Smart Electric Power Alliance

Managing Workplace Charging

Argonne National Laboratory's Reservation-Based Smart EV Charging Platform

IN PARTNERSHIP WITH

Argonne NATIONAL LABORATORY

NOVEMBER 2025

Managing Workplace Charging: Argonne National Laboratory's Reservation-Based Smart EV Charging Platform

Table of Contents

List of Figures

List of Tables

Managing Workplace Charging: Argonne National Laboratory's Reservation-Based Smart EV Charging Platform

Copyright

Authors

Brittany Blair, Manager—Research & Industry Strategy, SEPA

Garrett Fitzgerald, Senior Director—Transportation Electrification, SEPA

Janne Knieke, Analyst—Research & Industry Strategy, SEPA

Nithin Manne, Software Engineer, Argonne National Laboratory

Jason Harper, Principal Electrical Engineer, Argonne National Laboratory

About SEPA

The Smart Electric Power Alliance (SEPA), a 501(c)(3) organization with over 1,000 members, accelerates the transition to a clean, affordable, and resilient electricity system for all. SEPA engages with its diverse membership—which includes utilities, policymakers, regulators, and technology companies—through education, collaboration and convening, and the search for innovative policy, regulatory, and technology solutions. For more information, please visit www.sepapower.org.

About Argonne

Argonne National Laboratory seeks solutions to pressing national problems in science and technology by conducting leading-edge basic and applied research in virtually every scientific discipline. Argonne is managed by UChicago Argonne, LLC for the U.S. Department of Energy's Office of Science. The U.S. Department of Energy's Office of Science is the single largest supporter of basic research in the physical sciences in the United States and is working to address some of the most pressing challenges of our time.

Disclaimer

Acknowledgments

SEPA would like to thank the Argonne employees who participated in the survey and interview series as well as Carina Wallack and Lesley Jantarasami for their review.

About this Report

The Smart Electric Power Alliance (SEPA) partnered with Argonne National Laboratory (Argonne) to produce a case study on Argonne's workplace electric vehicle (EV) charging program, designed to optimize employees' ability to reserve EV chargers and allow Argonne to implement a workplace managed charging solution. Formally known as EVrez, the program offers Argonne's employees access to more than 50 Level 2 chargers and 4 DC fast chargers (DCFC). Employees must reserve and manage their EV sessions through the EVrez mobile app platform.

This report outlines the EVrez program, from inception to maturity, highlighting key learnings and best practices from the Argonne team. As other workplaces seek to offer their own workplace charging offerings, this report highlights foundational steps and considerations.

Table 1. Report Overview

Section	About this Section
Introduction	Description of the report and key recommendations for workplaces, utilities, and others looking to implement their own reservation and smart charge management program.
Section 1. Developing an In-House Program: EVrez	Explanations of how Argonne developed and deployed EVrez, including details on the mobile app and charger management systems, utilizing data and machine learning for smart charge management, and user satisfaction surveys.
Section 2. Employee Charging Behaviors & Trends	Data analysis on employee charging trends and implications for workplace charging.
Section 3. Lessons Learned & Future Opportunities	Summary of lessons learned throughout EVrez program and recommendations for future changes.
Conclusion	Summary of case study.
Appendix A: Argonne's EVrest Platform with Integrated CSMS	Technical details on Argonne's Charge Station Management System.
Appendix B: Technical Details on Opti-VGI	Technical details from Argonne's Opt-VGI smart charge management deployment under the EVrez program.

Source: SEPA (2025).

Introduction

Workplace charging provides employees with convenient and reliable access to EV charging. It also expands charging options for those without access to charging at home, making electric vehicle ownership more practical and accessible. In a national survey of EV owners, 19% indicated EV workplace charging was very important when considering a new job, while an additional 23% said it was important.[1] Among those survey participants, 98% without workplace charging access indicated they would appreciate their workplace adding that amenity.

While valuable to employees, workplace charging requires dedicated support to effectively manage chargers, ensure fair access among employees, and prevent charging sessions from contributing to the site's peak load. Effective management effectively involves integrating two key capabilities: a reservation system that helps employees schedule and monitor charging sessions, and a smart charge management (SCM) platform that dynamically adjusts charging to maintain site load limits, coordinate with onsite generation, and participate in grid programs such as demand response (DR) and virtual power plants (VPPs). For employers, workplace charging creates value by effectively using onsite generation, such as charging employee vehicles with excess onsite generation. This reduces the impacts of EV charging on the site's total demand, which lowers demand charges.

To improve its workplace charging employee offering, Argonne launched the EVrez program in October 2023. Through EVrez, Argonne allowed employees to use a mobile app-based reservation system to schedule and manage their charge sessions at more than 50 Level 2 and 4 DCFC chargers throughout Argonne's campus. Since the launch, employees have logged over 26,400 Level 2 and 5,400 DCFC sessions, dispensing nearly 570 MWh of energy and 1.8 million EV miles of charge. Employees pay a flat fee per month for charging, $7.50 per month in 2023 and $15 per month in 2025 to reflect Argonne's costs to operate the program. In Q1 of 2026, Argonne is moving to a set price per kWh consumed instead of a per-month flat fee.

Through this program, Argonne has collected extensive data on employee charging habits, including plug-in and out times, frequency of use, and availability for load management. One core data component EVrez tracks is the *requested miles* per EV charging session. This data is an important input for optimizing EV charging sessions because it directly reflects the amount of charge the employee is expecting at the end of the charge session. For smart charging optimization, the software algorithms modify the charge sessions using site power capacity limitations as well as the users' planned charging duration and total charge needed.

"EVrez has improved employee satisfaction with workplace charging, streamlined management of the chargers, and provided a platform for Argonne to manage employee charging as needed to reduce site capacity violations."

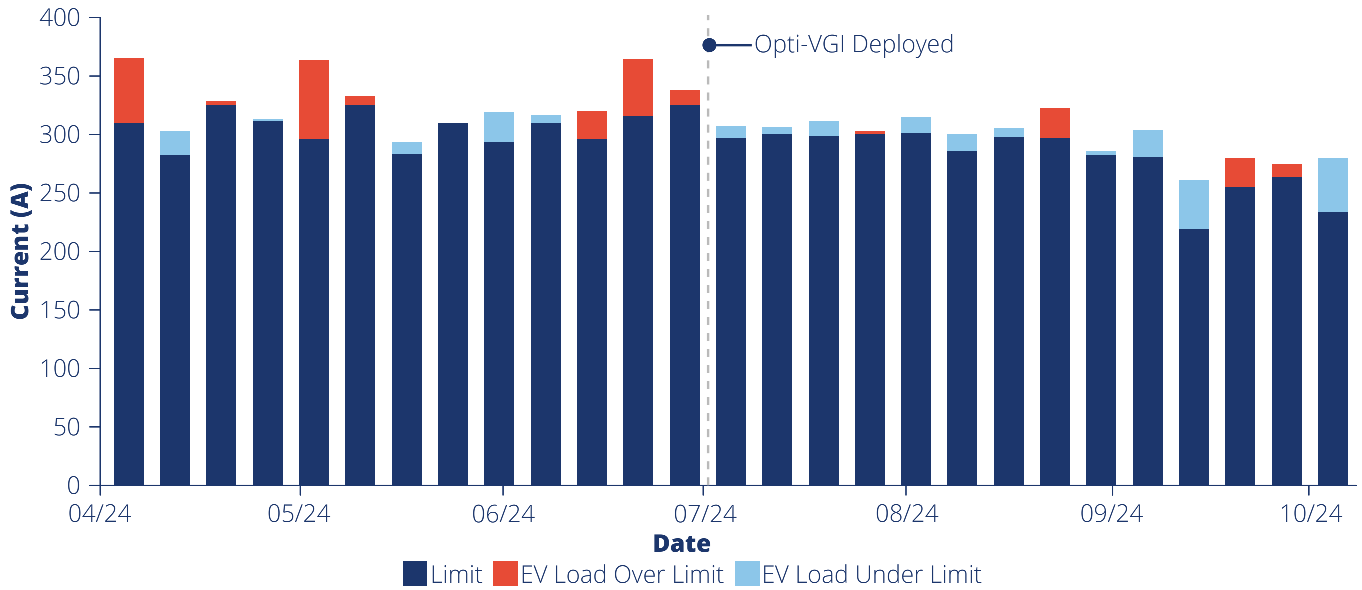
To expand the program's capabilities, in July 2024, the Argonne team deployed their smart charge management solution "Opti-VGI" at a select building, Building 300, on its campus to test its effectiveness in ensuring the charging sessions did not exceed the site's capacity limit. Opt-VGI is a custom, SCM solution developed by Argonne that optimizes EV charging based on site, power, and/or pricing constraints as well as solar forecasts to predict onsite generation.[2] Using the site as a test bed and charging behavior data from EVrez, Argonne used its "Opt-VGI" tool to reduce peak demand and minimize capacity violations. (Figure 1).

EVrez has improved employee satisfaction with workplace charging, streamlined management of the chargers, and provided a platform for Argonne to manage employee charging as needed to reduce site capacity violations. Through this program, Argonne has identified a set of recommendations for others looking to implement and/or support workplace charging solutions.

1 PlugIn America (2025). Workplace Incentives & Charging.

2 Argonne has created an open-sourced version of Opti-VGI, which is available at https://github.com/argonne-vci/Opti-VGI.

Figure 1. Managed Charging Solutions Can Effectively Reduce Site Capacity Violations



Source: Argonne National Laboratory (2025). Recreated by SEPA.

Recommendations

1. **Begin Simply:** Workplaces do not need to begin with advanced smart charging systems. The first step is to understand employees' charging behaviors and help them become familiar with using workplace chargers. As employees utilize the chargers, workplaces can collect data on employee charging habits to understand when and how employees like to charge.

   While smaller workplaces may not require a reservation system, such systems can promote fair access, ensure charger availability, and lay the foundation for more advanced capabilities such as scheduling, curtailment, and grid services participation (see "Developing an In-House Program: EVrez").

2. **Utilize a User-Friendly Interface:** Employees appreciate a simple, yet informative, app-based interface that allows employees to easily choose a charger and reserve their charging session (see "Program Design").

3. **Plan for Regular and Ad Hoc Maintenance:** Workplaces should plan for both scheduled maintenance and unexpected network outages. Chargers that go offline should be automatically removed from reservation systems and managed charging operations until they are restored. If an existing reservation involves an offline charger, the system should automatically notify the affected employee as soon as possible (see "Employee Feedback").

   Workplaces can also utilize Open Charge Point Protocol (OCPP)-based charge station management systems to communicate with chargers, providing real-time feedback and management of the chargers.[3] This allows workplaces to regulate charger use and to collect information on charger availability and maintenance needs.

4. **Design Pricing Structure:** Be intentional when establishing pricing structures for workplace charging, as they directly influence employee behavior. Flat or "all-you-can-charge" fees can unintentionally encourage employees to unnecessarily maximize charger use, raising energy costs and reducing charger availability for others. This approach can also lead to habits and expectations that are difficult to change once managed charging or more advanced control strategies are introduced. Instead, workplaces should consider pricing structures that reflect actual energy use, time-of-use rates, or session-based fees to promote efficient and fair charging behavior while supporting long-term

3 OCPP is a communication protocol designed to promote more efficient communication between chargers and third-party software systems. The use of standard communication protocols is an essential part of SCM deployments. Lawrence Berkeley National Laboratory (2024). Survey and gap prioritization of U.S. electric vehicle charge management deployments.

managed charging goals (see "Employee Charging Behaviors & Trends").

5. **Incentivize Smart Charge Management Participation:** Moving away from flat fees toward cost-reflective pricing can encourage users to charge efficiently and support system flexibility. Rates should remain simple and transparent so users can easily understand and respond to them, ensuring drivers can meet their charging needs while enabling the system to be managed effectively when necessary (see "Identifying User Availability for Smart Charge Management" and "Openness to Managed Charging").
6. **Standardize Driver Input for Charging Needs:** The industry should establish a consistent way for drivers to share their charging needs with a third-party SCM application.[4] Potential inputs include required battery state of charge (SOC), kWh, or requested miles of range. For SCM applications that interface with customer vehicles, the vehicle has the SOC and can convert that into an energy value for the program. However, for workplace charging applications that interface with the chargers and/or a user app, utilizing SOC requires both a starting and requested SOC from the user. Argonne chose to use *additional miles of range desired* as the user input because it does not require the SCM application to be aware of the EV's current SOC or range and is intuitive for drivers who are thinking of their commutes. Using known efficiency data for the user's make and model, EVrez converts mileage into equivalent energy (kWh), informing the SCM model of the user's session needs and potential for curtailment. (see "User Feedback").
7. **Understand User Charging Needs & Expectations:** Employees often overestimate charging needs for convenience or range security, requesting 200–300 miles regardless of commute distance or the amount of energy they can realistically receive during a typical charging session. Recognizing this bias is key to accurately modeling demand and designing programs that reflect real usage patterns (see "Employee Charging Behaviors & Trends").
8. **Balance Employee Charging Needs With Managed Charging Objectives:** EVrez meets a significant portion of employee charging needs; 45% of employees use Argonne chargers to meet 90% of their charging needs while 69% of employees use it for at least 70% of their charging. While employees rely on Argonne as a primary charge source, they are amenable to participating in managed charging so long as they are compensated for curtailed charge sessions. Workplaces can deploy managed charging solutions but will need to keep employee charging needs in mind. (see "Home versus Workplace Charging" and "Openness to Managed Charging").
9. **Machine Learning Improves Smart Charge Management Efficacy:** Machine learning models can analyze past charging sessions, and using the requested session duration and user's vehicle make and model, project how many miles the session should charge, rather than how much users *think* they need. By grounding predictions in actual behavior, the system can better identify when a user's charging session is flexible and ask whether they are willing to adjust their charging without compromising their expected outcome (see "Identifying User Availability for Smart Charge Management" and "User Accuracy and Flexibility on Required Mileage Entries").
10. **Fair Charger Access:** Workplaces with limited chargers and a high number of EV drivers should establish policies to ensure fair access. Consider implementing reservation quotas or priority windows to prevent a small number of users from monopolizing chargers. Clear rules and transparent scheduling help maintain fairness while ensuring all employees have reasonable opportunities to charge when needed (see "Energy Usage & Duration per Reservation").

    Workplaces can also utilize OCPP-based charge station management systems to communicate with chargers, providing real-time feedback and management of the chargers. This allows workplaces to regulate charger use and to collect information on charger availability and maintenance needs (see "Program Design").
11. **Utilize Collected Data for Future Charger Locations:** In workplaces with multiple buildings or large campuses, employee charging data can help identify charging hotspots and determine where future chargers could enhance employee usage. (see "Energy Usage & Duration per Reservation").

4 Third-party SCM applications are those like EVrez, or other Charge Station Management Systems, that interact with user vehicles and/or chargers. Often the SCM software company is different from the user devices, requiring device-to-device communication using standards such as ISO 15118 or custom APIs.

Section 1. Developing an In-House Program: EVrez

EV Charging Before EVrez

Prior to EVrez, Argonne allowed employees to access all of the campus's existing Level 2 and DCFC chargers for personal use, provided Argonne could recover all the costs for employee charging, in accordance with federal mandates for national labs. To simplify cost recovery, Argonne implemented a flat monthly fee of $7.50, which increased to $15 in 2025, for unlimited charging and required employees to reserve chargers through an online form.

This setup created several challenges for both Argonne and its employees. The reservation system did not physically control access to the chargers, meaning employees without reservations could still charge, sometimes superseding another employee's reservation. The system also lacked the ability to communicate with the chargers, creating a delay in gathering data on charger availability and maintenance issues. This data gap resulted in low satisfaction among employees, particularly those who honored the system and reserved a charger and time only to find someone else using it.

To address these challenges and lay a foundation for smart charge management, Argonne developed a charge station management system (CSMS) capable of communicating with users through a mobile app and directly to networked chargers. The following sections describe how Argonne developed the system, launched the program, and incorporated employee feedback.

Development of EVrez

Argonne's primary goals for the EVrez program were to:

- Improve user experiences by providing more efficient reservations, higher charger utilization, and more reliable charging through real-time data.
- Utilize EVrez as a resource for data collection on workplace charging behaviors and as a test bed for different research objectives.
- Create a workplace charging platform that could integrate with a smart charge management system and optimize for local building constraints.
- Reduce building peak power demand by intelligently curtailing charging while still meeting the EV driver's demands.

Program Design

The EVrez platform has two main components: 1) a backend CSMS for managing charger access and data flows for more than 50 charging ports, and 2) an app-based employee user interface for reservations.

