AGL SA Smart Charging Off-Street Car Parking Report

November 2025

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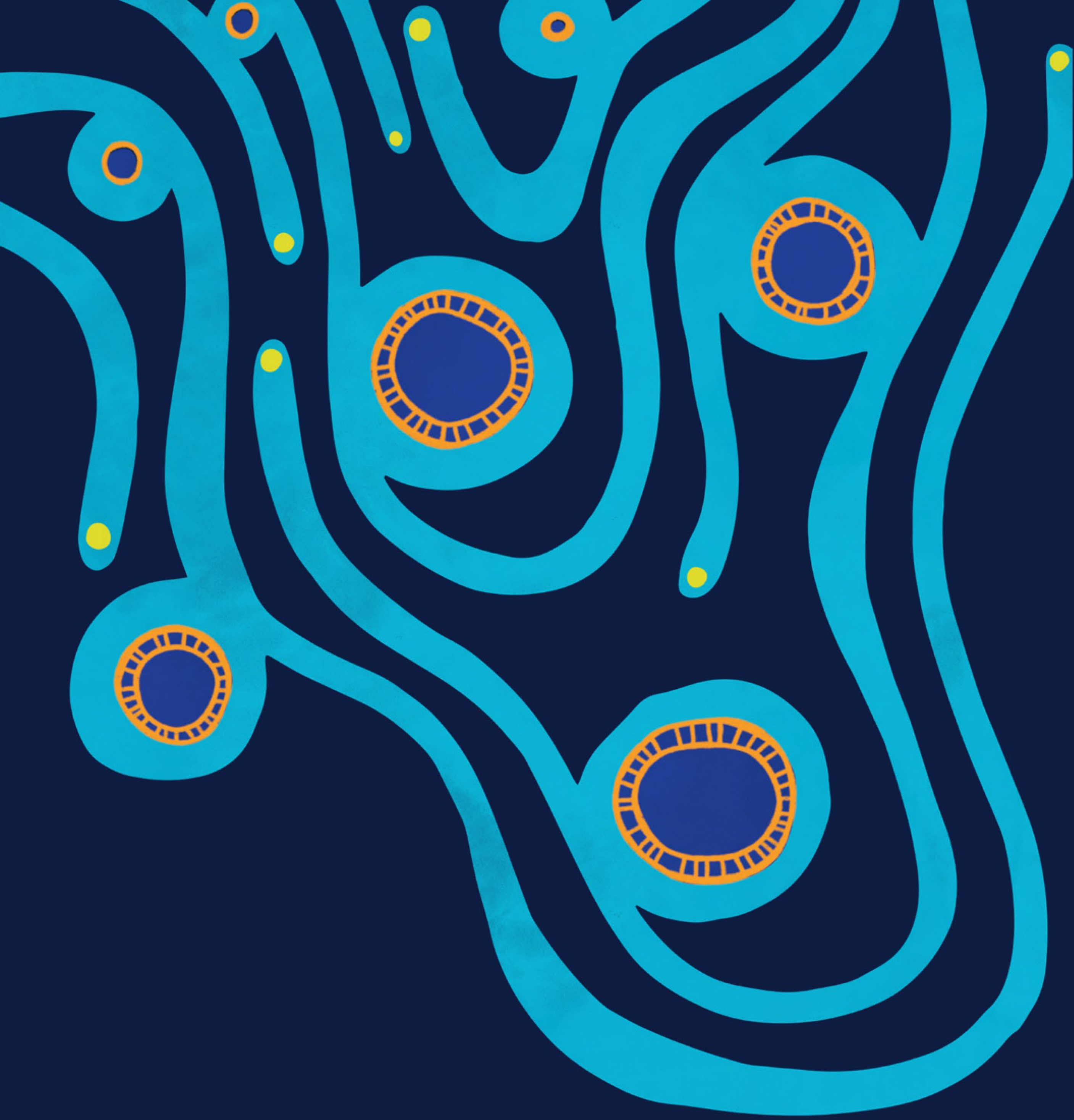

Acknowledgement of Country

AGL recognises the First Nations people as the Traditional Custodians of the lands on which we work, and acknowledges those communities' continuing connections to their lands, waters and cultures. We pay our respects to their Elders, past and present.

Acknowledgement of grant funding

AGL Energy Limited acknowledges the Department for Energy and Mining's contribution to the Smart Charging Trial through a Funding Agreement.

Some images included in this report are for illustrative purposes only.

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Executive Summary

The AGL South Australian Smart Charging Trial, initiated in December 2021, represents a pivotal exploration into the future of electric vehicle (EV) infrastructure in commercial settings. A collaborative project funded by the South Australian Department for Energy and Mining, the trial brought together AGL's electricity expertise and Wilson Parking's extensive off-street car park network, to move beyond simple technology testing, by examining the intricate interplay of technology, user behaviour, and commercial viability across 18 smart chargers in three Adelaide CBD locations. The trial has produced a set of foundational strategic insights that will help shape the future of urban electrification.

The trial was guided by three core objectives:

1. To test innovative product offerings that could accelerate the adoption of EVs within South Australia.
2. To trial smart charging practices in a real-world, off-street car park environment, incorporating pricing and event signals to influence user behaviour.
3. To demonstrate productisation of EV car parking to increase familiarity and confidence in smart charging solutions for commercial car park operators and corporate parking customers.

