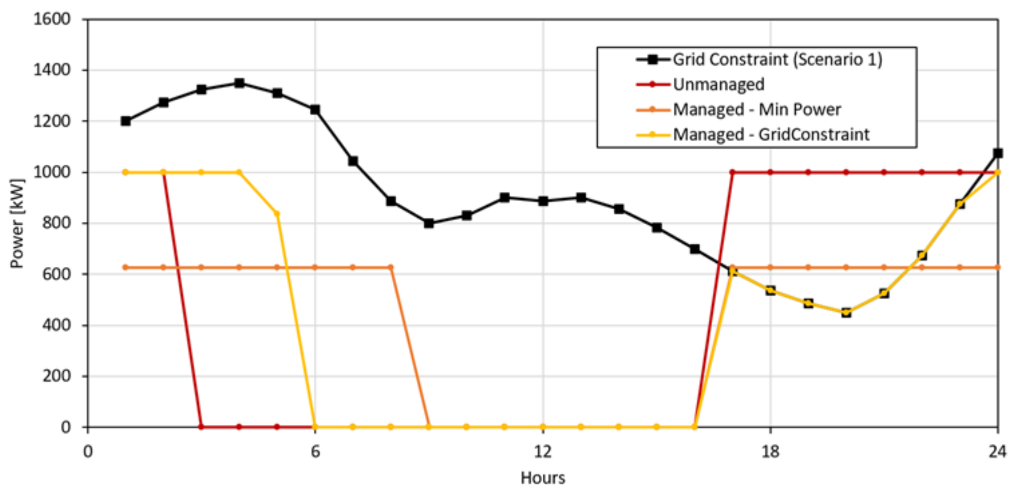

Figure 5. With and variability of load throughout the day, managed charging enables EV fleets to take advantage of local capacity when it is available, further prolonging the need for grid investments.

It is important to emphasize that targeting fleet electrification in areas with abundant capacity does not exempt fleets in other areas from participating. If customers reach out to utilities with a plan to electrify their fleet, the parties should exchange information, with the utility sharing the location of these abundant areas, the opportunities, and discuss whether fleet managers believe they have flexibility in their fleet charging requirements (where or when they charge). Those that do not have flexibility in charging location may have flexibility when they charge. In these cases, they would be good candidates for time-of-use (TOU) pricing programs or managed charging programs. The process of evaluating all the options for EV fleets helps to match the best solutions to meet the customer's needs while also avoiding or reducing additional infrastructure investments.

The process of evaluating all the options for EV fleets helps to match the best solutions to meet the customer's needs while also avoiding or reducing additional infrastructure investments.

The EPRI DRIVE™ tool is a way for planners to quickly identify areas of the distribution system with an abundance of capacity, considering peak and particularly off-peak hours when fleets will typically charge. DRIVE will identify feeders and substations with plenty of capacity to host new load including EV fleets. This information may be viewed geographically (see Figure 4) so that it can be overlayed with the location of customer fleets. Combining this information, planning engineers and customer representatives will be able to quickly identify fleet customers in areas with plentiful capacity. These customers should be among the first to be approached by the utility team to gather information about their fleet operations and may also be an early target to encourage fleet electrification using incentives and other means.

Identifying EV Fleet Candidates and Early Adopters

To further understand which fleets are likely to move first toward electrification, it is important to consider the drivers and the obstacles influencing EV fleet adoption. For fleet managers, the drivers are cost, technology maturity, operational requirements, and incentives (utility and local incentives, and tax breaks). The age of their fleet also influences their adoption rate. Using these criteria, it is easier to project where adoption is likely to occur first and at what pace.

Note that the adoption influences are different in each region of the country, so each utility will need to evaluate and make assumptions that fit their region. What follows may or may not be the outcome of your analysis.

The costs of EVs have come down significantly within the last few years especially with smaller vehicles and trucks. Manufactures are producing vehicles that are economically competitive with their ICE (internal combustion engine) counterparts and with better performance. The charging equipment for these vehicles is also proven and inexpensive. Early adopter, Amazon, has partnered with Rivian to deploy 100,000 electric vans by 2030,[1] but for most larger electric delivery vehicles, the technology is still relatively early. Large freight hauling type vehicles are thought to be a few years off as the technology is not as mature, including the charging tech-

[1] Amazon Staff, 10/8/2020, "Introducing Amazon's first custom electric delivery vehicle," accessed 10/6/2021, https://www.aboutamazon.com/news/transportation/introducing-amazons-first-custom-electric-delivery-vehicle.