Charge Station Management System

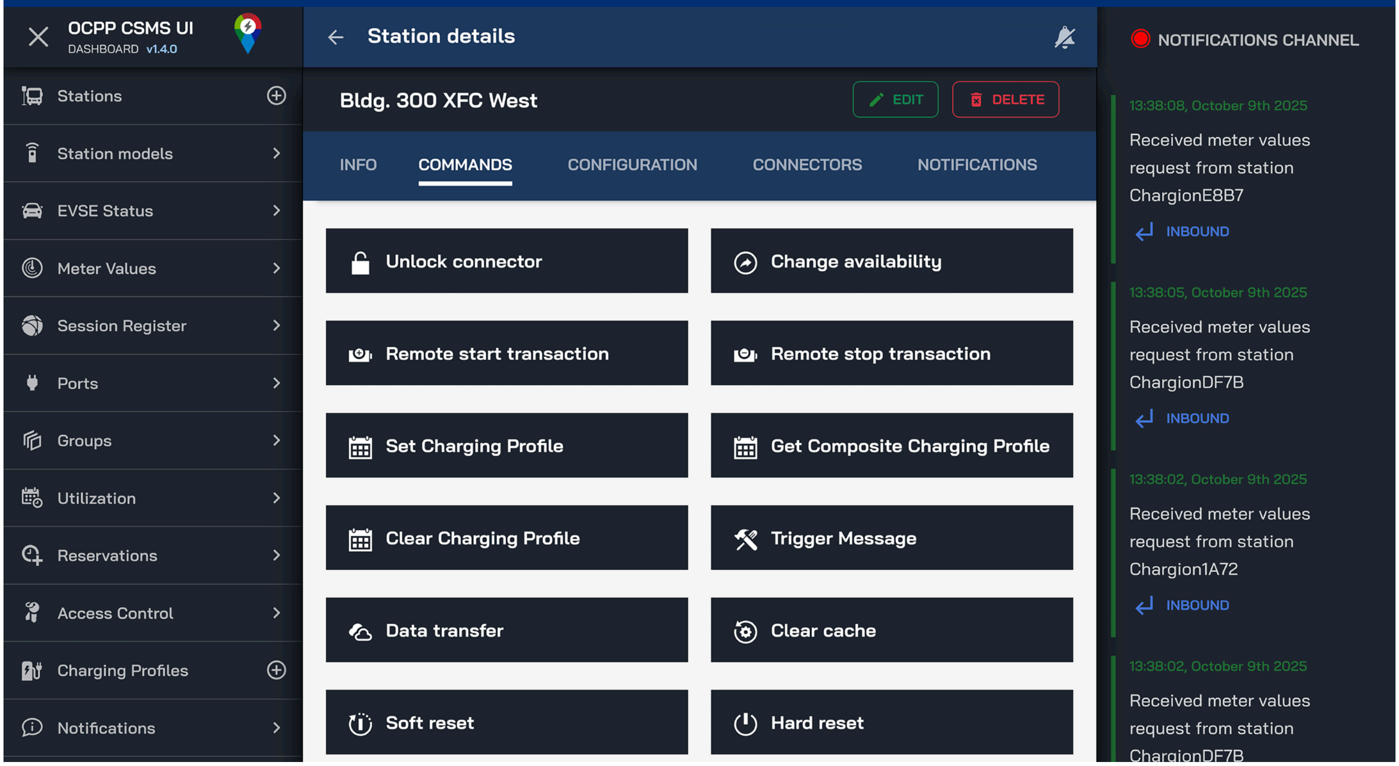
The backbone of the EVrez platform is an OCPP 1.6 J-compliant CSMS, consisting of various applications and servers that monitor, communicate, and control EV chargers (see Appendix A for more details on the system configuration).

This monitoring and control capability allows Argonne to prevent unauthorized usage of the system, collect user charging data, and integrate smart charge management capabilities. Within the platform, the CSMS serves as Argonne's control interface while the mobile app serves as the user's interface (Figure 2). As part of the CSMS interface, individual charger managers, such as different building managers across the Argonne campus, can configure the stations through a web dashboard. This dashboard is used to manually send any OCPP commands to the station, such as to reset or remotely start a transaction, and to monitor the current status and meter values of ongoing charging sessions.

EVrez Mobile App

The user interface is accessible through a mobile app for both iOS and Android devices. The app provides each user with a user profile including their vehicle make and model, history of charge sessions, a calendar for scheduling, and a map of the stations on Argonne's campus. Users can navigate through the app to select a charger on the site map, see specific charger information, reserve a time and date for the charging session, and obtain real-time

Figure 2. Charge Station Management System Owner's Dashboard (CSMS UI)



Source: Argonne National Laboratory (2025).

and historical charging data (Figure 3). Real-time charging data includes:

- Elapsed Time & Remaining Reservation Time
- Status of the Charge Session
- EV Range Added & EV Battery State of Charge for DC Charging Sessions
- Power and Energy
- Status Notifications Outlining if the EV or Charger was Limiting the Charge Rate

To reserve an EV charger, Argonne collects the following data:

- Date
- Requested Charging Station and Port
- Reservation Start Time and Duration (minimum 15 minutes, maximum 4 hours)
- Requested Miles

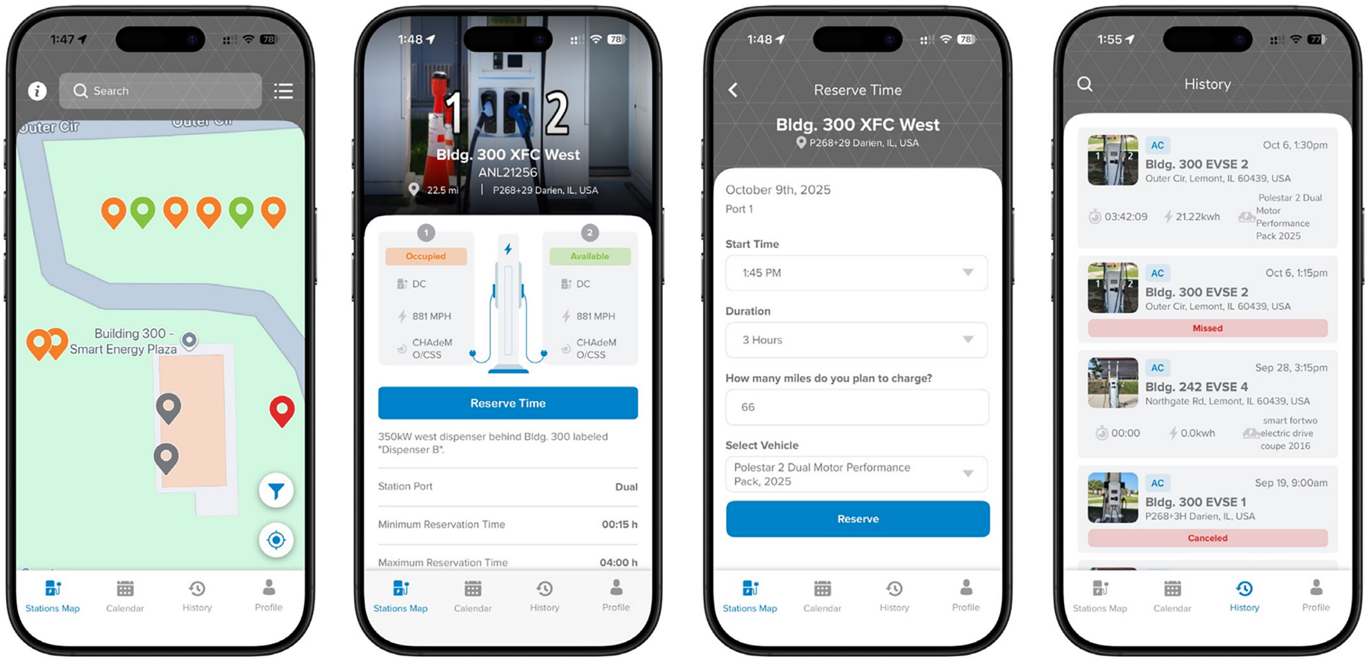
Argonne's EVrez platform uses the *requested miles* input to estimate the energy needed for a charging session and calculate how much of the vehicle's available charging power is actually required to meet that request within the reservation window. The unused portion of that capability represents the session's flexibility, the extent to which charging can be curtailed, paused, or reduced to lower site load while still meeting the driver's requested miles. Greater flexibility allows smart charge management programs to adjust charging more easily without affecting user needs. Currently, EVrez does not include incentives for drivers to request less than a full range of charge.

To evaluate which sessions are suitable for smart charge management, the platform combines requested miles, session duration, and the minimum power limits of either the charger or the EV's onboard charger to determine whether the energy goal can be achieved within the allotted time and to determine how much extra time remains. This calculation produces a flexibility score (Table 2), where:

- Scores between 0 and 1 indicate some flexibility, with values closer to 1 showing greater curtailment potential.
- Scores at or below 0 indicate no flexibility.

These flexibility scores may underestimate true user flexibility. Because EVrez currently uses a flat monthly fee, drivers have little incentive to limit charging to their actual needs for that day. They may request more miles or occupy chargers for the full reservation period.

Figure 3. EVrez Platform Employee Interface



Source: Argonne National Laboratory (2025).

Table 2. Calculating the Predicted Flexibility of Individual Charge Sessions

Score Type	Formula
Predicted Flexibility	$1 - \left(\frac{RequestedEnergy\ (\text{kWh})}{RequestedDuration\ (\text{h})} \times \frac{1}{EVmaxPower\ (\text{kW})} \right)$

Note. EVmaxPower is the minimum of either the charger power rating or the EV's onboard charger power capacity.
Source: Argonne National Laboratory (2025).

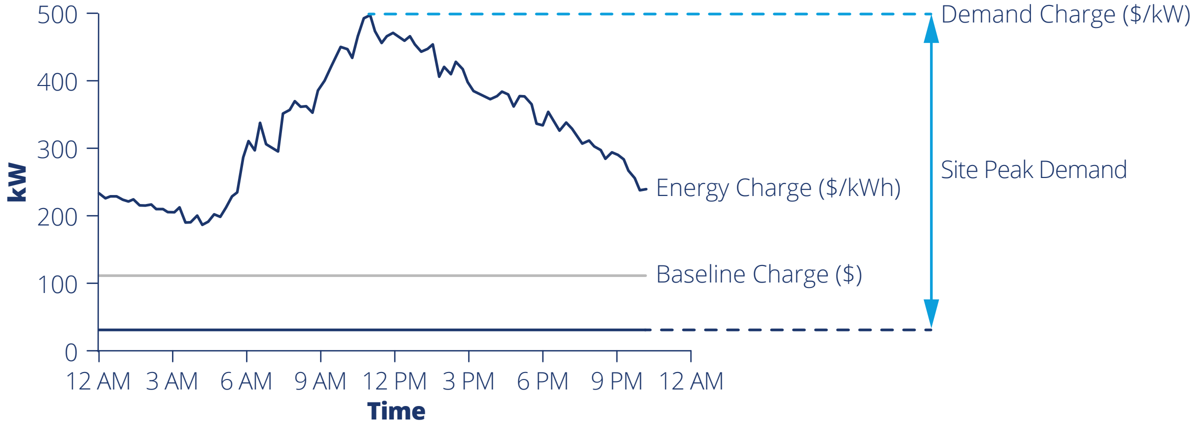
Benefits of Smart Charge Management

A primary consideration for workplace charging is the contribution of EV charging to site peak demand. Many commercial and industrial workplaces are subject to "demand charges," which are fees that reflect the customer's highest power demand each month (Figure 4).[5] EV charging requires a significant amount of power, especially when simultaneously using several chargers. At Argonne, a single Level 2 charger can contribute 7.2 or 9.6 kW to the site peak while the largest DCFC charger can contribute up to 350 kW, depending on the maximum rating of the charger and vehicle. For comparison, small businesses have a peak demand between 10 to 50 kW, and many larger businesses have peaks between 100 to 500 kW and higher.[6] In an unmanaged state, EV charging can easily contribute to the site's peak load, adding hundreds of dollars of demand charges per month.[7]

While some workplaces offset this charge by increasing the price of charging, others provide workplace charging as a discounted or free amenity for employees and do not recoup those costs. In either case, strategically managing EV charging can reduce utility bills by curtailing during peak periods and aligning EV charging more effectively with onsite generation.

5 National Renewable Energy Laboratory (2022). EV Charging & the Impacts of Electricity Demand Charges.
6 Lawrence Berkeley National Laboratory (2006). A Model of U.S. Commercial Distributed Generation Adoption.
7 National Association of State Energy Officials (2021). Demand Charges & Electric Vehicle Fast-Charging.

Figure 4. Illustrative Example of Demand and Energy Charges



Source: National Renewable Energy Laboratory (2022). EV Charging & the Impacts of Electricity Demand Charges. Recreated by SEPA.

To demonstrate the potential of active workplace charge management, Argonne selected one of its capacity-constrained facilities, Building 300, to pilot its custom, smart charge management solution "Opti-VGI." Opti-VGI optimizes EV charging based on site power limits, onsite generation forecasts, and dynamic load conditions. Opti-VGI has two primary objectives: meeting drivers' charging needs and maintaining compliance with site-level power constraints. To achieve this, the system manages multiple EV charging loads to ensure total demand stays within the site's infrastructure capacity. By integrating with EVrez, Opti-VGI accesses a diverse set of real-world charging sessions, allowing the system to be tested under realistic conditions, including variations caused by employee charging habits and dynamic power fluctuations from solar production. "Appendix B: Technical Details on Opti-VGI" describes in detail how Opti-VGI was designed and integrated with EVrez.

Optimizing Using Building Constraints

Building 300's EV charging infrastructure operates on a 200-amp feeder, which, per National Electric Code (NEC) 210.20 (A), supports a continuous load limit of 160 amps.[8,9] The EV charging infrastructure consists of twelve 30-amp Level 2 AC charging ports. Under full utilization, all twelve charging ports would need 360 amps of service, exceeding the 160-amp continuous limit.

The site is designed to power the chargers with both grid power and solar production, effectively increasing the current capacity of the EV chargers, while maintaining the bus bar limit of 400 amps (Figure 5). However, this amount fluctuates depending on solar production and does not provide a firm, predictable maximum current limit. Opti-VGI functions as an Automatic Load Management System (ALMS) under NEC 625.42,[10] dynamically controlling current across all charger ports to ensure total demand remains within the 160-amp continuous limit, taking into account solar production, and aligns with UL 3141 for Power Control Systems (PCS).[11] To better utilize the site's fluctuating capacity, a dynamic smart charge management solution helped Argonne align EV charging more closely with the site's current conditions. It curtailed and rerouted energy between chargers as necessary to align EV charging consumption with solar production while meeting site capacity constraints.

Opti-VGI is designed to actively manage employee charging in response to variable onsite solar production and peak grid events (Figure 6). Opt-VGI can modify and create charging profiles under diverse power constraints and user charging requirements using machine learning, solar forecasting inputs, and optimization algorithms. This approach eliminates the risk of site overloading while ensuring that employees' charging needs are met.

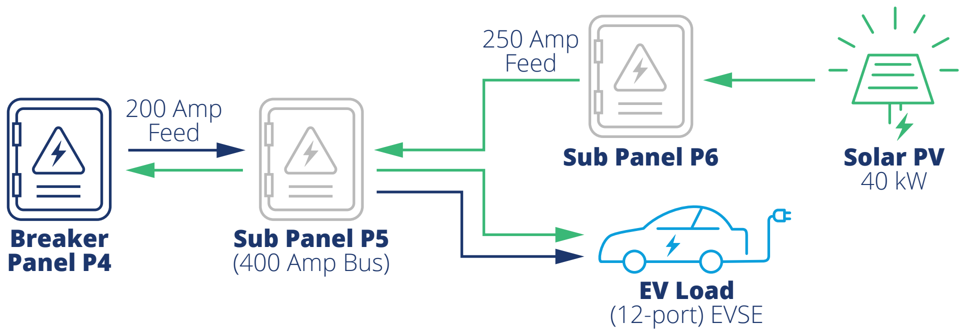
8 The NEC code is the benchmark for safe electrical design, installation, and inspection developed by the National Fire Protection Association (NFPA) and approved by the American National Standards Institute and is adopted by local Authority Having Jurisdictions (AHJs).

9 NEC 210.2 (A) defines the rating of overcurrent devices for continuous and noncontinuous loads.

10 NEC 625.42 outlines that circuits supplying electricity to electric vehicle supply equipment (EVSE), also known as a charger, need sufficient rating to supply the total load served unless the overall rating of the installation can be limited using a Power Control System or adjustable settings within an EVSE. NFPA (2025). National Electric Code. Code 2026.