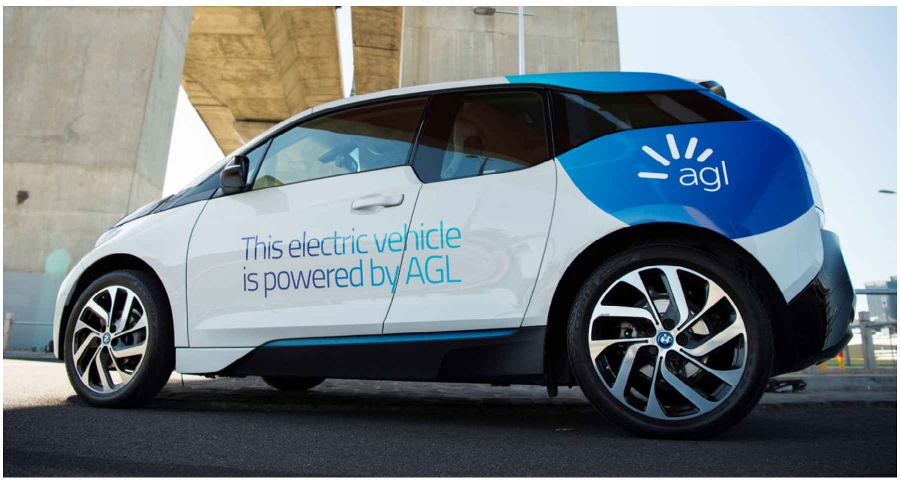
By collecting detailed data on charging patterns and user responses, the trial aimed to develop commercially viable propositions that support the broader goals of electrification and decarbonisation.

The trial's physical infrastructure consisted of 18 Ocular IQ Commercial 22kW chargers strategically deployed across three Wilson Parking facilities in Adelaide's CBD. These Level 2 chargers, compliant with the Open Charge Point Protocol (OCPP) 1.6J, formed the foundation for a sophisticated methodological approach that compared baseline behaviour with two distinct forms of charging.

Key Findings: Validated Success and Exposed Limitations

The trial yielded a wealth of data, confirming the viability of controlled charging while simultaneously exposing critical limitations in current technology and market structures.

Controlled Charging Success: For users with predictable, long-dwell parking patterns, such as daily commuters and fleet vehicles parked overnight, the controlled charging intervention was an unambiguous success. Across multiple user profiles, the system effectively redistributed electricity consumption, achieving a 24% increase during solar-sponge periods, a 38% reduction during peak periods, and a 14% increase during off-peak periods—successfully shifting the majority of usage into optimal windows (see Table 1 below). Controlled charging resulted in the reduction of charging during high-cost periods (peak period) and generated financial savings for Wilson Parking, all while being functionally invisible to the end-user, who simply found their car charged as needed.



User Archetype	Baseline (Uncontrolled Charging) Peak Period Consumption* (%)	Controlled Charging Peak Period Consumption Reduction* (%)	Controlled Charging Increase in Solar/Off-Peak Consumption* (%)	Estimated Annual Savings ($)	Key Qualitative Finding
User 1 (Tech Commuter)	41%	↓ 41%	↑ 41%	~$254	Rejected the rigid profile when schedule became unpredictable, highlighting the need for urgent charging.
User 2 (Garage Orphan)	21%	↓ 21%	↑ 21%	~$70	Found the system seamless but noted the overall service was too expensive for many EV owners without home charging.
User 3 (Long-Distance Commuter)	69%	↓ 69%	↑ 69%	~$676	Highly accepted the system, understanding the mutual grid and cost benefits; praised the reliability and convenience.
User 6 (Fleet)	59%	↓ 20% for 1st Controlled charging period and ↓ 40% for 2nd Controlled Charging period	↑ 2% for 1st Controlled charging period and ↓ 13% for 2nd Controlled Charging period	~$400 (across 3-4 bays)	Successfully optimised fleet charging overnight without impacting operations; exposed building infrastructure as a key barrier.

*Peak period (3:00 PM – 1:00 AM, 6:00 AM – 10:00 AM), Solar (10:00 AM – 3:00 PM), Off Peak (1:00 AM – 6:00 AM)

Table1: Showing the electricity consumption during baseline period (uncontrolled charging) and Controlled charging along with estimated savings.

Controlled charging has generated savings for Wilson Parking, and based on this, a transparent and compelling financial model to share the revenue generated from these grid services with end-users can be built. This creates a powerful financial incentive for participation, fundamentally changing the economics of EV ownership and turning every connected EV from a simple electrical load into a potential revenue-generating grid asset for car park operators.

User-Centric and Systemic Barriers: The trial also surfaced significant challenges. The most telling was from User 1, a tech-savvy early adopter who initially benefited from controlled charging but later requested its removal. A change in his work routine required him to charge outside the prescribed window, revealing a fundamental tension between system-level optimisation and the need for individual flexibility and control. Furthermore, users reported technical friction, such as charger ‘handshake’ issues, and expressed a desire for the seamless, integrated experience offered by proprietary networks, highlighting a user experience gap in the broader market.

The trial also highlighted systemic barriers facing commercial fleets. The car-sharing service (User 4) experienced very low utilisation of its bay, as the off-street location was inconvenient for its high-turnover, customer-facing rental model, which favours easily accessible on-street parking. The Department of Infrastructure and Transport (DIT) fleet (User 6) used the Wilson Parking facility primarily as a workaround, because their own office building had reached its electrical capacity, demonstrating how legacy building infrastructure can be a major impediment to corporate EV adoption.