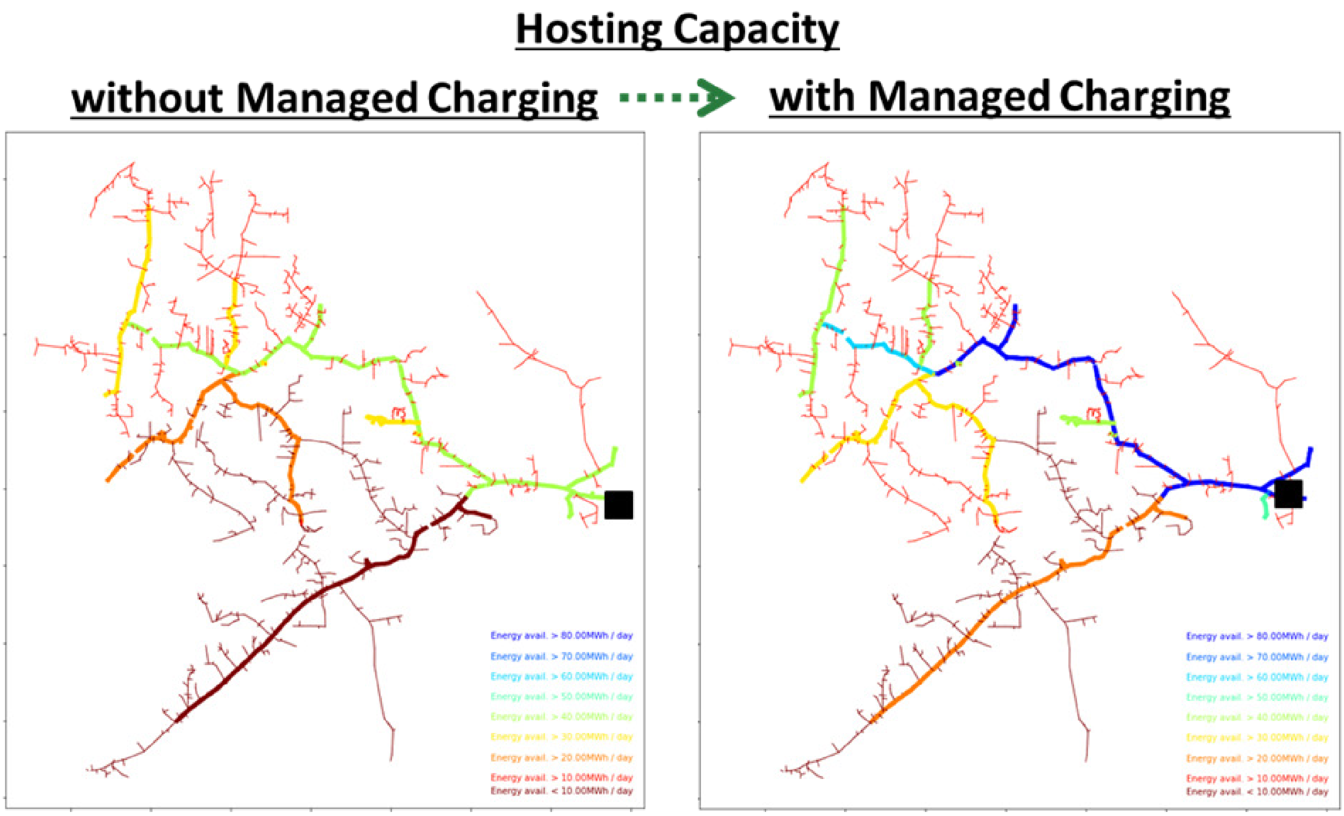

Figure 6. Hosting capacity improves with managed charging.

nology. Therefore , it makes sense for planners to initially target fleets with sedans, SUVs, and light trucks. Electric delivery vans should be another early focus, especially in areas where Amazon is deploying them; however, within a few years, planners should be ready for the electrification of any last mile delivery fleet. Large freight hauling type vehicles that travel on relatively short haul routes of less than 200 miles are likely to follow soon after. While the large freight hauling vehicles on long haul routes will be the final adopters.