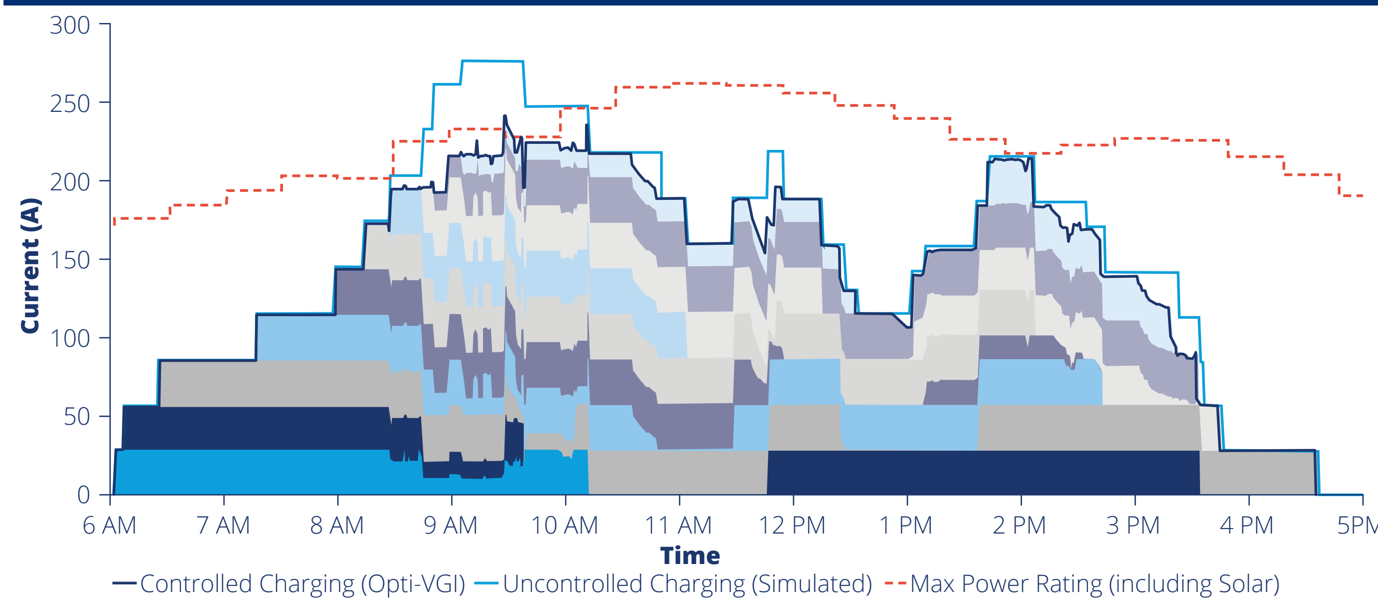
11 The system's functionality aligns with the PCS concept defined in UL 3141, an increasingly important standard for managing customer sites with capacity limitations. UL (2025). Power Control Systems: Advancing Electrification for New and Existing Infrastructure.

Figure 5. Illustration of Building 300's Electrical Design



Source: Argonne National Laboratory (2025). Recreated by SEPA.

Figure 6. Daily Peak Power Demand: Unmanaged vs. Scheduled Charging Scenarios



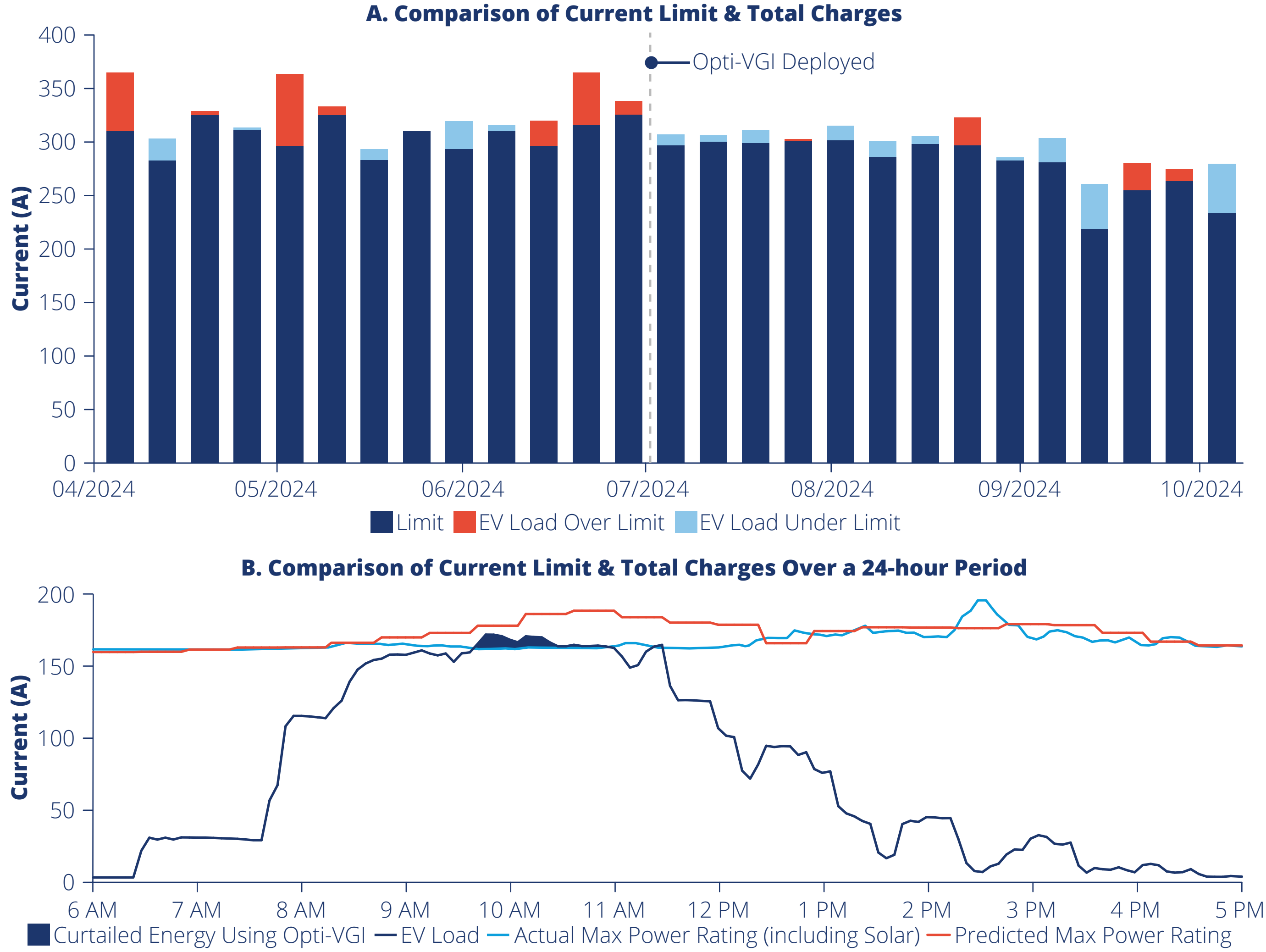
Source: Argonne National Laboratory (2025). Recreated by SEPA.

Prior to implementing Opti-VGI, Building 300 regularly exceeded panel limits due to EV charging (Figure 7A). Through EV charging curtailment and optimized scheduling, Opti-VGI reduced the number of times the EVs exceeded the capacity limit. Currently, Opti-VGI relies on solar irradiance forecasting that provides four-hour-ahead forecasts, which are then used to create a dynamic power limit curve. While forecasting has helped reduce panel exceedances, incorrect solar forecasting data can still result in overloads (Figure 7B). Reliable, real-time monitoring and control remain essential to ensure system stability under dynamic conditions. Algorithmic optimization can be effective, but should be supported by real-time monitoring.

A notable example of Opti-VGI preventing panel overcapacity occurred on an unusually cloudy day when solar output dropped on 7/16/25, decreasing the maximum site limit from 260 to 210 amps. Without Opti-VGI managing the EV charging sessions, the breaker panel could have tripped because the system load exceeded the limit by more than 50 amps (light blue line, Figure 8). With Opti-VGI, the charging sessions were curtailed (dark blue) and kept below the new real-time site limit of 210 amps. SCM, when paired with on-site generation, enables more effective management of site loads, maintaining capacity limits while maximizing EV charging available to employees.

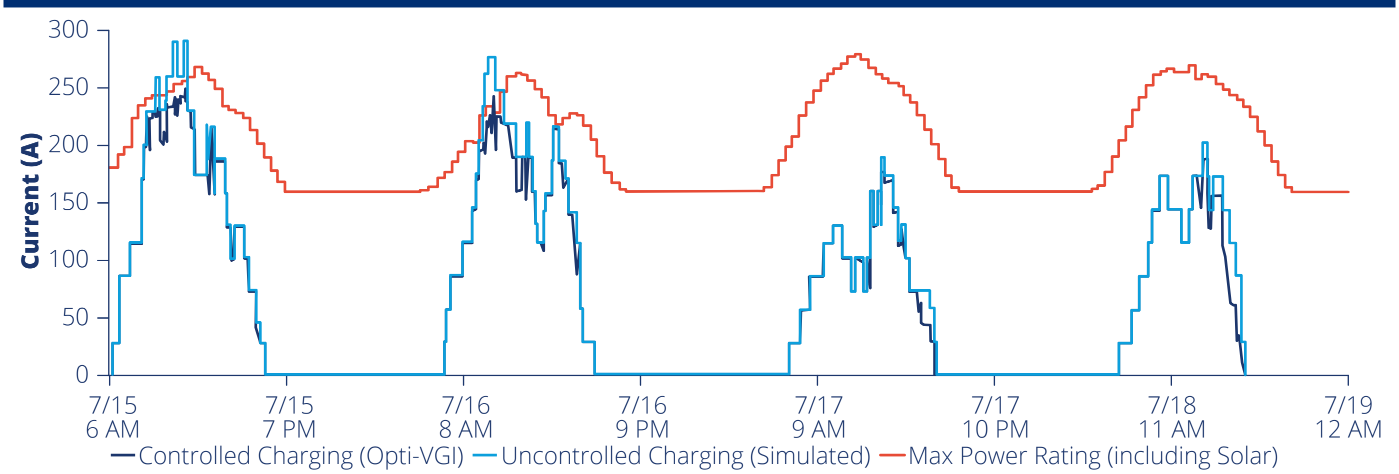
Managing Workplace Charging: Argonne National Laboratory's Reservation-Based Smart EV Charging Platform

Figure 7A and 7B. Contribution of EV Charging to Load Limit Prior and Post Opti-VGI Deployment



Source: Argonne National Laboratory (2025). Recreated by SEPA.

Figure 8. Benefits of Smart Charge Management with Onsite Generation



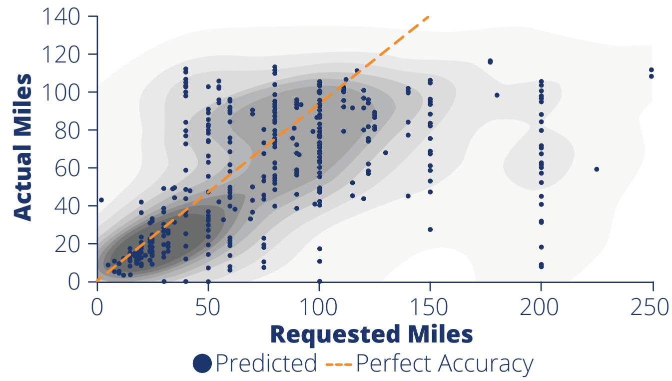
Source: Argonne National Laboratory (2025). Recreated by SEPA.

Identifying User Availability for Smart Charge Management

While some EV owners may already be familiar with smart charge management through a utility program, managed workplace charging has different grid and user considerations. At home, EVs are parked for up to 15 hours and typically only need two to three hours to charge when using a Level 2 charger.[12] This longer dwell time gives utility-managed residential programs greater flexibility to optimize charging schedules. In contrast, workplace charging offers shorter dwell times, and when reservation-based systems are used, the available charging windows become even more limited. To provide a positive managed charging experience to employees, workplace managed charging solutions require data on the employees' requested energy amount and dwell durations for each charging session.

The "requested miles" data points allow Argonne to track the anticipated charging requests of employees and assign a predicted flexibility score. Scores above 0 represent flexibility, while scores at or below zero indicate no flexibility.[13] Opti-VGI uses the predicted flexibility to rank which charge sessions to curtail first and which sessions to reallocate power to after curtailment ends. To evaluate the efficacy of using "requested miles" and the "predicted flexibility scores" for Opti-VGI, Argonne also assigned charge sessions with a "session performance score" (Table 3). The session performance score is similar to the predicted flexibility score, but uses the charge session's dispensed energy instead of the requested energy. The session performance measures how much energy was dispensed compared to the maximum expected based on the session duration and charger output. Charge sessions that meet user inputs should have the same performance and flexibility scores. A higher session performance score indicates that the user did not require as much energy as requested and could have accommodated curtailments without impacting the driver's needs.

Figure 9. Level 2 Charging—Requested vs. Actual Mileage per Session Accuracy Prior to Machine Learning Integration



Source: Argonne National Laboratory (2025). Recreated by SEPA.

Argonne's analysis of session performance scores and dispensed energy revealed that the majority of drivers were requesting more miles than they ended up charging (Figure 9). While the requested miles are an important data point for each charge session, it may not reflect actual charging behavior on a 1:1 basis. As discussed previously, users' tendency to request a higher number of miles than they ultimately charge may be due to the flat-rate nature of the subscription model or other behavioral factors. Employees are likely to request more electricity than they need because they pay less per kWh under a flat-rate subscription model, and there is a positive financial incentive for them to maximize their charging at work.

Table 3. Calculating Predicted Flexibility and Session Performance Scores

Score Type	Formula
Predicted Flexibility	$1 - \left(\frac{\textit{RequestedEnergy}\ (\text{kWh})}{\textit{RequestedDuration}\ (\text{h})} \times \frac{1}{\textit{EVmaxPower}\ (\text{kW})} \right)$
Session Performance	$1 - \left(\frac{\textit{DispensedEnergy}\ (\text{kWh})}{\textit{RequestedDuration}\ (\text{h})} \times \frac{1}{\textit{EVmaxPower}\ (\text{kW})} \right)$

Note. EVmaxPower is the minimum of either the charger power rating or the EV's onboard charger power capacity.
Source: Argonne National Laboratory (2025).

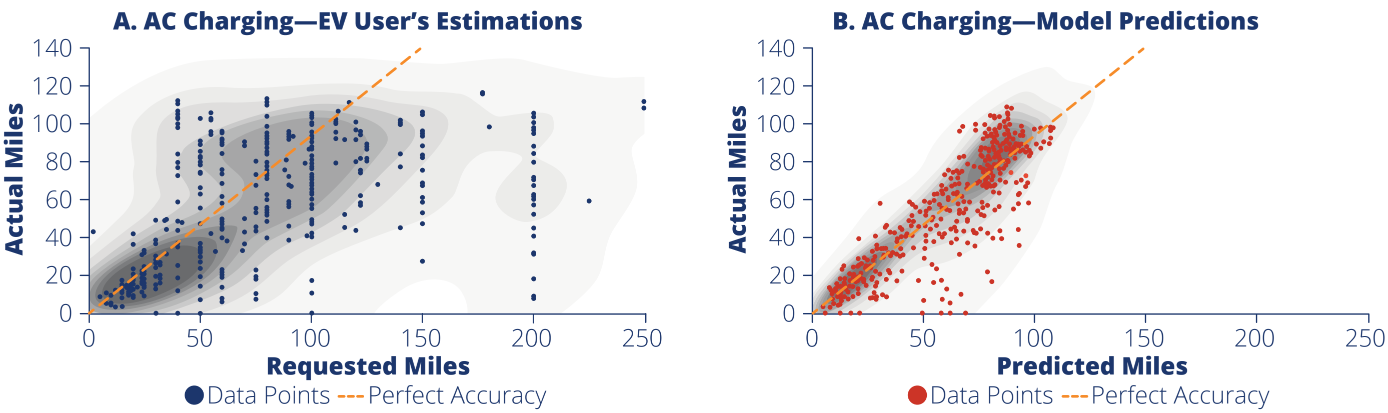
12 Smart Electric Power Alliance (2025). Demonstration of Utility Smart Charge Management for Multiple Benefit Streams.

13 Scores below zero occur when users request more miles (i.e., energy) than is possible during the charge session. Argonne limits requests that are not achievable based on the dwell time and/or the vehicle's battery. i.e. an employee cannot request more energy than could charge the vehicle to 100% SOC.

While employees often request more miles than they actually are able to charge during the reservation window, they do not state their *firm* minimum number of required miles. This lack of precision makes predicting exactly how many more sessions could be available for SCM difficult. To improve user accuracy, Argonne refined the EVrez system using machine learning to pre-populate the requested miles field using data trained on users' sessions, vehicle types, and charging behaviors such as reservation timing and duration. Users can either keep the pre-populated value or change it based on their needs for that specific session. Prior to using pre-populated suggestions, user-estimated requests for AC charging sessions had a root mean squared error (RMSE) of 51.23.[14] The addition of the machine learning suggestions improved the predicted miles of charge by 53% (Figures 10A and 10B). For DC charge sessions, predicted miles of charge were improved by 12% (Figures 11A and 11B).