Technical Constraints: A recurring technical limitation throughout the trial was the use of the OCPP 1.6 protocol. This version of the protocol has limited support for transmission of State of Charge (SOC) from the vehicle to the charger. This fundamentally limited the "smartness" of the system, preventing precise, needs-based charging, forcing the use of estimates for calculating idle capacity, and making intelligent management of the unpredictable car-sharing fleet nearly impossible.

Principal Conclusion: The Hybrid Imperative

The report's most critical strategic conclusion is that neither controlled charging nor smart charging, in their tested forms, represents the optimal solution in isolation. While controlled charging proved highly effective for cost savings, it lacked flexibility. Conversely, the smart charging system, while technically functional, revealed a critical flaw: on one occasion, it charged vehicles during a high-cost evening peak period because renewable generation was available on the grid. This action, while aligned with a "renewable" signal, ignored the economic signal and missed an opportunity to shift the load to the much cheaper overnight off-peak window.

This suggests that the future of advanced EV charging lies in a hybrid model. Such a model must be sophisticated enough to integrate the cost-certainty and simplicity of controlled charging (e.g., defaulting to the solar sponge period) with the grid-responsive intelligence of smart charging (e.g., modulating power based on real-time price signals). Critically, this entire process must be governed by user-defined parameters, such as required departure time and desired range. This approach transforms the charging station from a simple utility into a sophisticated, user-centric electricity management asset, resolving the inherent tension between user needs, site economics, and grid stability.

1. Introduction

The AGL SA Smart Charging Trial was initiated in December 2021 as part of the EV Smart Charging Trials that are funded by the Department of Energy and Mining. This project represents a collaborative effort, with AGL receiving funding support from the Department to implement and evaluate smart charging technologies and methodologies.

This report focuses specifically on the outcomes and learnings from Wilson Parking Adelaide CBD off- street car parks. Through detailed analysis, we can provide valuable insights into the practical challenges and opportunities associated with adopting EVs in off-street car park settings, while highlighting potential solutions for off-street car parks considering similar transitions.

The findings from this trial will serve as a blueprint for organisations looking to electrify their car parks to facilitate EV charging for their customers, offering practical insights into infrastructure requirements, operational considerations, and change management strategies. Additionally, the data collected will inform future policy decisions and infrastructure planning at both organisational and government levels.

The objectives of this trial were to:

1. Test innovative offerings through new products that will drive the adoption of EVs to support the electrification and decarbonisation of South Australian commercial fleets by 2030.
2. Trial smart charging infrastructure in an off-street car park that introduces dynamic pricing and event signals.
3. Demonstrate productisation of the EV car parking to increase familiarity with smart charging practices for commercial operators of car park.

Using various supporting systems trial data was analysed to understand the charging behaviour of off-street car park customers. The Trial then introduced charger control and dynamic factors including price and event signals designed to alter user charging behaviour. This understanding should enable development of new viable commercial propositions that will increase adoption of EVs and smart charging practices in South Australia.

The installation of 18 smart EV chargers across three Wilson Parking facilities located in Adelaide’s CBD provided convenient off-street charging options for the public. This component aimed to address the critical need for accessible charging infrastructure in urban areas.

The trial incorporated controlled charging and Smart charging to understand and influence charging behaviours. By collecting and analysing data from the installed EV chargers, the trial derived insights on off-street car park users charging patterns. This understanding is crucial for developing new, commercially viable solutions that can encourage broader adoption of EVs and smart charging practices.

Trial timeline

December 2021
DEM Grant Approval

February 2022
Quote on Installation of chargers at Wilson Parking Adelaide CBD Off-Street Car Parks

April 2022
Installation of 9 EV chargers at Wilson Parking Off-Street Car Park 61-67 Wyatt Street Adelaide completed

September 2022
Installation of 3 EV chargers at 189-207 Hindley Street Adelaide and 6 EV chargers at Lot 14 Frome Terrace Adelaide Wilson Parking Off-Street Car Park Locations

June 2023
1 EV bay Leased to User 5

Baseline data collection period (July 2023 – May 2024):

July 2023
7 EV bays Leased to User 6

August 2023
1 EV bay Leased to User 1

September 2023
1 EV bay Leased to User 2

October 2023
1 EV bay Leased to User 3

November 2023
1 EV bay Leased to User 4

May 2024
Migration of chargers to Exploren Charger Management Platform. Commencement of Controlled Charging

June 2024
Controlled and Smart Charging Experiments

June 2025
Completion of Trial at Wilson Parking Off-Street Car Parks

2. Trial Setup

2.1. Wilson Parking

Wilson Parking, South Australia's largest private car parking operator, participated in the trial to support the acceleration of EV adoption and implementation of controlled and smart charging solutions in South Australia.

Key aspects of Wilson Parking's participation:

Strategic Infrastructure Deployment

- The installation of 18 EV chargers across three strategically selected Wilson Parking locations marks a deliberate approach to creating accessible charging networks at locations where drivers naturally congregate. This deployment strategy recognises that parking facilities are ideal charging hubs, allowing EV owners to simultaneously park and charge their vehicles during extended stays. Distributing chargers across multiple locations, rather than concentrating them at a single site, ensures broader geographic coverage and reduces potential congestion at charging points.