Figure 7. Electric delivery vans like these will soon become commonplace. Amazon recently ordered 100,000 Rivian electric vans for their delivery fleet.

This narrows the initial customer target and potential early adopters to those that include all the following criteria:

- Light duty fleet vehicles,
- Daily travel requirements that are local and less than 200 miles,
- Return to base for charging, and
- In planning areas with an abundance of capacity.

Local Forecasts for Every Hour

Most of what we have discussed so far was to understand the demographics of vehicle fleets in each planning area and where on the system vehicle charging would present the best opportunities. We have also begun to answer question 2 regarding when fleets will transition to electricity and which are likely to go first. However, we should be able to get additional useful information that will help us further clarify question 2 and answer question 3 by visiting the customer. Recall question 3 asks, "What will the load shape be, and are they flexible about when and where they charge?"

Customer Visit and FleetCalc

EPRI has developed FleetCalc, a tool that will help translate fleet characteristics into load profiles for new EV fleets. Without visiting the customer, planners may be able to use site location and square footage information to estimate fleet location, size and possibly demand. This may be acceptable for an initial study where time and data are limited, and it may also be good enough for annual planning processes in areas where capacity is abundant. However, if the utility will be engaging fleet customers anyhow, the additional information gathered from those visits will improve the precision of the FleetCalc tool. Without them, operating characteristics and flexibility are still unknown, while electrification timing information needs validation. Therefore, distribution planners and other utility representatives should visit the customer whenever possible, so they can conduct a site demand and energy requirements assessment to identify fleet characteristics including: vehicle types, operating schedule, driving distances, charging behavior and other considerations that influence load shape and timing. By providing consultations as a service, utilities can provide useful information to fleet customers who are considering electrification while also collecting valuable planning insights.

Georgia Power has a program that takes this idea of a site assessment even further. It is part of their *Make Ready Electric Transportation Program*. The program takes customers through a straightforward, easy to navigate process that engages the customer from application through activation. It not only informs the customers, enabling them to make informed decisions, but it also provides planners with data that can be used to plan the behind-the-meter charging infrastructure and consider impacts on the distribution system. The results are presented to the customer to help inform and support their transition to an electric fleet.

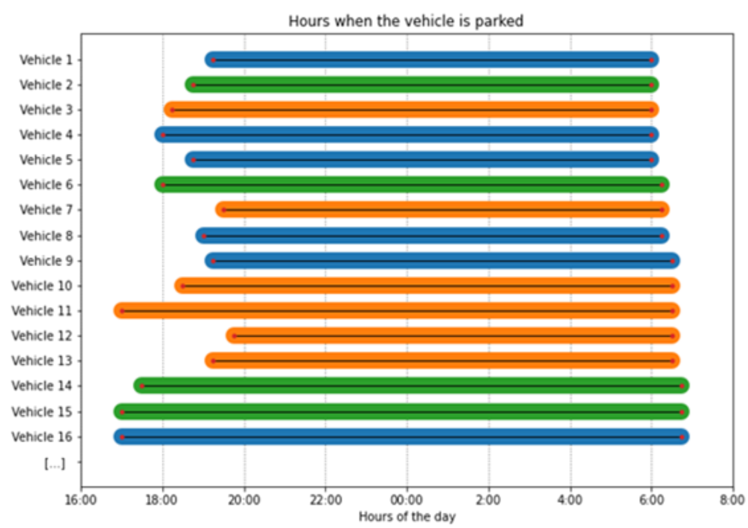

Figure 8: Fleet vehicles non-operation times (parked) is a good data point to measure when evaluation charging options, as well as their flexibility on when and where they charge.

Creating Load Shapes

There are many ways to gather fleet vehicle use data to help inform customers as well as the utility planners. Utilities can develop a telematics capability themselves or work with any of the telematics companies that provide this service. Combining this data with information from customer interviews and using it as inputs to FleetCalc gives utility planners the best visibility of load shape as well as when and where the load will likely develop. In addition, they will learn whether specific fleet customers have flexibility on when and where to charge their fleet. This information not only informs planners, but also pricing programs and customer programs that can be used to influence the fleet customer's adoption timing, location, as well as their charging behavior. Each customer and each site will be different, so there are several other factors to consider when developing programs. For example, electrification is easier at a new site prior to construction than at an existing fully developed site. If the customer's only option is at an existing site, the transition may happen more slowly, but this can be clarified during the customer visit. Given this reality, utilities may want to design programs with multiple variables in mind to address these different situations, but to also influence behavior that meets the planning goals of the utility.