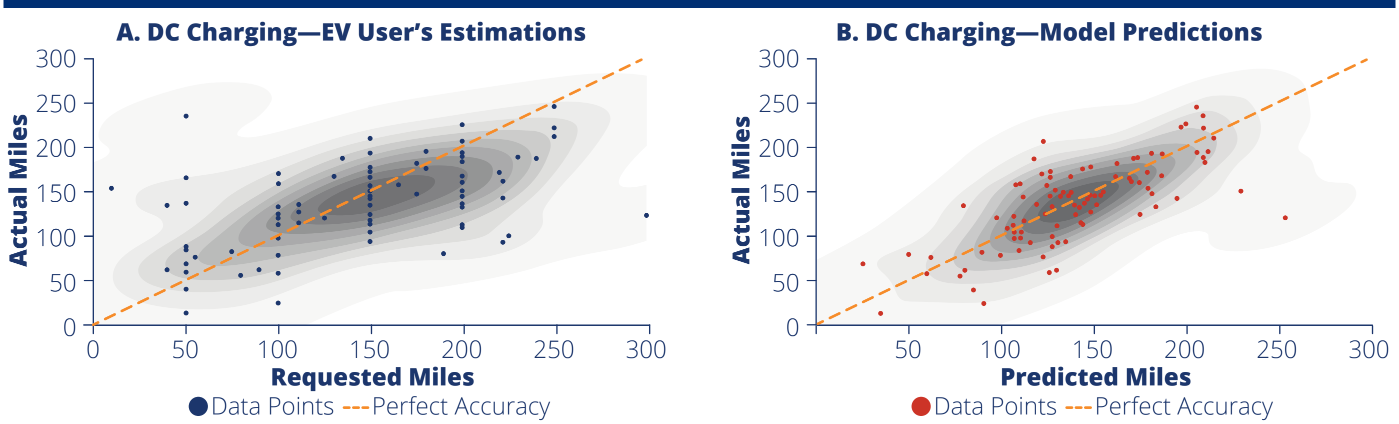
Improving the accuracy of user-entered requested miles helped improve the accuracy of Opti-VGI because it better aligned predicted flexibility scores with an achievable amount of charge, creating a more realistic and historically accurate dataset of mileage requests. Using machine learning prediction, the accuracy of charge sessions increased to 75%, up from 66% without the machine learning predictions. This improvement is especially significant at higher ranges, where drivers often overestimate their charging needs. See "User Accuracy and Flexibility on Required Mileage" for more information on machine learning changing user behaviors.

Figures 10A and 10B. Comparison of User Estimations for Requested Mileage (A) and Machine Learning Predictions (B) for AC Charging



Source: Argonne National Laboratory (2025). Recreated by SEPA.

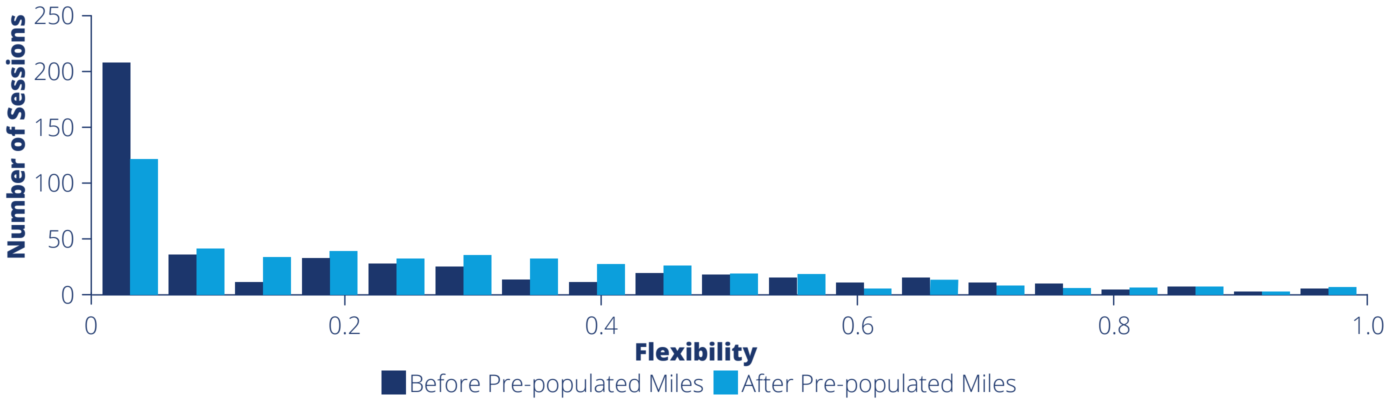
Figure 11A and 11B. Comparison of User Estimations for Requested Mileage (A) and Machine Learning Predictions (B) for DC Charging



Source: Argonne National Laboratory (2025). Recreated by SEPA.

14 RMSE is a standard way of measuring how much individual estimates differ from the actual values—lower values mean the predictions are closer to reality.

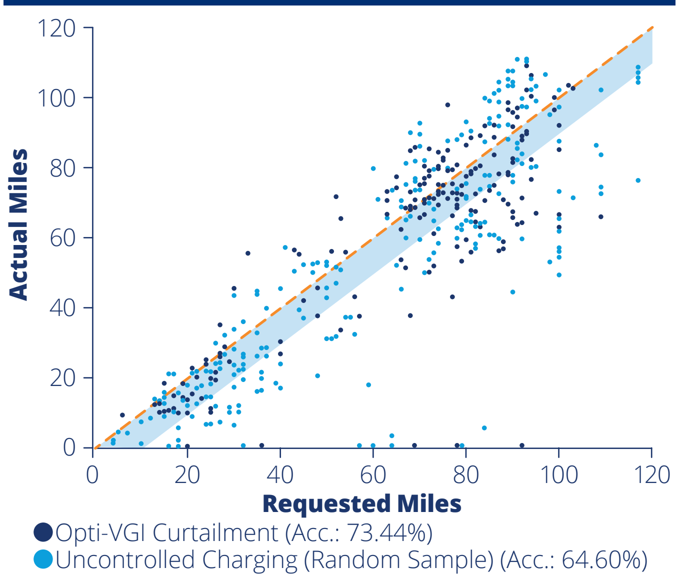
Figure 12. Comparison of Historical Flexibility versus Post-Machine Learning Integration



Note: Reflective of 500 sessions pre-population and 500 sessions post-population.
Source: Argonne National Laboratory (2025). Recreated by SEPA.

This improvement in data accuracy increased the average predicted flexibility scores, allowing Opti-VGI to allocate resources more effectively while meeting driver expectations. Prior to machine learning, the average flexibility score was 0.187; post machine learning, it was 0.234, representing a 25% increase (Figure 12). The addition of pre-populated miles also reduced sessions with zero flexibility from 200 out of 500 sessions to 125 sessions.

Figure 13. Comparison of Opti-VGI Curtailed Charging and Uncontrolled Charging



Source: Argonne National Laboratory (2025). Recreated by SEPA.

While machine learning and Opti-VGI improve sessions and assist with aligning requested miles with actual dispensed miles, not all sessions will meet the user's requested mileage target (Figure 13).

A significant portion of reservations that fail to meet their requested mileage targets are due to factors outside the program's control:

- 45% of missed mileage targets are due to EVs keeping a safety margin and charging slower than expected.[15]
- 21% occur when drivers depart before their declared end time, and sessions are cut short.
- 11% are due to charging interruptions, such as a battery reaching full charge, people requesting more miles than are available, or an error with the vehicle and/or charger that pauses charging.
- 8% are due to drivers requesting the maximum amount of energy during their session, leaving no room for needed curtailment. While Opti-VGI is designed to prioritize charging sessions with more flexibility, sometimes sessions still need to be curtailed to meet site limits.
- 8% are due to unusually low solar production on busy charging days, which causes users to miss mileage targets because Opti-VGI is required to curtail most sessions.

15 Rex, Green & Harper, Jason (2025). Plug-in Electric Vehicle Charging Response Characterization for Grid Integration.

Section 2. Employee Charging Behaviors & Trends

Since the program's launch in October 2023, Argonne employees have completed over 26,400 Level 2 and 5,400 DCFC sessions, totalling over 1.8 million charged miles. Data from these sessions allows Argonne to monitor employee charging behavior, including plug-in and plug-out times, usage frequency, availability for load management, and overall program satisfaction.

"Having the ability to charge at work has made it possible for me to have an EV at all."
—Argonne Employee

Employee Charging Habits

The program currently has over 340 registered users, and among those users, more than 300 have completed at least one reservation. Among users, there is a wide diversity in the vehicle makes and models, including a variety of plug-in hybrid vehicles (PHEVs) with smaller battery packs to fully battery electric vehicles (BEVs), ranging from small sedans to trucks (Table 4). As survey responses indicated, the size and type of vehicle (e.g., PHEV vs BEVs) influences how often employees charge and how much energy they require.

User Session by Day of Week and Time of Day

During the initial launch phase, 35 of the 65 registered users completed at least one charging reservation. Initial session data indicated a clear preference for charging on Mondays and Fridays, with significantly lower activity observed on Wednesdays (Figure 14A). As of 2025, charging use is roughly even among users with a slight preference for Thursday (Figure 14B). The preference

Table 4. Diversity of Vehicle Adoption Among Argonne Employees

Vehicle Type	No. of Employees	Vehicle Type	No. of Employees	Vehicle Type	No. of Employees	Vehicle Type	No. of Employees
Acura	3	Fisker	2	Lincoln	2	Porsche	3
Audi	14	Ford	40	Lucid	2	Rivian	2
BMW	12	Genesis	2	MINI	1	Subaru	3
Cadillac	1	Honda	5	Mazda	3	Tesla	145
Chevrolet	125	Hyundai	31	Mercedes-Benz	4	Toyota	9
Chrysler	5	Jeep	7	Mitsubishi	1	Volkswagen	7
Dodge	1	Kia	16	Nissan	6	Volvo	13
Fiat	3	Lexus	2	Polestar	5	smart	1

Source: Argonne National Laboratory (2025).

for time of day and charge duration has also normalized over more hours of the day (Figure 15A and 15B).

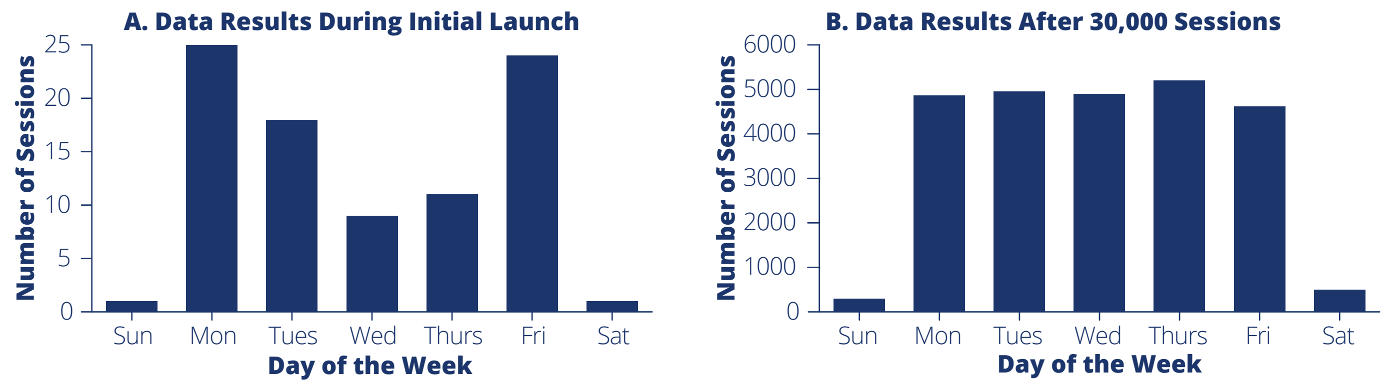
During the initial launch, all users charged between 6 a.m. and 5 p.m.; now there are outlier users who charge between 4 and 6 a.m. and 5 p.m. and 10 p.m. Sessions that begin later in the day tend to be shorter in duration, likely reflecting users' preference to charge closer to their departure time rather than during early morning hours when vehicles remain plugged in throughout the workday. As users have grown accustomed to the system, they tend to start their sessions between 8 and 9 a.m. (likely when they come to work) or after lunch between 12 and 1p.m. (likely after their lunch break) (Figure 16). Those four hours of the day account for nearly a third of all the sessions since program inception.

> **"I don't have home charging because it was so easy to do it here. So I didn't really see the need to go through the process of installing a charger at home. But that could change depending on where the program goes; I'll see about getting one or not."**
> **—Argonne Employee**

User Session Duration and Frequency

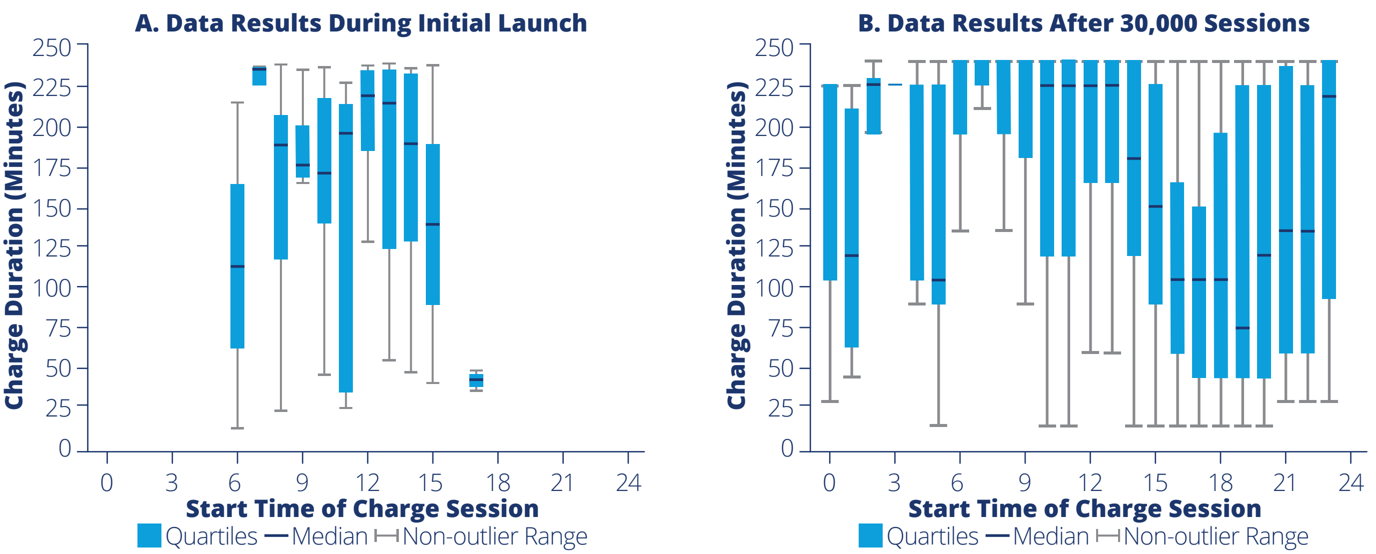
Most Argonne employees charge two to four times per week, averaging around three sessions (Figure 17A). This trend is consistent over the course of the program (Figure 17B), with most users falling within mid-range

Figure 14A and 14B. User Preferences for Charging During the Week



Source: Argonne National Laboratory (2025). Recreated by SEPA.

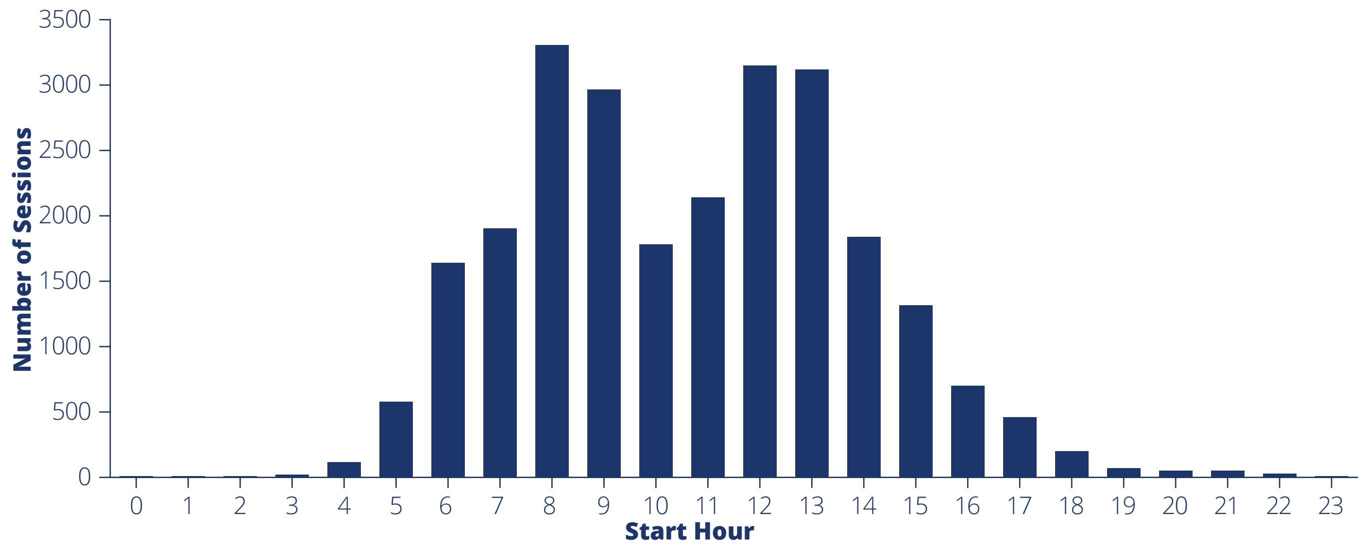
Figure 15A and 15B. Influence of Time of Day on Charge Duration



Source: Argonne National Laboratory (2025). Recreated by SEPA.