Integration with Existing Operations

- Wilson Parking's participation demonstrates how traditional parking operators can integrate new technology into their existing business models. The trial required careful consideration of electrical infrastructure upgrades, parking space allocation, and operational protocols to ensure that EV charging capabilities complement rather than disrupt standard parking services. This integration process provides valuable insights for other parking operators considering similar upgrades in Australia and internationally.

Controlled Charging Solutions and Grid Integration

- The trial's focus on controlled charging solutions addresses a critical challenge in EV adoption: the potential strain on electrical grid systems during peak demand periods. Wilson Parking's involvement in testing these solutions helped validate technologies that intelligently distribute charging loads, potentially reducing electricity costs for both operators and users while maintaining grid stability. This approach is particularly crucial as EV adoption increases, ensuring that charging infrastructure can grow sustainably alongside electric vehicle uptake.

2.2. Site Selection

The success of the trial depended heavily on the careful selection of charging locations, focussing on placing EV chargers to effectively support daily vehicle operations and ensure user accessibility. The following sites were chosen:

Location 1:

Address: 61-67 Wyatt Street Adelaide CBD.
Infrastructure: Nine smart EV chargers were installed to support the trial.

Figure 2.2 (a): Location at 61-67 Wyatt Street, Adelaide CBD, where 9 EV chargers were installed.

Location 2:

Address: 189-207 Hindley Street 5000 Adelaide.
Infrastructure: Three smart EV chargers were installed to support the trial.

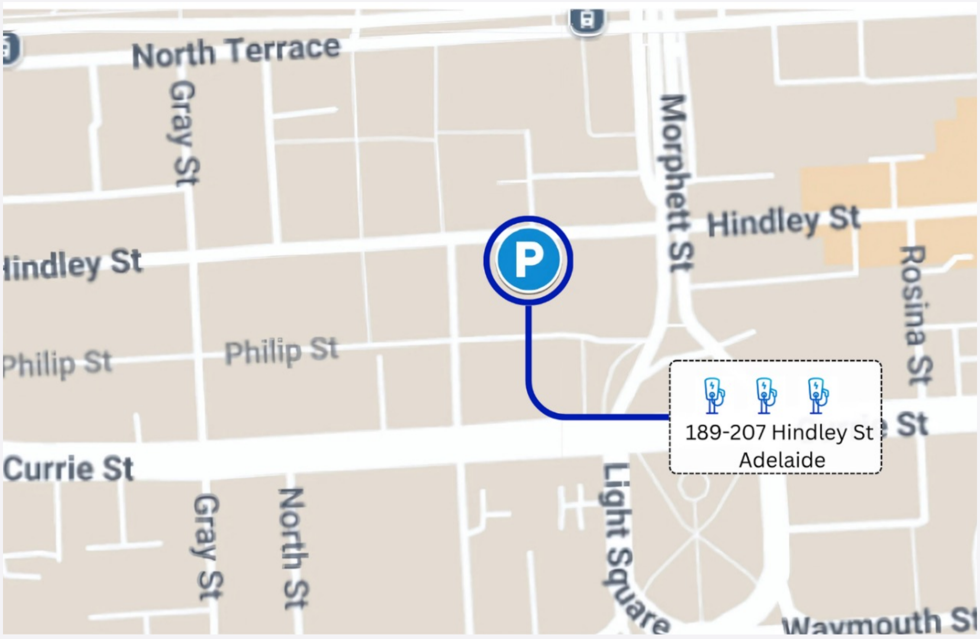


Figure 2.2 (b): Location at 189-207 Hindley Street, Adelaide CBD, where 3 EV chargers were installed.

Location 3:

Address: Lot 14 Frome Road 5000 Adelaide.
Infrastructure: Six smart EV chargers were installed to support the trial.

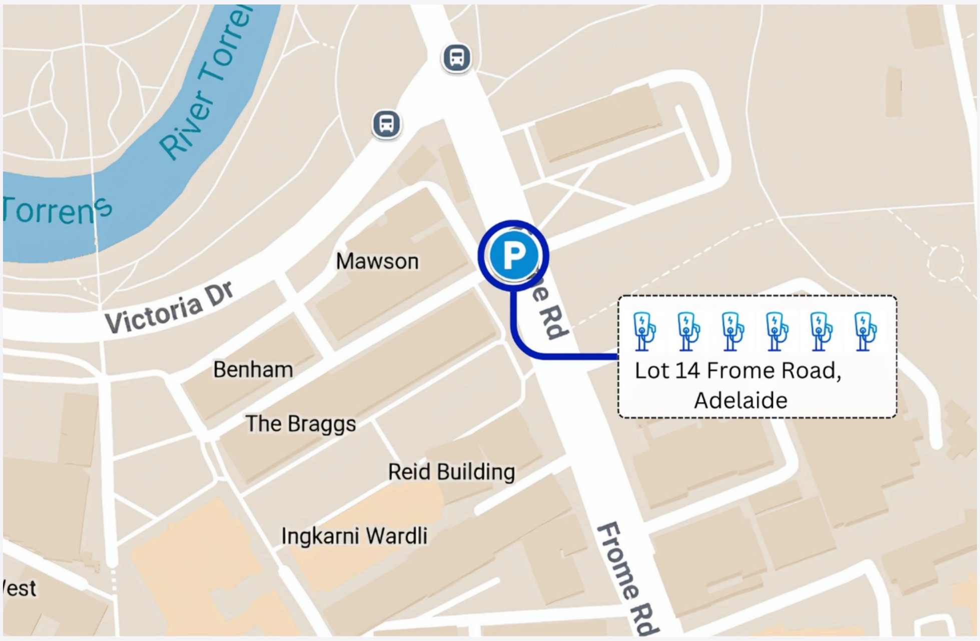


Figure 2.2 (c): Location at Lot 14 Frome Road, Adelaide, where 6 EV chargers were installed.