> It is questionable whether fleets will be willing locate their fleet charging at a different location than their current fleet parking location, but would they be willing to charge at a nearby common fleet charging location, where many different fleets are charging their vehicles?

Once the information has been gathered, one can then consider developing a fleet electrification roadmap and review it with the customer. This will help to further extract the customer's intensions and readiness for electrification helping planners to better forecast the actual load and timing expected at the site.

Summary of the Fleet EV Planning Steps

So far, we have focused on EV fleet planning within the first two elements of advanced distribution planning – *Planning Area Demographics* and *Locational Forecasting*. These elements are the most useful in answering the three questions presented at the beginning of this paper. (Where are the vehicle fleets; which ones will transition to electric first; and when they do, what will the load look like?) The answers to these questions can now be incorporated directly into most distribution planning processes. In doing so, the planners are incorporating not only this potentially impactful new load into the planning process, but they are also applying low-cost mitigation techniques that lead to better utilization of the grid.

For convenience and to help demonstrate this, we summarized the planning steps for EV fleet planning, so it may be more easily integrated into an annual planning process as shown in the table below. Steps 1 through 6 were covered in this paper, and the resulting information informs the remaining steps (7 through 10). This provides high level context to guide planners where in the planning process the EV fleet information can be integrated. Every planning process is different, so planners will need to consider exactly how to incorporate steps 1 through 6 into each utility's unique process, but the information discussed in this paper are intended to be adapted into your utility's annual process.

Fleet EV Planning Steps

1. Define planning areas if your process doesn't already have them (See Planning Areas, page 2)
2. Identify vehicle fleet locations using customer data and fleet finding tools (e.g., similar to the tools under development at EPRI) (Tool Development and Applications, page 8)
3. Evaluate planning areas
    a. Identify high-priority areas with an abundance of capacity. (See Planning Area Valuation, page 3)
4. Identify EV fleet candidates (See Identifying EV Fleet Candidates and Early Adopters, page 4)
    a. Overlay fleet customers in areas of abundant capacity
    b. Evaluate for early adopters by looking at the following criteria
        i. Light duty fleet vehicles,
        ii. Daily travel requirements that are local and less than 200 miles,
        iii. Return to base for charging, and
        iv. In planning areas with an abundance of capacity.
    c. Prioritize candidates for targeted engagement
5. Site assessment and consultation (See Customer Visit and FleetCalc, page 6)
    a. Consult on customer's plans, fleet size and operational characteristics
    b. Review available programs and incentives
    c. Determine customer flexibility
    d. Consider telematics to gather data on fleet operations
    e. Input data into FleetCalc, perform analysis, inform the customer of electrification options and fit.
    f. Conduct electrification roadmap review with customer
6. Determine load shape over planning horizon (See Creating Load Shapes, page 6)
    a. Adoption timing
    b. Charging location and schedule
    c. Develop flexibility options and scenarios (see Planning Area Valuation, page 3)
7. Based on information gathered, develop forecast scenarios for evaluation
8. Apply forecasted scenarios to impacted planning areas (many areas may not have an impact).
9. Impact Analysis
    a. Planners will want to include the EV fleet load in their local forecasted peak during analysis of each planning areas, looking for overloads, voltage issues and other impacts.
    b. Note that DRIVE is often used to readily measure grid impacts making it a good tool to evaluate specific customer requests and day-to-day analysis on feeder and substation impacts. The visual reporting also provides a useful communication tool. During annual planning process, the information gathered on fleet EVs and fleet EV programs can be used to evaluate their influence on peak load within a planning area for each planning year.
10. Mitigation
    a. Traditional
        i. Switch load around, add switching, look for other low-cost mitigation.
        ii. When these don't work, add infrastructure such as feeder upgrades and new capacity (substation bay, substation)
    b. Advanced approaches (requires close coordination between planners and customer program developers)
        i. Develop scenarios for managed charging, offsite charging, DER, DR, and compare the costs and risks with traditional infrastructure solutions. This provides input to customer programs, and pricing process. These programs can be used to influence the timing of customer adoption, as well as when and where charging occurs, therefore delaying or mitigating impact levels.
        ii. The use of the advanced approaches provide better utilization of infrastructure, lowering costs, and puts downward pressure on rates. Include these benefits when comparing to more traditional approaches.