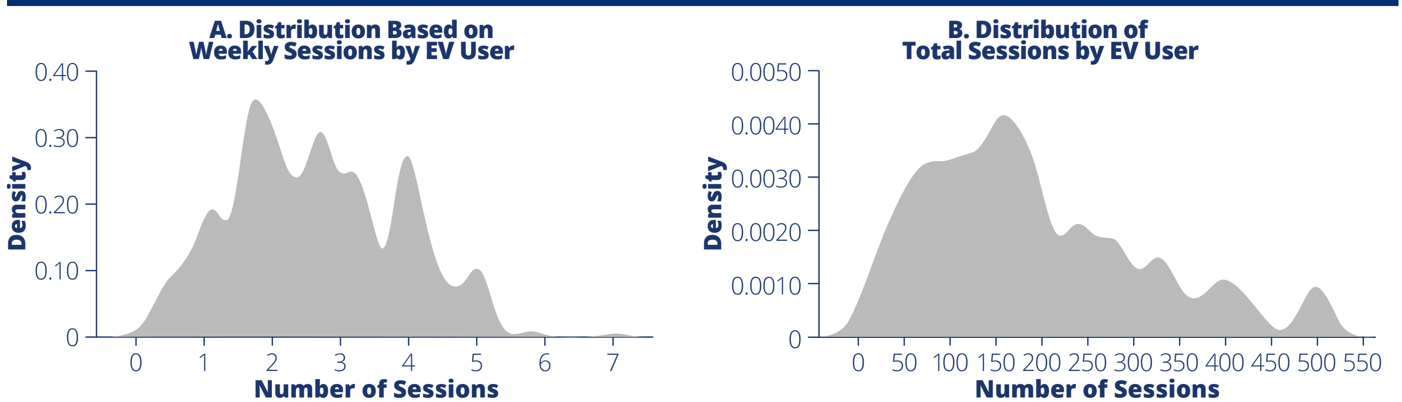
"If I can't find a charging spot within a one-mile radius, then I'm just gonna burn gas."
—Argonne Employee with a Hybrid Vehicle

Figure 16. Distribution of Charge Sessions by Start Hour



Source: Argonne National Laboratory (2025). Recreated by SEPA.

Figure 17A and 17B. Distribution of EV Sessions by EV User—Weekly and Total Averages



Source: Argonne National Laboratory (2025). Recreated by SEPA.

charging frequency. Vehicle type also influences charging frequency. Those with plug-in hybrids charge for shorter periods but more frequently due to having smaller batteries. Drivers with older EVs need charging more frequently, while vehicles with very large batteries may only need to charge once a week. Wintertime also increases the frequency and duration of charging. During interviews, Argonne employees indicated that they charge one extra day per week and for longer periods due to higher utilization of EV batteries during the winter.

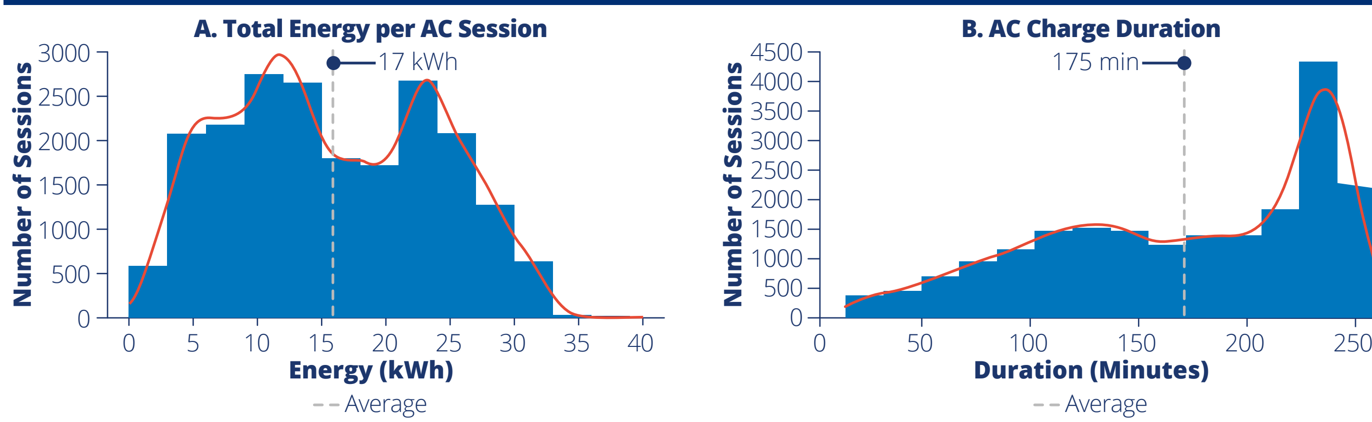
The four-hour duration on Level 2 in the winter sometimes would not be enough. So occasionally, I'd have to do DC charging."
—Argonne Employee

Energy Usage & Duration per Reservation

Energy usage and session duration vary between Level 2 AC chargers and DCFC due to power capacity of the chargers. The majority of Argonne's Level 2 chargers are rated at 7.2 or 9.6 kW, while the DCFCs are rated at 50 kW, 200 kW, or 350 kW. For Level 2, the average energy per session is nearly 17 kWh per session with an average of 175 minutes in charge duration (Figure 18). Customers using AC charging are more likely to have longer session durations due to the lower power draw. AC energy consumption is also impacted by vehicle type. Plug-in hybrids have smaller batteries, often with ranges around 30 miles, and therefore need less energy per session. Battery electric vehicles have much larger batteries and typically consume more energy and need the full four-hour reservation duration. In contrast, DCFC sessions follow more of a bell curve distribution for average energy consumption and skew shorter for average session length. The average DCFC session is 46 minutes long and uses 30 kWh of energy (Figure 19).

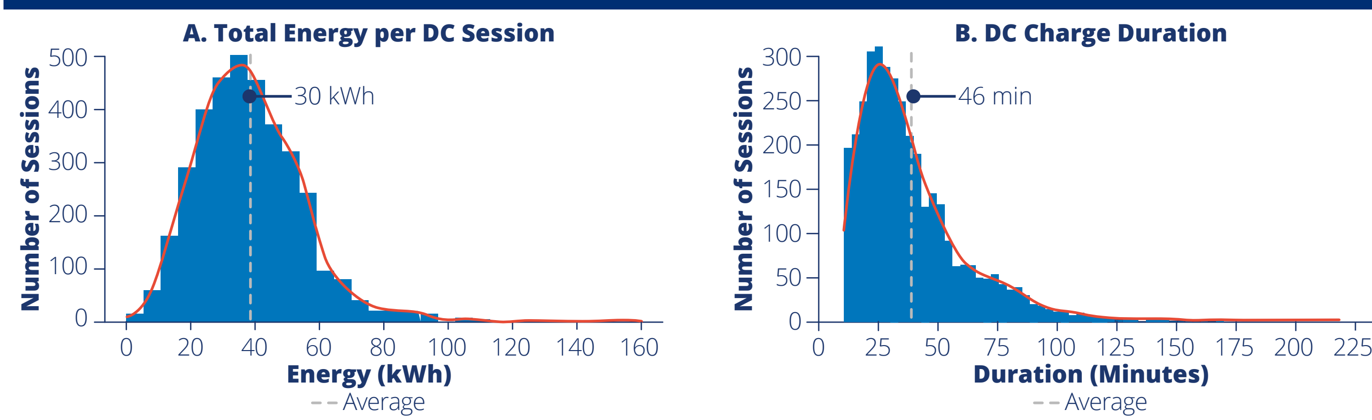
Users also start their charging session with a variety of starting battery SOCs, although the majority fall between 20 and 60% (Figure 20). Ending SOCs are less variable, with the majority of sessions ending between 80% and 100% SOC. These charging behaviors follow a bell-curve, with the average battery charge between 40 and 60% SOC (Figure 21). There are a non-trivial number of sessions that start above 75% SOC charging, indicating that some users engage in opportunistic charging, which could have flexibility to be managed. During interviews with Argonne employees, some stated that they mostly charge up to 80% SOC to maintain their battery health and sometimes charge up to 100% per their manufacturer's recommendations.

Figure 18A and 18B. Average Level 2 Charge Duration & Energy per Session



Source: Argonne National Laboratory (2025). Recreated by SEPA.

Figure 19A and 19B. Average DCFC Charge Duration & Energy per Session

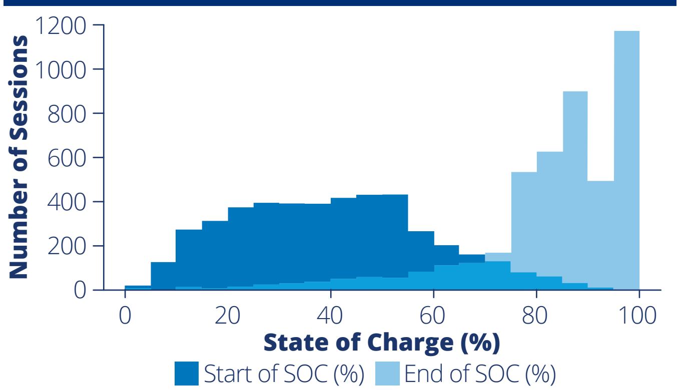


Source: Argonne National Laboratory (2025). Recreated by SEPA.

Expectedly, the starting SOC influences how much energy is added during a session. For example, vehicles that begin charging below 20% SOC typically add about 60%, while those starting above 50% add closer to 20%, aligning with user habits to charge to 80 to 100% SOC (Figure 22). However, starting SOC has little effect on total charging duration. Regardless of whether vehicles begin below 20% or above 50% SOC, most sessions last around one hour, with some extending to two or three hours (Figure 23). During interviews, several employees noted that they reserved the full four-hour charging window to avoid moving their vehicles, even if less time was needed. Overall, while starting SOC helps predict the amount of energy required, it is a weaker indicator of session length.

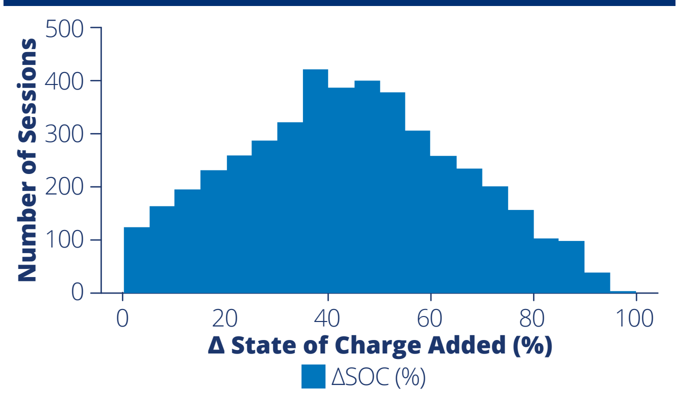
Charging behavior also varies by charger location, driven by the concentration of EV-driving employees near specific buildings. Certain chargers are in use nearly 70% of the time during working hours (i.e., 9 am to 5 pm), while others see utilization less than 10% of the time. During interviews,

Figure 20. Distribution of Start versus End State of Charge



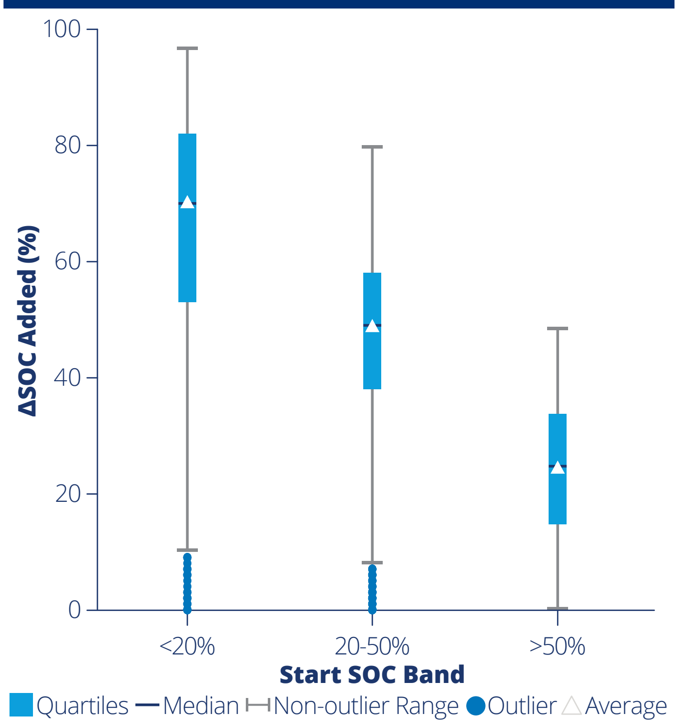
Source: Argonne National Laboratory (2025). Recreated by SEPA.

Figure 21. Distribution of Delta State of Charge Gained per Session



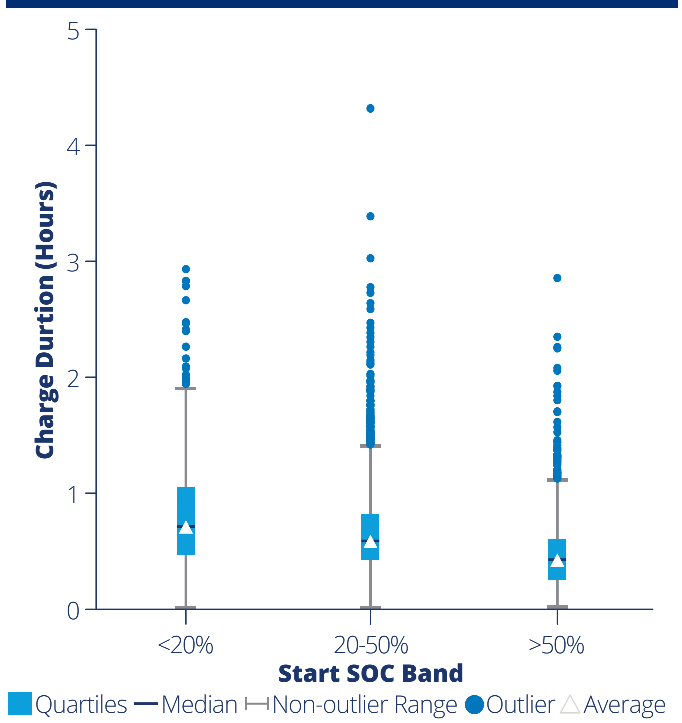
Source: Argonne National Laboratory (2025). Recreated by SEPA.

Figure 22. Delta State of Charge Gained per Session by Starting State of Charge



Source: Argonne National Laboratory (2025). Recreated by SEPA.

Figure 23. Session Duration by Starting State of Charge



Source: Argonne National Laboratory (2025). Recreated by SEPA.

employees noted that those working near heavily used chargers were less likely to charge or had to reserve sessions well in advance. Some users indicated that while Argonne had enough chargers across the campus, sometimes only four would serve 600-plus employees, creating very high demand.

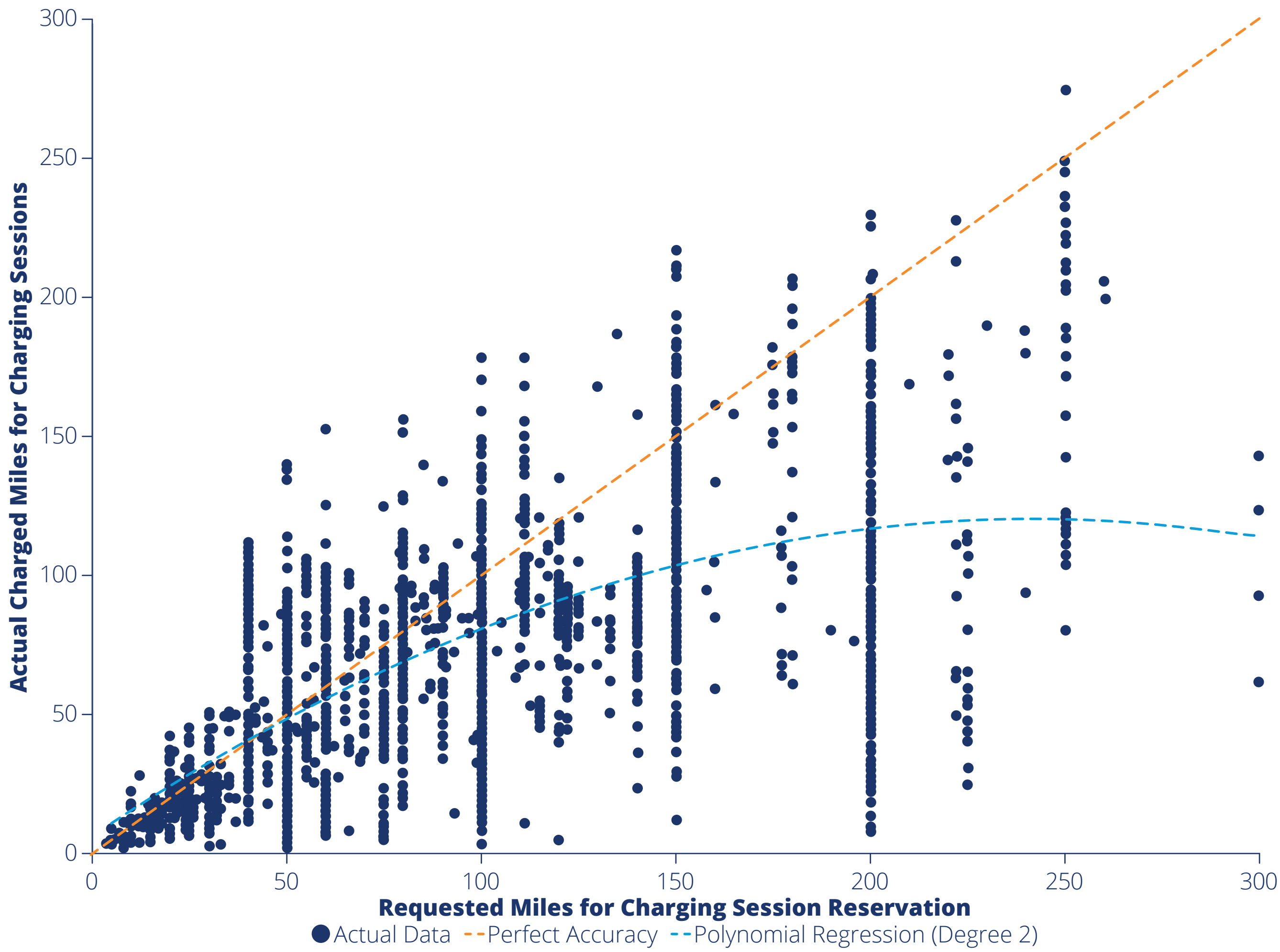
Employee interviews also revealed differences in charging needs based on vehicle type. Those with hybrid vehicles needed to charge every day for two to three hours, while those with full battery electric vehicles tended to charge every other day for the full 4-hour duration.