2.3. Selection of EV Chargers

The trial required careful selection of charging hardware that would meet both technical requirements and user needs.

After comprehensive evaluation, the Ocular IQ Commercial 22kW charger was chosen for all commercial locations, as it met our key requirements listed below.

1

Technical Specifications

- Level 2 charging capability^
- Charging speed: 2.9-22 kW (adding up to 51 km/hr range)
- 22kW capacity charging cable
- Full OCPP 1.66J compatibility

2

Safety and Protection

- Overload protection
- Fault protection
- Commercial grade construction
- Outdoor rating

3

Connectivity Features

- RFID authentication
- Ethernet connectivity
- Wi-Fi capability
- Programmable charging schedules

4

Installation and Compatibility

- Flexible mounting options (wall or post)
- Universal compatibility with EV models
- Type 1, Type 2 connector or Type 2 socket options
- Support for both single-phase (7kW) and three-phase (22kW) power

^ Difference between different Levels of EV charging listed here.

Selecting the right charging equipment is a critical long-term investment. Getting it right the first time avoids costly replacements and operational disruptions.

2.4. Charging Management Platform Requirements

The selection of a suitable charging management platform was critical to the trial's success. This platform acted as the central control and monitoring system for the entire charging network. Our evaluation focused on identifying a platform that offered comprehensive control, reliable monitoring, and scalable operations.

The core functionality requirements included:

a) **Monitoring and Remote Management**

The platform needed to provide real time visibility of charging operations across all sites, including live status monitoring, fault detection, and remote troubleshooting. This functionality proved essential during the trial, enabling the rapid identification and resolution of charging issues without requiring on-site visits, thereby significantly reducing operational costs and downtime.

b) **Load Management and Electricity Distribution**

A sophisticated load management system was crucial for optimising power distribution across multiple charging points. The platform was required to intelligently balance charging loads while respecting site power limitations. This capability facilitated efficient power utilisation, avoiding the need for expensive electrical infrastructure upgrades.

c) **Authentication and Payment Systems**

The platform needed to support multiple authentication methods and provide flexible access control. Although the trial primarily used RFID authentication, the system's ability to accommodate various payment and authentication methods ensured future scalability.

d) **Data Analytics and Reporting**

Comprehensive data collection and analysis capabilities were necessary to:

- Track charging patterns and usage metrics
- Generate detailed reports on electricity consumption
- Monitor charger utilisation rates
- Provide API functionality for charging profile management (using OCPP 1.6)

Implementation Experience:

- **During the trial, a transition to the Exploren platform occurred due to market changes. This transition highlighted the importance of vendor stability, data migration capabilities, API functionality, and platform reliability when selecting a charging management platform.**
- **The successful integration of suitable hardware, an intelligent platform, and a forward-thinking strategy is fundamental for effective EV charging operations.**

2.5. EV Charging Power and Battery Capacity Among Car Park Users

The charging performance of EVs is determined by two critical factors: the vehicle's onboard charger capacity and the available AC power supply, with either potentially becoming the limiting factor in the overall charging process.

There was a mix of EVs among users, and the onboard chargers ranged from 3.7 -11 kW. In anticipation of technological advancement, the charging infrastructure installed was designed to deliver up to 22 kW of power.