There are other EPRI documents that can also be referenced to provide guidance on the distribution planning process, such as EPRI's Distribution Planning Guidebook.[2] Traditional distribution planning practices are outlined within and provide an excellent foundation of distribution planning knowledge and practices. In addition, EPRI is developing additional content on advanced distribution planning and integrated planning. The content discussed in this whitepaper follows much of the same strategy and practices that will be outlined in these coming planning documents, but the coming documents will have a backdrop with a much broader scope.

Tool Development and Applications

As part of a board initiative, EPRI has developed a process and a series of new analytical capabilities to provide guidance and address industry needs regarding fleet electrification. This streamline process (see Figure 10) is built around the questions distribution planners may have: (i) Where and how big are fleet depots? (ii) What will their electrical demand be? (iii) How will they impact the grid? (iv) How do we meet the new demand? To answer these questions, four analytical objectives were defined, along with the capabilities needed to further support the planning process:

- **Assessing fleet characteristics (FleetForecaster):** The objective is to assess the specific fleet characteristics that would impact the needs from a specific site on the network (e.g. location, number of vehicles, type of vehicles, miles driven, vehicle efficiency, etc.).
- **Assessing fleet demand (FleetCalc):** The objective is to translate fleet characteristics into a power demand and energy requirements from a specific site while considering factors that may affect the loadshape (e.g. rate structure, operations, etc.).
- **Assessing grid impacts (DRIVE):** The objective is to understand how fleet demand will impact the grid and understand what new constraints that may arise.
- **Assessing mitigation solution (DERVET):** The objective is to identify infrastructure or non-wires alternative solutions to reduce grid impacts or address grid constraints.

While defining the objectives of each step in the process provides valuable insights, the initiative also focused on specifying the information exchange between each step. The objective is to make the streamline process flexible and modular to fit different utilities internal processes and capabilities (e.g. data availability). For instance, fleet size could either be estimated alternatively via vehicle registration records or through customer outreach, but the main objective is to estimate the fleet size to assess the fleet demand. By defining the general objectives and data exchange, the process can also be adapted to different types of studies, from a specific customer's electrification request to a general fleet electrification evaluation used as an input to an annual planning process.

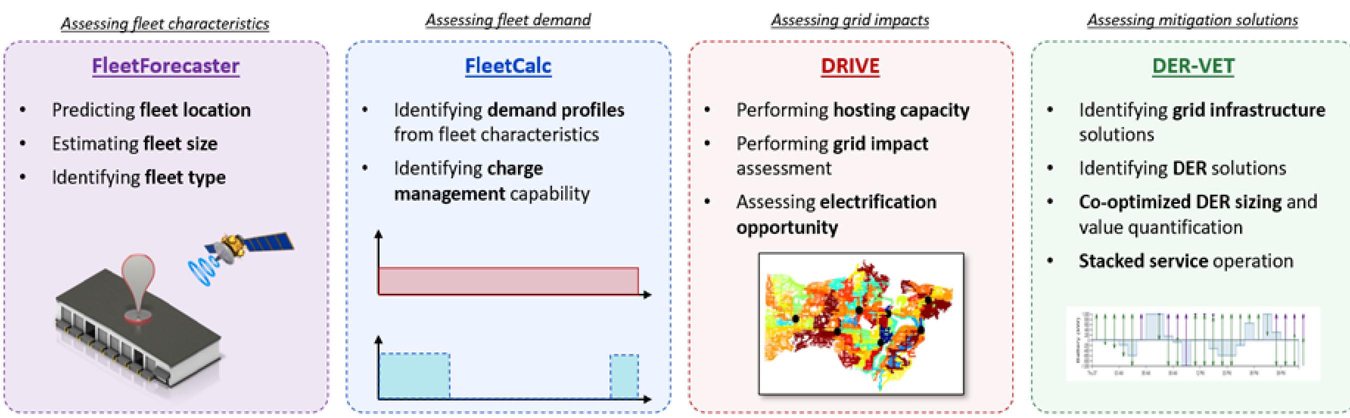

Figure 10. EPRI tools and process to guide planners through the analysis of EV fleets.

[2] Distribution Planning Guidebook for the Modern Grid: 2020 Edition, EPRI, December 2020, Reference Number 3002018813.