Additionally, some vehicles do not draw power at the charger's full rated capacity, effectively derating the charging session. For instance, a Level 2 charger rated at 9.6 kW may deliver only 7 kW if the vehicle limits power intake. This behavior is often due to built-in safety mechanisms that maintain a buffer below the vehicle's maximum power threshold. At Building 300, where Opti-VGI was deployed, lower capacity utilization was also observed, reflecting software-imposed limits on charging sessions.

User Accuracy and Flexibility on Required Mileage Entries

When comparing users' "requested miles" with the actual miles dispensed, users were generally more accurate when requesting lower amounts (Figure 24). Accuracy decreased at higher requested values, likely because some users intentionally overestimated their needs—either to secure the maximum possible charge or to ensure their

Figure 24. Accuracy of Users Determining Miles of Charge Prior to ML Integration



Source: Argonne National Laboratory (2025). Recreated by SEPA.

reservation was the full four-hour session. Users also tended to select round numbers such as 150, 175, 200, or 225 miles, contributing to further inaccuracy. During interviews, most Argonne employees reported that they did not understand why the app required a mileage input. Many viewed their charging sessions in terms of time (for example, three or four hours) or battery percentage (for example, charging to 80%) rather than in miles.

Suggesting "requested miles" for users improved the overall accuracy of charging sessions. Even when users manually entered their own values, exposure to the auto-suggested estimate improved accuracy (Figure 25C). For users unfamiliar with vehicle mileage, the machine learning–based suggestion was especially helpful, as it ensured they received their typical charge without needing to estimate miles. Utilizing machine learning to auto-suggest "requested miles" reduced the number of overly large requests and aligned user inputs more closely with how much charging was possible given the session duration and vehicle constraints (Figure 25). Using machine learning prediction, charge session accuracy increased to 75%, up from 66% without machine learning predictions.

Employee Feedback

Argonne has collected participant feedback throughout the program to inform program design and employee satisfaction.

Initial Launch

During the first few weeks of the program, Argonne noted some basic user errors with using both the app and the chargers, including:

- Some employees plugged in their vehicles but forgot to press "Start Charging" in the app before leaving.
- Some employees plugged into a different port than they had reserved, especially on the dual-port chargers.
- Some vehicles that were plugged in before the reservation window occasionally entered a low-power or sleep state, preventing charging session from initiating when the reservation began.

Other challenges Argonne addressed to improve the program included:

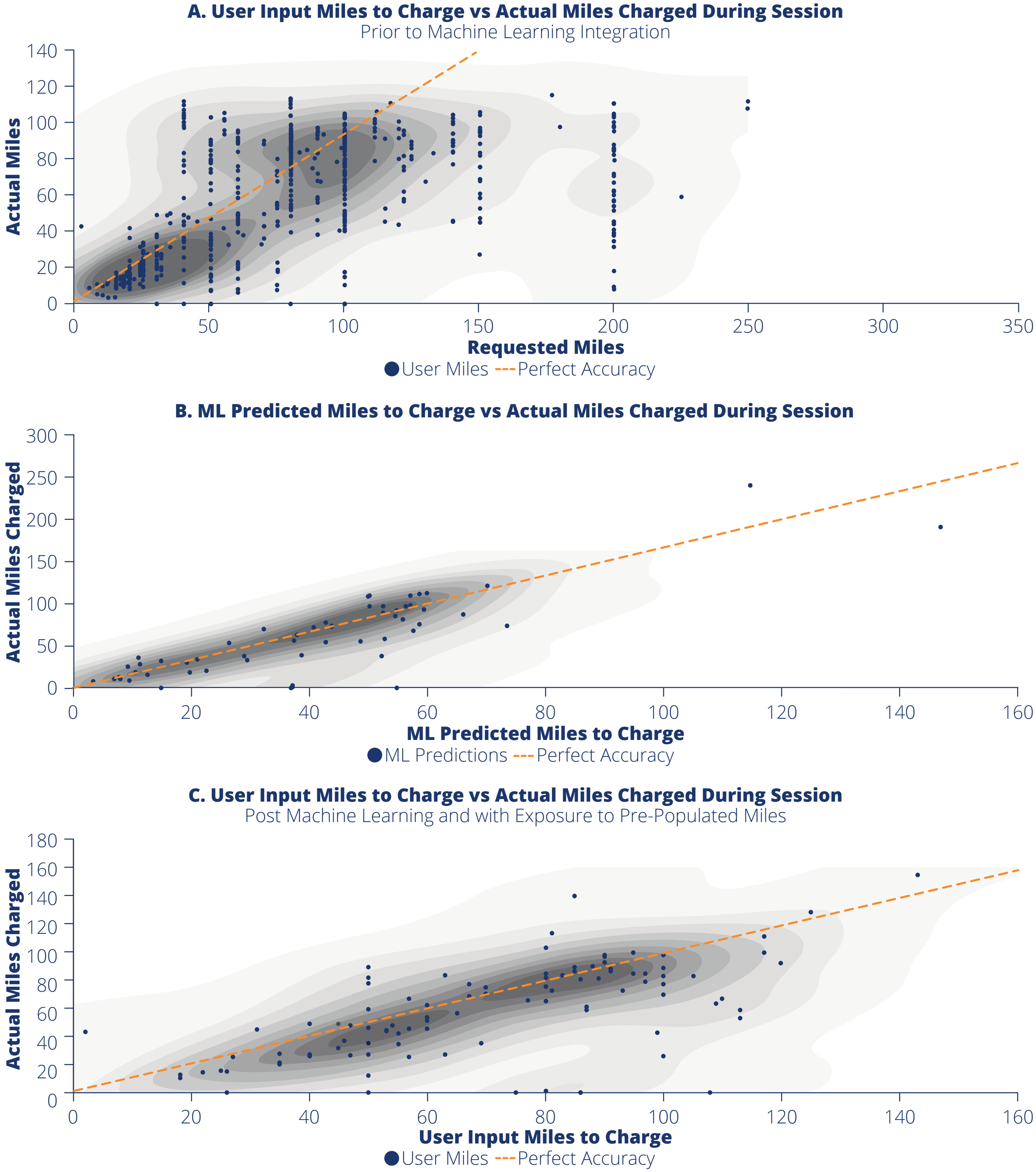
- **Enhanced error tracking and reporting:** The system was updated to more accurately capture and categorize user-reported issues, improving visibility into operational errors and supporting faster resolution.
- **Removed inoperable chargers from the reservation system:** Chargers identified as out of service were removed from the reservation calendar to prevent scheduling conflicts and user frustration experienced during the initial launch.
- **Incorporated user feedback into app functionality:** User input directly informed several software updates, including the ability to begin a session early when a charger is available and the resolution of bugs identified through user testing.
- **Restricted unrealistic "requested miles" entries:** The app now limits the "requested miles" input to reflect the maximum charging potential based on the vehicle type, charger rating, and reservation duration, improving data accuracy.
- **Expanded reservation access for Argonne fleet users:** Fleet drivers were granted longer reservation windows to better align with operational and logistical requirements.
- **Enabled limited early session starts:** When the charger is unoccupied, users can now initiate charging up to 15 minutes before their scheduled reservation time, improving flexibility and charger utilization.

Post-Launch Survey

After running the EVrez program for a few months, Argonne conducted an employee survey. The EVrez team asked respondents how they rated the overall user-friendliness of the app, when they planned to make reservations, their overall satisfaction, opinions on the app functions, and the implementation of a conduct score. Of the 160+ users, 30 responded to the survey. Of those respondents, the majority found the app to be user-friendly and were overall satisfied with the program (Figures 26A and 26B).

> **"I just did it by time. I don't understand asking for miles versus asking for time. It was more that I needed a percentage, like I needed 50% of my battery. I don't know what that equates to as far as miles." —Argonne Employee**

Figure 25A, 25B, and 25C. Session Accuracy Prior to Machine Learning Integration, with Machine Learning Pre-Population, and Post-Machine Learning Integration with Exposure to Pre-Population

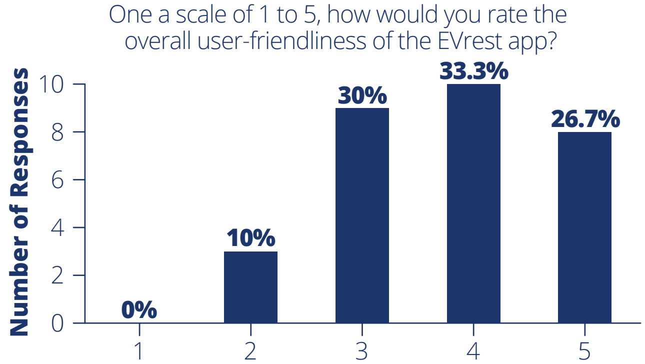


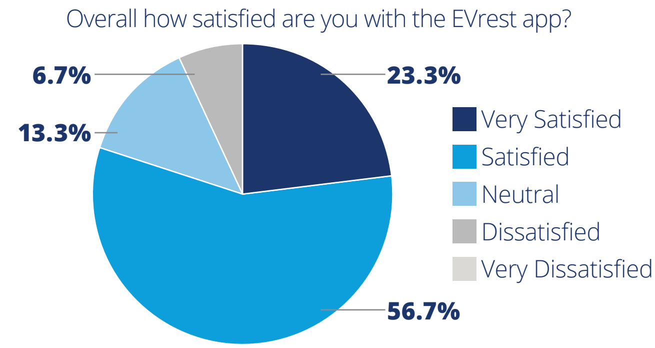
Note. (A) User Accuracy for Level 2 Charging Prior to Machine Learning Integration, (B) User Accuracy with Machine Learning Pre-Populated Mileage, (C) User Accuracy Post-Machine Learning Integration User Accuracy Post-ML Integration with Exposure to ML Pre-Population, i.e., users could manually update the pre-populated mileage.

Source: Argonne National Laboratory (2025). Recreated by SEPA.

Managing Workplace Charging: Argonne National Laboratory's Reservation-Based Smart EV Charging Platform

Figure 26A and 26B. Customer Satisfaction with EVrez App





N=30

Source: Argonne National Laboratory (2025). Recreated by SEPA.

Reservation Timing

Respondents had mixed approaches to making their EV charging reservation, with a slight majority of users reserving in advance (i.e., hours, days, weeks in advance) while the rest made reservations upon arrival. 46% of sessions are typically reserved within 15 minutes of starting, 11% are made within an hour, and 43% are made more than an hour in advance. Workplaces should consider different employee reservation habits to ensure the system does not overly favor one or the other type of employee. The location of the charger also impacts reservations; some buildings are busier than others and/or have fewer chargers, leading to more advanced reservations and higher charger uptime.

App Features

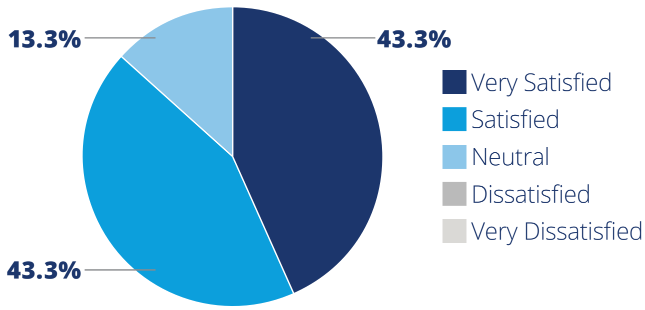
The EVrez app provides users with real-time charging status updates, including charge state, charge rate, energy, etc. (Figure 27). Users were receptive to push notifications from the app, which alerted them when their vehicle is close to being done charging and if the vehicle stops charging because it is full or if there is an issue (Figure 28). EVrez notifies users 15 minutes before they can begin charging and 15 minutes before their reservation ends so they have time to move their vehicle when their reservation ends.

Conduct Score

Argonne implements a conduct scoring system as a non-punitive approach to reduce the number of drivers who do not adhere to program rules, such as overstaying their reservation duration or failing to cancel a reservation when their charging plans change. Users start with a score of

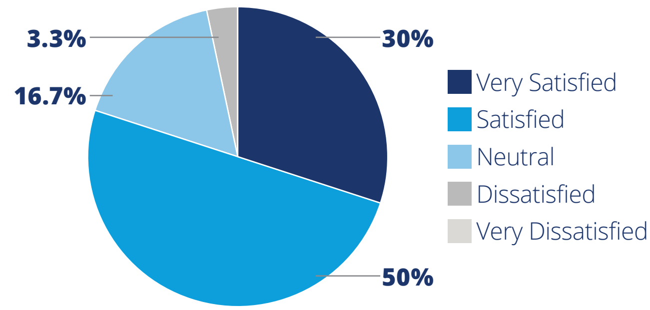
> **"If the conduct score doesn't really have any play in my ability to charge or function, then I don't really care about it. Maybe if it's public, I'll care about it; if co-workers see how rude I am." —Argonne Employee**

Figure 27. User Satisfaction with Real-Time Charging Status Updates



Source: Argonne National Laboratory (2025). Recreated by SEPA.

Figure 28. User Satisfaction with Push Notifications



Source: Argonne National Laboratory (2025). Recreated by SEPA.

100 and receive score reductions whenever they overstay past their reservation or miss their reservation without canceling. Users were almost evenly split on satisfaction with those scores, 53% satisfied and 47% unsatisfied, indicating potential revision or that a change to the scoring system could improve satisfaction while maintaining the intent of the scores. The conduct score is implemented as a first step before implementing penalties, such as short term bans for repeat offenders or charging fees for rule violations. However, interviewed users indicated that they typically ignore their conduct scores, particularly because they can not improve the score and the score is not public. Some users said behaviors may change if scores were public, increasing adherence so they aren't seen as a "bad colleague" or even gamifying a good score if there is a leaderboard.

User Feedback

Overall, employees reported high satisfaction with the program's initial launch, particularly noting improvements in their ability to access chargers at their reserved times (Table 5). Before EVrez, one of the main frustrations for employees was that reservations were honor-based, and people would charge without a reservation. The app allowed users to know exactly when a charger would be available or if a previously reserved charger suddenly became available. Notably, users did not understand the *requested mileage* data, likely given that it differed from the data they would need for charging at home or elsewhere in public. Educating users can improve the functionality of specific features in the charging reservation system, particularly if they are required for smart charge management programs.

Table 5. EVrez User Feedback

Category	Key Topic	User Comments
User Feedback	User Convenience	▪ "Great work! thank you for developing the app and it makes charging much more convenient!" ▪ "Map is easy to deal with, good feedback from User interface." ▪ "It's a great system (so much better than Vector) [previous system]."
	Improved Accessibility & Management of Chargers	▪ "The app has been great I think in cutting down a lot of frustrations that users have had (people parking in your spot randomly even though you booked in advance is a big one)." ▪ "I like that it will cancel a reservation if not activated within 15 minutes of start time. This allows for others to take a spot if someone reserved it but didn't show up for the appointment time."
		▪ "I like that I know the charging station will be free if I've reserved it, and I like that the app lets me know when my car is finished charging."
Improvement Suggestions	Payment Features	▪ "Can you add a payment feature to only charge for the kWh used? I have a hybrid and typically only charge 2.5 hrs at 3x/week."
	Session Modifications	▪ "Allow user to start the session, say, up to 15 mins before the reservation starting time without the need to delete the session then rebook the reservation if the user arrives slightly early. The 4 hour window can be kept the same."
	Streamlined Experience	▪ "A copy and paste option. Or something similar. I have a set schedule at work so I charge at the same time everyday. I counted 15 taps just to make a single reservation. Also entering in the miles seems useless." ▪ "Not much value in the "miles you plan to charge" from a user perspective."
		▪ "It always asks what mileage I want to charge for a session. I don't know the exact number, but I just want to charge it using the maximum power."