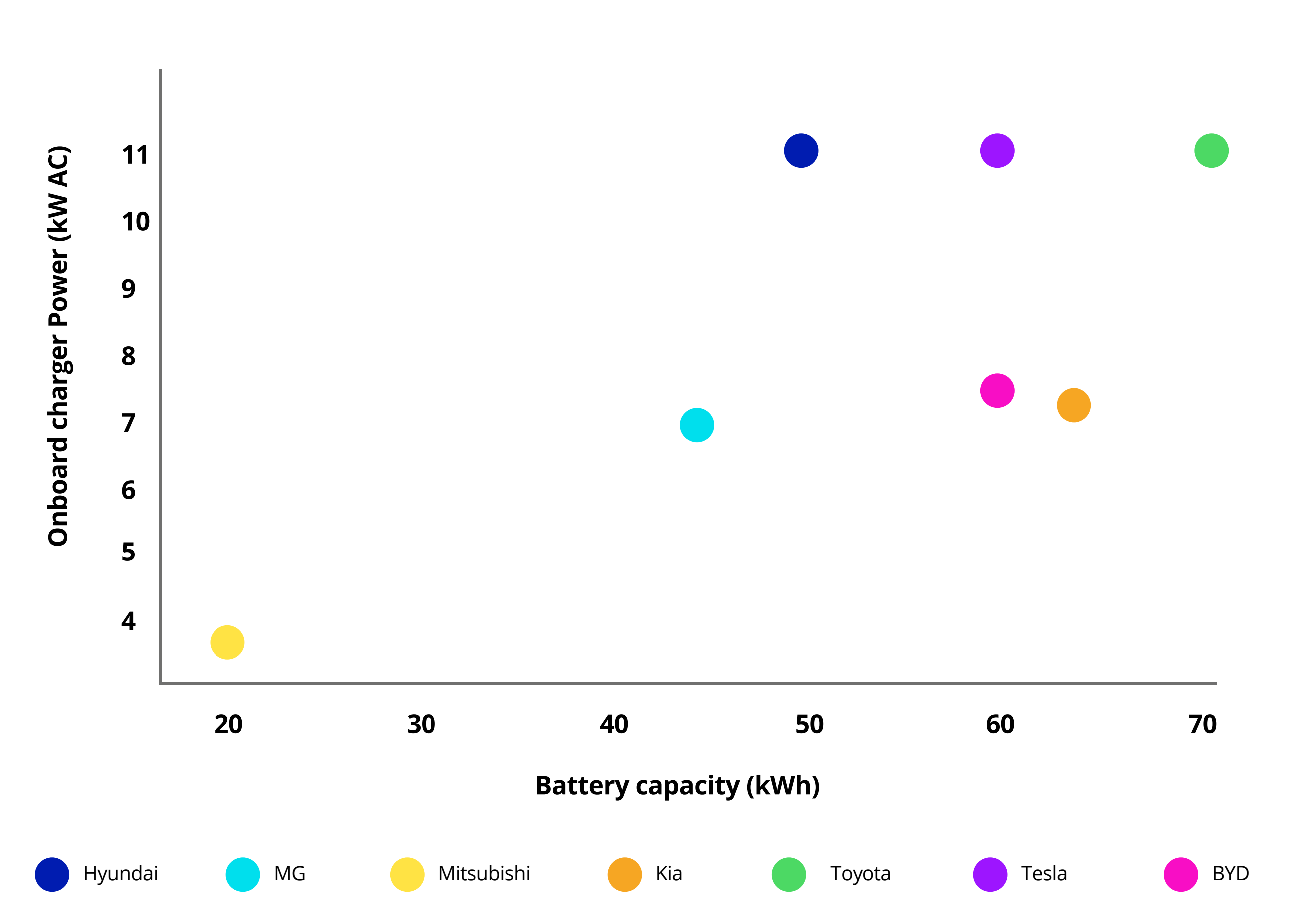


Figure 2.5: Comparison of the onboard charger capacities (kW AC) and gross battery capacities (kWh) for all EVs parked at electrified parking bays for the trial duration.

2.6. Wilson Parking's Monthly Reserved EV Charging Subscription

Wilson Parking recognised the growing demand for reliable EV charging infrastructure and responded by providing a Monthly Reserved Parking Subscription product specifically designed for customers seeking guaranteed access to electrified parking bays. This forward-thinking service addresses one of the most significant pain points for EV owners: the uncertainty of finding available charging stations when needed.

Flexible Subscription Options

The subscription model was designed to accommodate diverse customer needs and preferences. Customers were presented with two primary options for their parking commitment. Customers seeking long-term stability and potentially better rates could opt for extended lease agreements, providing them with predictable monthly costs and guaranteed bay availability over an extended period. Alternatively, customers who preferred maximum flexibility could choose the month-to-month subscription model, allowing them to adjust their parking needs as circumstances changed without being locked into lengthy commitments.

This dual approach ensured that commercial and government fleets, car rental operators, committed daily commuters, and occasional users could find a subscription model that matched their usage patterns and financial preferences. The flexibility was particularly valuable for customers who might experience seasonal variations in their parking needs or were uncertain about their long-term parking requirements.

By guaranteeing dedicated spaces with integrated charging at fixed monthly costs, the dual subscription model (long-term vs flexible) captures both fleet operators and casual users effectively.

Bundling charging into subscriptions eliminates per-session fees while creating predictable revenue streams. This transforms charging infrastructure from a cost centre into a customer retention tool.

Comprehensive Service Inclusions

The Monthly Reserved Parking Subscription was structured as an all-inclusive package that eliminated the common frustrations associated with public EV charging. Each subscription guaranteed customers their own dedicated parking bay, removing the stress of searching for available spots during peak hours or busy periods. This reserved space model provided peace of mind, particularly valuable for daily commuters who needed reliable parking solutions.

The integration of EV charging as a core component of the monthly subscription represented exceptional value for customers. Rather than treating charging as an additional service with separate fees, Wilson Parking bundled the electrical supply directly into the subscription cost. This meant customers could charge their vehicles without worrying about additional per-session fees, time-based charging costs, or the inconvenience of multiple payment systems.

Strategic Benefits for EV Adoption

By offering this comprehensive subscription service, Wilson Parking positioned itself as a facilitator of EV adoption, addressing infrastructure concerns that often deter potential EV buyers. The service model provided predictable costs for customers while ensuring sustainable revenue streams for Wilson Parking, creating a win-win scenario that supported the broader transition to electric vehicles.

The reserved bay system also maximised utilisation efficiency, as customers with guaranteed access were more likely to use their allocated spaces consistently. This approach helped Wilson Parking optimise their investment in charging infrastructure while providing customers with a premium, reliable service experience.

2.7. Customers Access to EV Charger Infrastructure

Wilson Parking has implemented a comprehensive access management system for customers utilising electrified parking bays across their locations. Upon securing a Parking Subscription for an electrified car park bay, each customer received a dedicated Radio Frequency Identification (RFID) card that serves as their primary access credential for the charging infrastructure. This RFID technology ensured seamless and secure access to charging stations while maintaining operational control over the charging network.