The Final Step - Measuring Performance

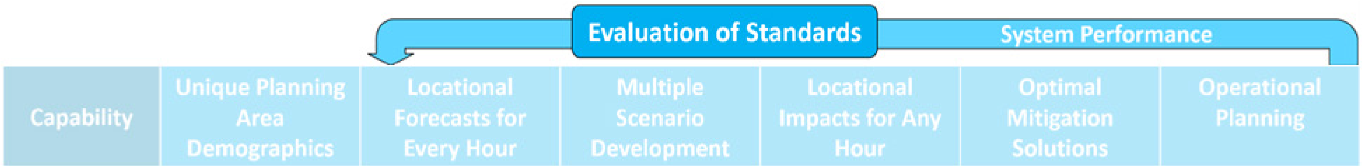

Figure 11. Advanced planning - measuring system performance.

Planning for and serving EV fleets is a learning process, and both the fleet service and electric utility industries are just beginning to scratch the surface on how to plan together and transition to electrified transportation. By planning together, all will continue to learn in a rapidly changing environment, and the opportunity of lower costs will compound over time. Finally, the models we use are always improving, so as we collect data and perform analysis, we will need to refine and improve the models. Therefore, the last step in the EV fleet planning process is to monitor and track performance. What we learn can be fed back into program improvement, pricing programs, model enhancements and the interconnection process to better optimize the solutions and the process itself. Some performance metrics for utilities to consider developing and monitoring include:

- Capacity utilization (overall distribution system, planning areas, substations, feeders, and even phase loading)
- Customer satisfaction surveys (customer and pricing programs, and after each customer engagement)
- Forecast accuracy
- FleetCalc accuracy
- Customer and pricing program participation rates
- Charging behavior relative to the program participation
- Impacts on load shape and capacity factor

Conclusion

Distribution planners do not have to simply react to large scale adoption of electric vehicles by fleet customers. They can plan for it, and given the timing of anticipated adoption, the time to start the planning processes discussed in this paper are immediate. Preparing may seem overwhelming at first; however, by dividing the problem into three groups of questions outlined within this paper helps planners address them one by one. We also discussed several approaches and tools that help planners gather useful information that lead to the solutions.

Customer engagement is a crucial step toward answering the questions. Through engagement, utilities learn the customer's needs and how to influence their behavior, which leads to better utilization of infrastructure, and avoided costs. These are not new concepts for utilities, but the use of advanced distribution planning methods and tools will help planners achieve greater cost reduction objectives. The approach also gives utilities the opportunity to lead and manage the electrification process rather than simply reacting to it, and it creates a path for utilities and their customers to make a significant reduction in carbon emissions using methods that also reduce costs, benefitting everyone. Finally, monitoring the effectiveness of these programs to achieve planning objectives provides ongoing guidance to planners and other utility stakeholders to improve these programs and processes over time.

THE ELECTRIC POWER RESEARCH INSTITUTE (EPRI) PREPARED THIS REPORT.

NOTE

For further information about EPRI, call the EPRI Customer Assistance Center at 800.313.3774 or e-mail askepri@epri.com.

The Electric Power Research Institute, Inc. (EPRI, www.epri.com) conducts research and development relating to the generation, delivery and use of electricity for the benefit of the public. An independent, nonprofit organization, EPRI brings together its scientists and engineers as well as experts from academia and industry to help address challenges in electricity, including reliability, efficiency, affordability, health, safety and the environment. EPRI also provides technology, policy and economic analyses to drive long-range research and development planning, and supports research in emerging technologies. EPRI members represent 90% of the electricity generated and delivered in the United States with international participation extending to nearly 40 countries. EPRI's principal offices and laboratories are located in Palo Alto, Calif.; Charlotte, N.C.; Knoxville, Tenn.; Dallas, Texas; Lenox, Mass.; and Washington, D.C.

Together . . . Shaping the Future of Energy™

Contact Information

For more information contact the EPRI Customer Assistance Center at 800.313.3774 (askepri@epri.com).

EPRI Resources

Greg Adams, *Technical Executive, Distribution Operations and Planning*
650.855.2412, gadams@epri.com

Watson Collins, *Sr Technical Executive, Electric Transportation*
650.855.7492, wcollins@epri.com

3002023019 October 2021

EPRI
3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com