Source: Argonne National Laboratory (2025).

2025 Survey Results

"I think it's a great program. I'm an advocate for it, and I've referred at least three or four other Argonne employees that bought EVs to participate. I hope they can maintain a quality program with affordable prices." —Argonne Employee

In 2025, Argonne and SEPA surveyed 119 of the 340 participating users to gather data on how many users had home charging, what percentage of charging occurred on Argonne's workplace program, and if participants were open to managed charging. SEPA also interviewed eleven users directly about how they used the program.

Home versus Workplace Charging

Approximately 70% of respondents indicated they had home charging, with an almost even split between Level 1 and Level 2 charging at home (Figure 29). During the interviews, a few users indicated that due to a lack of ability to charge at home, Argonne's workplace charging program allowed them to more easily consider an EV, especially as a commuter vehicle.

Among employees with at-home charging, 33% did not know how much they were paying per month, and 20% stated their $/kWh rate, which ranged between $0.04/kWh and $0.19/kWh with a mode of $0.12/kWh. Employees with solar PV stated that they do not pay anything monthly for at-home charging because they charge using their solar. The majority of employees who knew how much they charged at home typically paid between $20 and $40 per month for home charging. Employees that charged very little at home typically paid less than $10 per month.

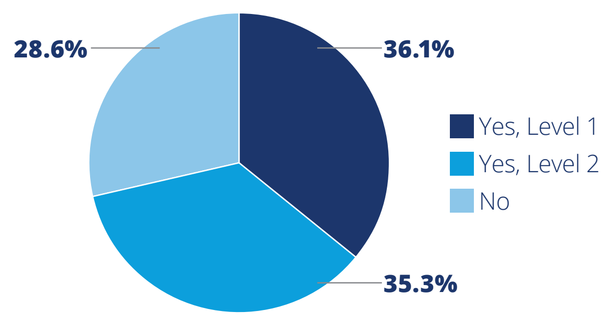
While many employees have access to at-home charging, the majority of employees use Argonne as their primary source of charging (Figure 30). Employees indicated that they charge mostly at Argonne due to the low cost, $15 per month flat rate and the convenience of charging at work. However, interviewees indicated that their charging habits could change once the program shifts to a $/kWh basis depending on the price point and how comparable the price was to both at-home charging options and public charging. Respondents also expressed that when the program moves to a $/kWh basis, they would like transparency around costs, including electricity and administrative costs. When asked how much they currently pay at home, more than 60 respondents said they did not know or could not compare because they did not currently have home charging.

"With the kilowatt-hour and maybe an administrative fee, if it was less than 20 cents per kWh, I'll probably charge here exclusively… I'd find it disappointing if its 40 cents per kWh." —Argonne Employee

Respondents without home charging or access only to Level 1 charging rely heavily on workplace charging (Figure 31). Those with Level 2 charging have a wide diversity in how much they charge at work, with a slight preference for workplace charging.

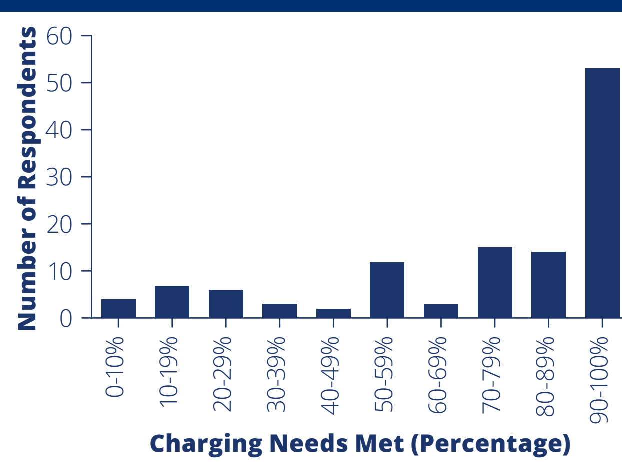
Access to at-home Level 2 charging appears to influence how often employees charge at work, with those lacking home charging relying more on workplace stations.

Figure 29. Users with At-Home Charging



N=119.
Source: Argonne National Laboratory (2025). Recreated by SEPA.

Figure 30. Percentage of Charging Needs Met at Workplace



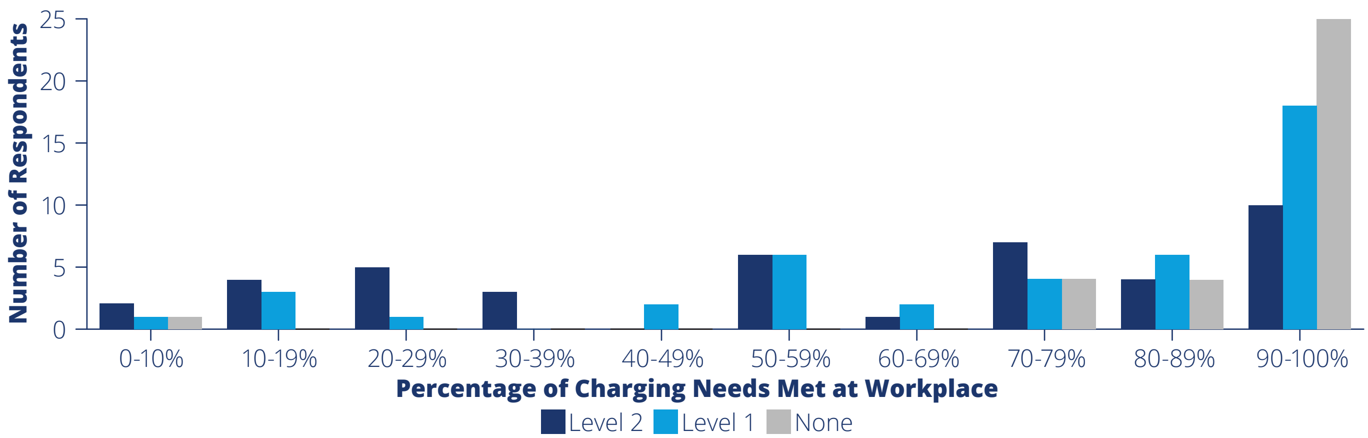
N=119.
Source: Argonne National Laboratory (2025). Recreated by SEPA.

However, home charging access is not strongly correlated with the number of sessions throughout the week (Figure 32). Instead, charging frequency is more closely tied to the vehicle type (hybrid vs. battery electric) and the specific make and model.

Users with plug-in hybrids or older EVs tended to charge daily. Many of these drivers had shorter commutes, typically under 30 miles, and selected hybrid models because their electric range roughly matched their round-trip distance. These users often depleted their full battery during the commute, recharged completely during a three-hour Level 2 session, and were able to return home using their battery, instead of using fuel.

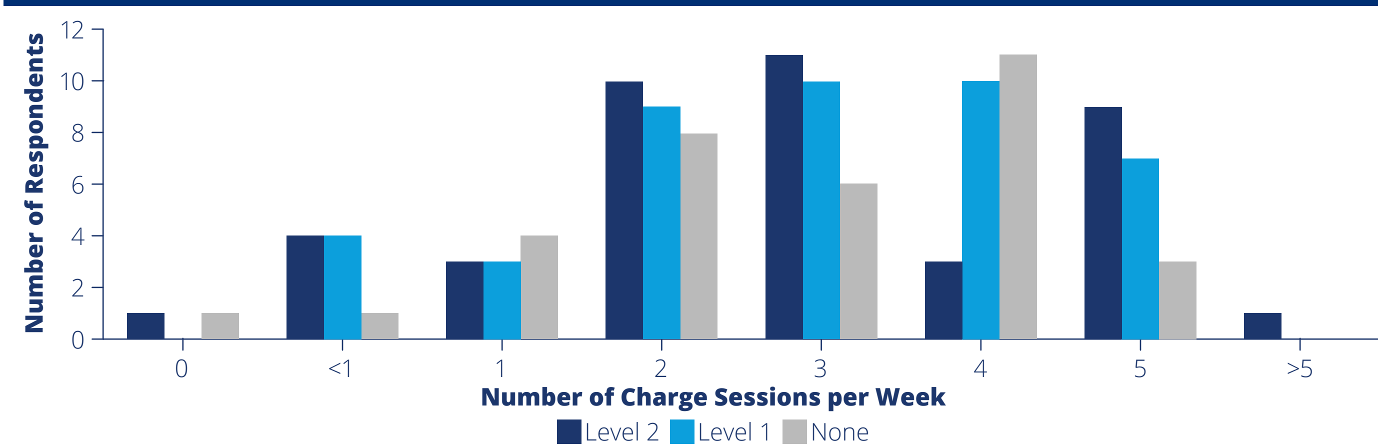
> **"Level 1 charging is an excellent idea. There are a lot of people who use the Level 2 charging who don't really have much need for it. I have an intense need and when those stations are booked by people who have a hybrid, and don't have the same level of need, it would be helpful for those people to be able to plug-in the whole day at Level 1 and leave Level 2 open for people who do need it" —Argonne Employee**

Figure 31. Percentage of Charging Needs Met at Workplace Compared to At-Home Charging



N=119.
Source: Argonne National Laboratory (2025). Recreated by SEPA.

Figure 32. Number of Charge Sessions per Week at Workplace Compared to At-Home Charging



N=119.
Source: Argonne National Laboratory (2025). Recreated by SEPA.

"As long as the pricing isn't unreasonable, it's still saving money per year to charge at work. Unless a lot more people start charging at work then make it harder to use the program."—Argonne Employee

By contrast, drivers with longer commutes typically owned fully battery electric vehicles. They often used the full four-hour reservation period to charge and noted that this duration was sometimes insufficient, particularly in winter months when cold temperatures consumed more of the battery for cabin and battery heating, requiring more total energy for the same mileage in warmer months.

Interviewees with full battery electric vehicles preferred an 8-hour charging session to achieve a full charge in a single session. They also supported offering additional options, such as Level 1 charging, to accommodate employees with shorter commutes and smaller batteries who could fully charge over an 8-hour period using slower, trickle charging. In both the survey and the interviews, employees expressed that the program has become more popular and has experienced more charger shortages, in part due to construction and some charger maintenance issues, including WiFi connectivity issues. Some respondents indicated that they used to charge the majority of their sessions at work, but have since stopped charging at work altogether or only use the DC fast chargers at the end of the day before leaving.

Shifting to a per kWh Model & Program Usage

The majority of survey and interview respondents indicated that when Argonne shifts to a $/kWh rate instead of a flat rate that their charging habits will largely be dependent on how costly the price is and how it compares to both their home charging and public DCFC charging. Users indicated that home charging is far more convenient and that the flat rate charging outweighed the disadvantages of having to move their vehicle in the middle of the work day, compete for charging, and walk an additional 5-30 minutes to park and re-park their vehicles. Many survey respondents wanted transparency around the $/kWh change, including administration and energy fees that contribute to the new pricing, and encouraged the program to keep the fees low to be competitive with home and/or public charging options. Additionally, many employees felt that workplace charging was one of the best perks at Argonne and advocated that Argonne should keep prices low just like they would for any other workplace benefit.

"With a hybrid car, I need to charge at work in order to make it home on electricity. My Jeep takes a full charge each way to make it on battery, so hybrid models would not be the best to manage reservations on." —Argonne Employee

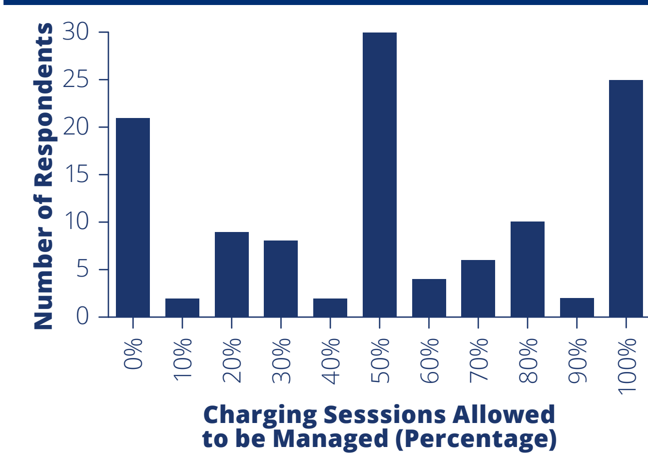
Openness to Managed Charging

When asked about managed charging, 18% of respondents preferred no management, while the rest were open to some level of control (Figure 33). Most were comfortable with 50% or more of sessions being managed, and 21% were comfortable with complete management. Several noted that throttling should not be excessive and that modified sessions should include appropriate incentives. Overall, users supported managed charging as long as they received enough charge to meet their driving needs.

When asked about their desired incentives for participating in a managed charging session, the majority of respondents wanted a reduced price for that specific charge session while others were fine with non-monetary or even no incentives (Figure 34). During interviews, users expressed that they understood that certain facilities have

"It would be nice if you could leave the cars plugged in for the whole 8 hours and distribute [power] between several chargers based on reservation, price, solar, etc., so you don't need to bother moving your car. Everyone has more charge by the end of the day and you don't have to move the car." —Argonne Employee

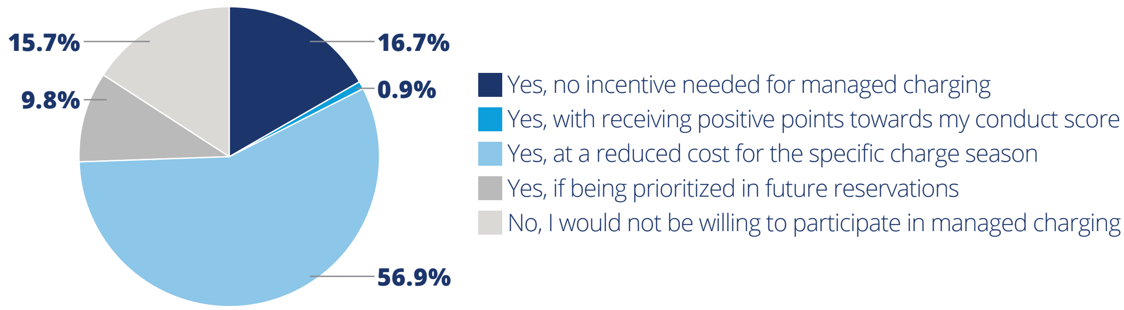
Figure 33. User Comfortability with Managed Charging



N=119.

Source: Argonne National Laboratory (2025). Recreated by SEPA.

Figure 34. User Preference for Managed Charging Incentives



N=102.
Source: Argonne National Laboratory (2025). Recreated by SEPA.

grid constraints and/or have onsite generation, so they were open to having their sessions managed even without incentives. Users were particularly comfortable with managed charging if the session durations were longer. Some users felt that 4-hour sessions were not enough time to get their minimum amount of charge while participating in managed charging. However, they indicated that if the sessions were eight hours, to align with the workday, they would not mind managed charging on every session.

Section 3. Lessons Learned & Future Opportunities

- "Requested Miles" is a useful input for ranking charge sessions in smart charge management, but users often overestimate their needs and do not understand how this information is used. Future versions of EVrez should explain how requested miles inform flexibility, allow users to indicate their level of flexibility, and connect these inputs to simple, transparent pricing or incentives to encourage realistic requests and improve participation.
- Workplaces should standardize user inputs for SCM applications, using SOC or requested miles. For workplaces like Argonne that do not interface with user vehicles, requested miles is a simpler input metric for users, especially for those thinking about how many miles they need for their commutes. User interfaces should be intuitive for customers to use and similar to how they may use apps at home or for public charging.
- Workplaces should plan for both scheduled maintenance and unexpected charger outages to minimize user disruptions. Establishing a clear, convenient system allows employees to quickly report inoperable chargers and provides maintainers with real-time tracking and resolution tools. Integrating automatic notifications and removing offline chargers from reservation and managed charging systems can further improve reliability and user satisfaction.
- Organizations implementing workplace charging programs should consider releasing anonymized charging data to support broader industry progress. Sharing real-world data enables researchers, utilities, and other site operators to analyze charging behavior, identify effective program designs, and improve managed charging strategies. Open data access promotes transparency, collaboration, and innovation across the workplace charging ecosystem. Argonne has released a public version of Opti-VGI to support other workplace initiatives.
- When implementing a conduct score, it is important to educate users on how the score is calculated, what behaviors it aims to encourage, and how users can improve their scores over time. Programs should also consider assigning tangible consequences or incentives tied to the score to reinforce its importance. Many users reported ignoring the score because it carried no penalties for low ratings and offered no clear pathway to improvement.

- Challenges can arise when implementing a workplace smart charge management program if charging behaviors and expectations are established before SCM is introduced. For example, if users become accustomed to flat, low-cost charging rates, they may be less receptive to future managed charging or dynamic pricing structures. Transitions to a cost-per-kilowatt-hour ($/kWh) pricing model should be planned carefully to ensure compatibility with future SCM pricing mechanisms and to maintain user acceptance.