Individual Customer Access Management

For individual customers, the RFID card system provided a straightforward and user-friendly approach to accessing charging facilities. Each card is uniquely programmed and linked to the customer's specific parking bay allocation. This personalised access ensured that customers can efficiently utilise their designated charging infrastructure without the need for complex authentication procedures or mobile applications, creating a streamlined charging experience that integrates naturally with their daily parking routine.

Fleet Management Integration

For customers operating vehicle fleets within Wilson Parking locations, the RFID access system scales effectively to accommodate multiple vehicles and drivers. Fleet managers received administrative control over card distribution, allowing them to strategically allocate RFID cards based on specific EV booking schedules and operational requirements. Cards are distributed according to planned EV bookings rather than providing universal access.

2.8. Costs Associated to Installation of EV Chargers

The implementation of EV charging infrastructure involves a range of upfront capital expenditures (CAPEX) and ongoing operational expenses (OPEX). Initial investments vary significantly based on site requirements, installation complexity, and equipment selection. Analysis across trial locations revealed that total CAPEX ranged from $14,000 to $40,000 per charging station, while OPEX typically accounts for 8% of total costs annually. The breakdown of these expenses in Figure 2.8 shows that EV charging infrastructure costs varied across sites. Electrical installation and on-site upgrades represented the largest investment at 47-54% of total costs, notably higher at Wyatt Street due to 9 EV chargers.

Charger units made up 38-46% of expenses, with Ocular IQ Commercial deployed at all three Wilson Parking Car Park Locations.

Charger Management Platform from Plugsurfing and Exploren contributed 4% of costs, while internet connectivity installations necessary for connectivity with chargers accounted for 4% of the total investment.

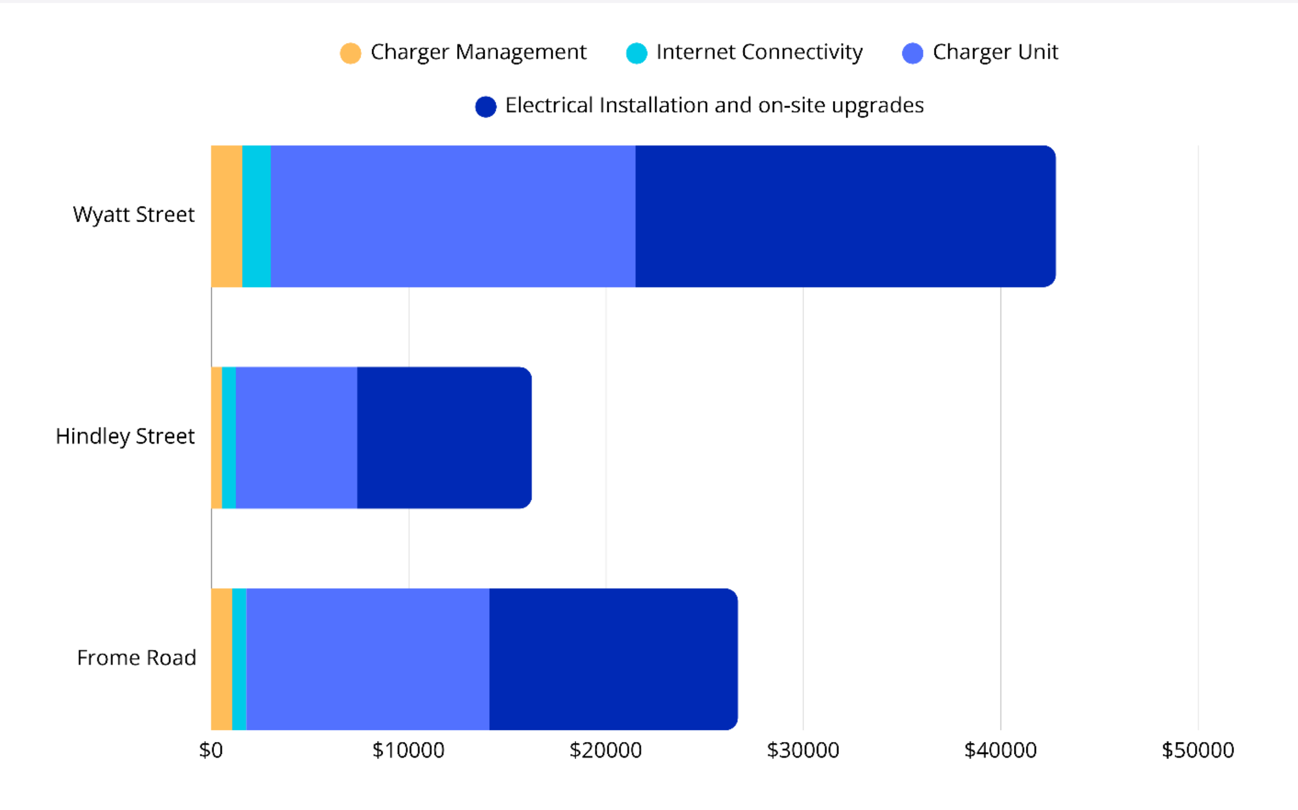


Figure 2.8: EV charging infrastructure cost breakdown by installation location.

Electrical Installation and on-site upgrades:

- Electrical installation and onsite upgrades, such as panels, circuit breakers, new cables and wiring, and electrician labour, comprised between 47 - 54 % of the upfront costs.

Charger Units:

- The Ocular IQ Commercial charger units were used across all three locations: Wyatt Street, Hindley Street, and Frome Road. These units provided a dedicated 230V circuit with AC energy.