Conclusion

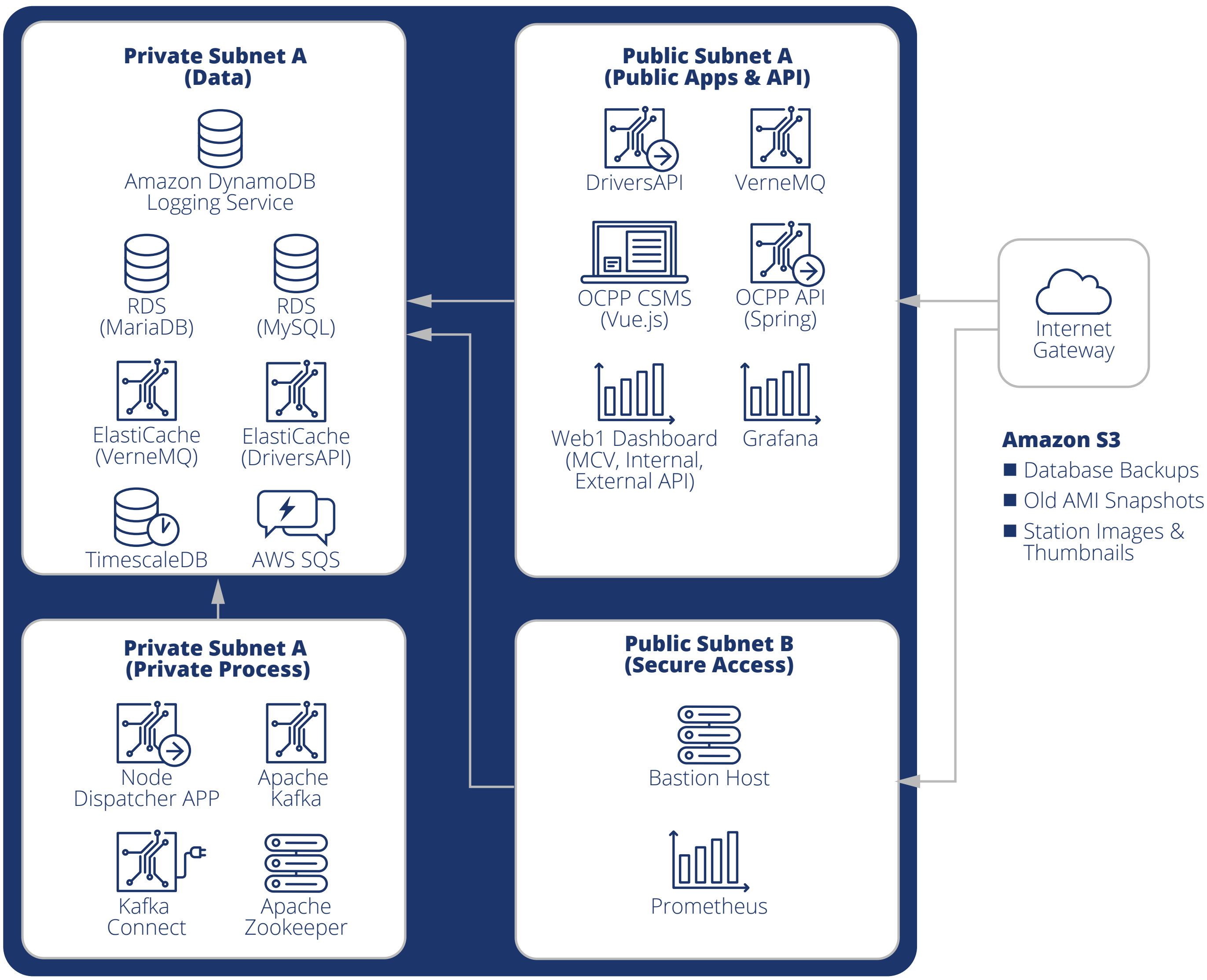
Argonne's experience demonstrates that successful workplace charging programs evolve through deliberate, data-driven steps. Beginning with a simple reservation system allowed Argonne to establish user trust, gather baseline charging data, and build the foundation for a scalable smart charge management program. The evolution of EVrez highlights that employee charging behavior and access to at-home charging strongly influence workplace charging demand and flexibility. Understanding these behavioral drivers is essential for designing effective programs and identifying where management and incentives can provide the most value. Well designed, transparent pricing encourages efficient charging behavior, ensures equitable access, and aligns user needs with grid objectives. As workplaces expand EV charging access, Argonne's approach provides a replicable model, one that integrates technology, behavior, and pricing to balance employee satisfaction, operational efficiency, and long-term grid benefits.

Appendix A: Argonne's EVrez Platform with Integrated CSMS

Argonne's EVrez Platform with Integrated CSMS is built on Amazon Web Services (AWS) cloud infrastructure, using a scalable and secure architecture designed for high availability and control of a large network of stations.

The system is segmented into private and public subnets to protect sensitive data and processes while exposing necessary services to the internet.

Figure 35. Argonne's EVrez Platform with Integrated CSMS



Source: Argonne National Laboratory (2025). Recreated by SEPA.

Technical Details

The architecture is built from a collection of specialized components running in containers rather than a single, monolithic application. This modern design uses the most effective tool for each specific task, and makes it easy to add more services for advanced features such as smart charge management. The architecture is organized into the following key layers:

- **Data Layer:** The system's core resides in a private subnet, which houses a suite of databases to handle various data types. This includes a MySQL database for relational data, ElastiCache (Redis) instances for in-memory caching and fast data retrieval, TimescaleDB for storing time-series data from charging sessions, and a DynamoDB instance for logging.
- **Processing Layer:** A separate private process subnet manages asynchronous tasks and data streaming. It utilizes Apache Kafka as a message bus to reliably handle high-volume event data from chargers and users, ensuring no information is lost during peak times.
- **Public API Layer:** This public-facing layer handles all communication with users' devices and charging stations via a proxy gateway. It hosts the core OCPP CSMS and various APIs and dashboards for users and administrators. A Grafana instance is also deployed here for data visualization and monitoring.
- **Secure Access Layer:** A secure public subnet controls administrative access to the system. This layer contains a Bastion Host for secure shell (SSH) access to all other services and a Prometheus server for system monitoring, ensuring that management and oversight are performed securely.

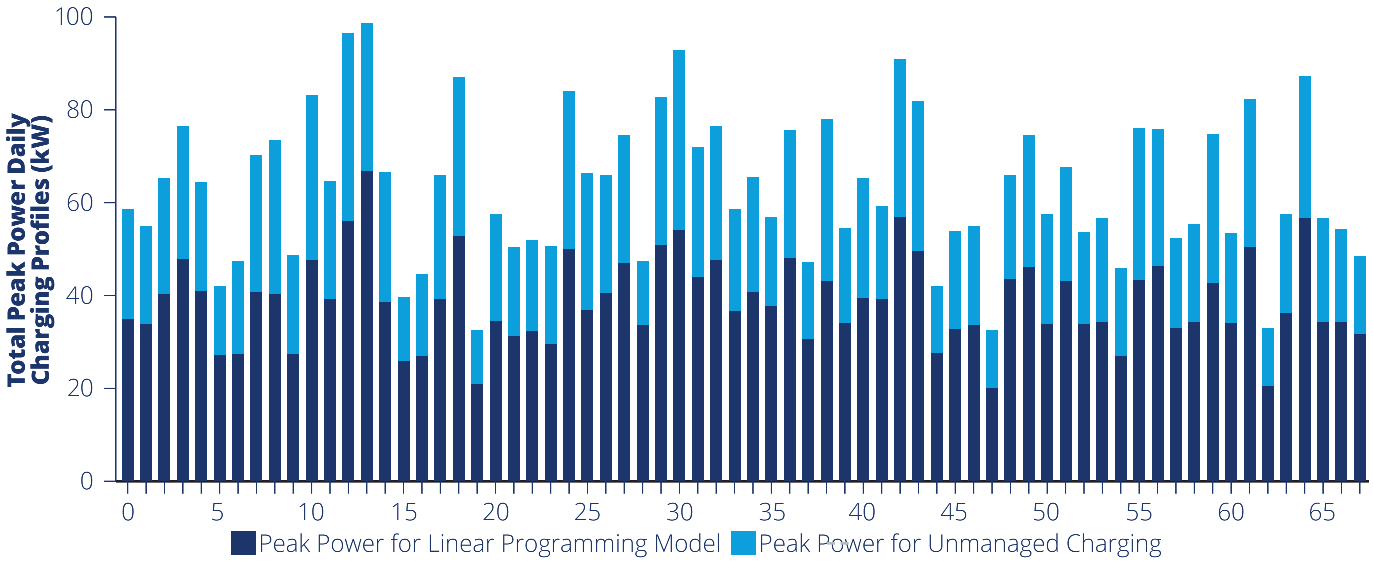
These components work together to create a cohesive and efficient system. For example, when a user initiates a charge from the mobile app, the request travels to the DriversApi, which validates the user's session by consulting the MySQL database for user and station details, before sending a direct OCPP command to the charger to begin the session. Throughout the charging process, the charger sends a continuous stream of telemetry back to the central server, which is then logged in TimescaleDB for analysis. This separation of components ensures that user activity does not interfere with the operation of the chargers, allowing the EVrez platform to function as both a user-friendly service and a powerful grid management tool.

Appendix B: Technical Details on Opti-VGI

Opti-VGI, now open-source, enables the testing, validation, and benchmarking of multiple SCM algorithms, providing valuable insights into their operational effectiveness across varying grid and market conditions (Figure 36).[16]

To ensure broad interoperability, the application integrates with OCPP 2.X CSMS to enable ISO 15118-based charge scheduling, as well as with OCPP 1.6 CSMS to support smart charging through J1772 PWM duty cycle control.

Figure 36. Opti-VGI Can Dynamically Schedule Charging to Reduce Capacity Exceedances



Source: Argonne National Laboratory (2025). Recreated by SEPA.

Technical Details

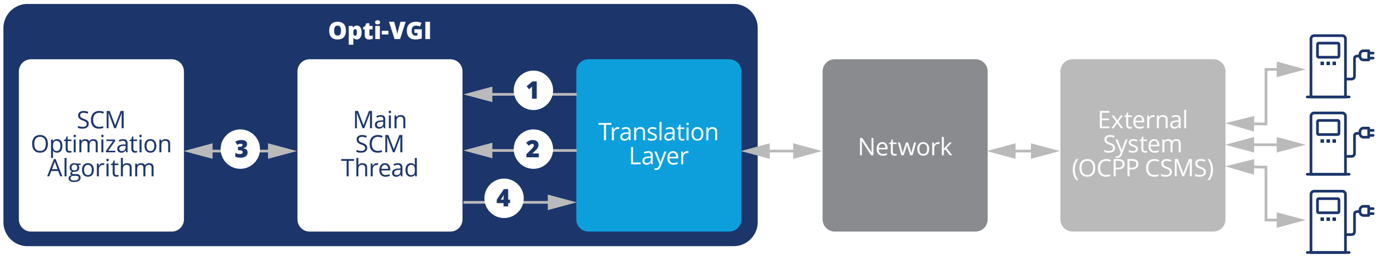
Opti-VGI is a modular charge scheduling management application designed to support flexible testing and evaluation of different scheduling approaches. At the core of this framework is a well-defined API specification, which allows developers to swap in and test a variety of SCM algorithms without altering the broader system architecture. This modularity ensures that new methods can be integrated and validated efficiently, enabling rapid experimentation under realistic operational conditions.

A translation layer sits between the CSMS and the SCM algorithm, serving as the interface that standardizes communication across platforms. This layer implements the API specification required to support different CSMS implementations, ensuring seamless interaction regardless of the charging system in use (Figure 37).

To incorporate renewable energy resources into charging operations, Opti-VGI integrates with a solar irradiance forecasting API developed by Solcast. This service estimates expected solar generation for the next four hours, which is then used to establish a dynamic power limit curve. By leveraging these forecasts, the application adjusts charging schedules in real time to maximize the utilization of onsite generation while maintaining reliable service within site-level constraints.

16 Argonne (2025). Opti-VGI. *GitHub*.

Figure 37. Sequence Diagram Showing the Flow of Data and Commands Between the Chargers, Opti-VGI, and the CSMS



1. **Translation.get_peak_power_demand:** Get the peak power profile for the SCM group.
2. **Translation.get_evs:** Get the timings and energy needs of current and future EVs.
3. **Algorithm.calculate:** Run the SCM algorithm using the above metrics and create a charging plan.
4. **Translation.send_power_to_evs:** Send the generated charging profiles back to the EVs.

Source: Argonne National Laboratory (2025). Recreated by SEPA.

The OCPP and ISO 15118 are complementary standards that operate at different layers of the EV charging ecosystem.[17] ISO 15118 enables secure, automated communication directly between an EV and a charging station. It facilitates smart energy management, including scheduling of charging power and bidirectional charging interactions. The OCPP governs communication between charging stations and backend CSMS, enabling operators to monitor and control charging infrastructure remotely. Its modern versions support encryption, certificate management, secure firmware updates, and detailed reporting, allowing network operators to enforce policies such as load limits and pricing in real time. When used together, OCPP and ISO 15118 provide a layered and interoperable framework that bridges backend control with real-time EV charging. For example, an EV may authenticate and negotiate a charging plan with a station using ISO 15118, while the charging station communicates session details to the backend over OCPP for billing, monitoring, and load balancing. This integration ensures secure, intelligent charging at the vehicle–station interface while maintaining comprehensive visibility and coordination at the system level.

Scheduling Algorithm

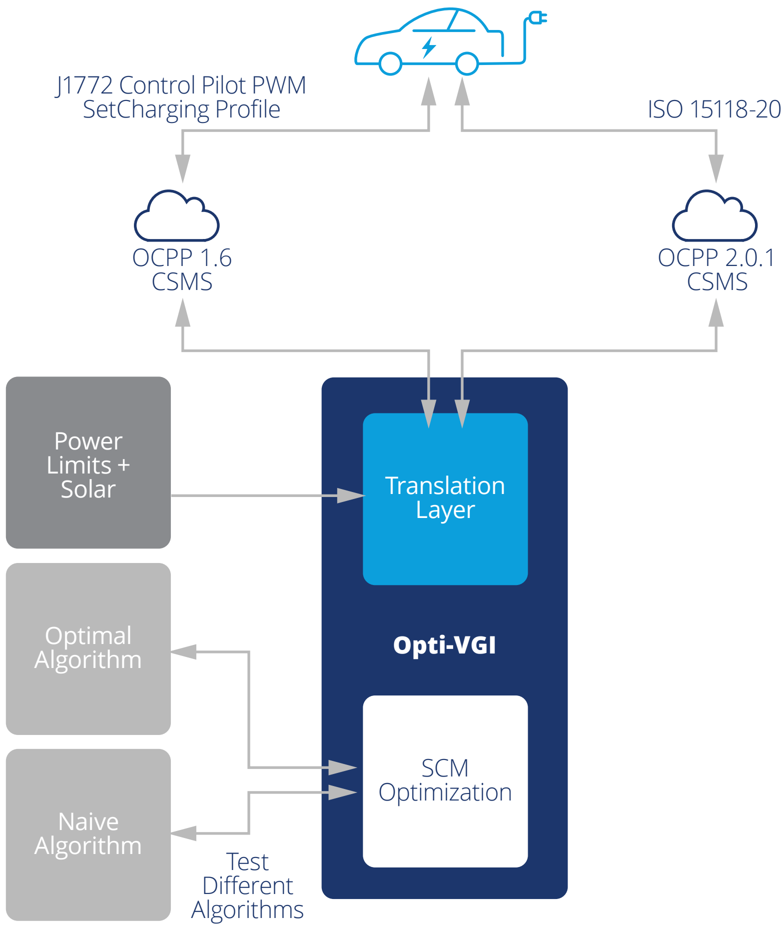
Opti-VGI supports multiple approaches to EV charging management; two representative methods currently implemented are rule-based proportional allocation and an optimal numerical algorithm (Figure 38).

The rule-based proportional allocation approach distributes available charging power across all connected EVs in proportion to their charging needs. Because the allocation is deterministic, the results are highly predictable and consistent, which makes this method well-suited for real-world deployment where reliability is essential. However, the simplicity of this method means it does not always guarantee the best possible outcome in all scenarios. In particular, when power demand exceeds supply or unusual edge cases arise, the rule-based method may fail to allocate resources most efficiently.

The optimal numerical algorithm takes a more sophisticated approach by formulating the scheduling problem as an integer linear programming (ILP) model. This method utilizes an optimization solver to determine the charging plan that optimizes the allocation of resources. The main advantage of this approach is that it can guarantee optimality for the chosen objectives and based on the given constraints, ensuring the most efficient use of available power. On the other hand, this method can introduce unpredictability at the level of individual vehicles, since the solver may frequently re-prioritize EVs over time. As a result, drivers may experience fluctuations in charging speed, which can reduce the perceived stability of the charging process.

17 Pacific Northwest National Laboratory (2024). Electric Vehicle Standards — Grid Service Capabilities.

Figure 38. Opti-VGI System Architecture



Source: Argonne National Laboratory (2025). Recreated by SEPA.

Smart Electric Power Alliance

1800 M STREET, NW FRONT 1
#33159
WASHINGTON, DC 20036
202-857-0898