Charger Management:

- To leverage the smart charging functionality provided via OCPP, a charger management solution from Plugsurfing and Exploren were utilised during the trial period.

Internet Connectivity:

- Internet connectivity was essential for data collection from the EV chargers and communication for smart charging features.

2.9. Controlled Charging

Controlled charging is a strategic approach to electric vehicle charging that optimises when and how EVs charge by adjusting charging schedules or power levels. This method benefits both customers and the electrical grid by avoiding peak demand periods and reducing grid strain. For this trial we have implemented controlled charging strategies based on SA Power Networks' different Time of Use periods listed below:

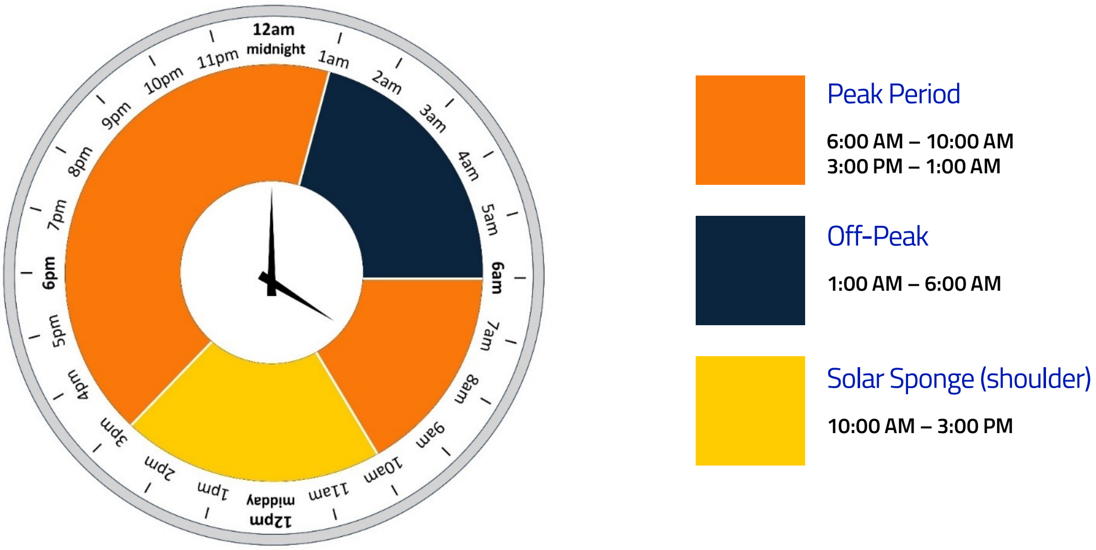


Figure 2.9: Tariffs applicable at different times of the day. Source: SA Power Networks' different Time of Use periods.
(Note: SAPN Solar Sponge changed from 9:30 AM – 4:30 PM as of 1 July 2025)

Peak Period

6:00 AM – 10:00 AM and 3:00 PM – 1:00 AM

These are traditionally the times of highest demand and when electricity costs the most.

Off-Peak

1:00 AM – 6:00 AM

Pricing applied for a five-hour off-peak block every day, usually overnight.

Solar Sponge

10:00 AM – 3:00 PM

Also sometimes known as 'shoulder': This is usually the cheapest time to use electricity - in the middle of the day when solar generation is typically at its highest.

Charging costs and potential savings outlined in the report as based on the AGL Time of Use Tariff Standing Offer price SA Power Networks distribution as of April 2025.

Peak Period	Off-Peak	Solar Sponge (Shoulder)
52.151 c/kWh	36.333 c/kWh	31.350 c/kWh

2.10. Controlled vs Uncontrolled Charging

Implementing EV Charging Profiles Using OCPP 1.6

The implementation of charging profiles for EV chargers was successfully accomplished using the Exploren API. While programming these charging profiles through Charger Management Platform, we encountered several technical challenges that required diligent problem-solving and iterative development. After multiple refinements, the charging profiles were successfully configured as per the requirements.

Technical Implementation of Controlled Charging

The programming of customised charging profiles proved more complex than initially anticipated and required significant technical expertise. Our approach centred on configuring the chargers handle varied charging schedules. We created a schedule that tells the charger when to charge the EV and when to stop. It looks like a list of instructions with times and power levels. Example below:

```
"chargingSchedulePeriod": [
  {"startPeriod": 0, "limit": 0},
  {"startPeriod": 3600, "limit": 32},
  {"startPeriod": 25200, "limit": 0},
  {"startPeriod": 36000, "limit": 32},
  {"startPeriod": 54000, "limit": 0}
]
```

The schedule works in time periods measured in seconds from midnight:

- 0 seconds = midnight (12:00 AM)
- 3600 seconds = 1:00 AM
- 25200 seconds = 7:00 AM
- 36000 seconds = 10:00 AM
- 54000 seconds = 3:00 PM

The "limit" number controls charging speed:

0 = no charging allowed, 32 = charging at 32 amps

This is like telling the charger: "Don't charge at first, then start charging after one hour, stop charging after seven hours, start again at ten hours, and finally stop at fifteen hours."

An important consideration during implementation was accounting for daylight saving time adjustments, which required updates to the charging profiles to maintain accurate scheduling.

Implementation Process

We established a systematic workflow for deploying charging profiles across the charging infrastructure. This process was iteratively applied to configure various charging schedules tailored to different operational requirements:

1. Construct required charging profile payload
2. Clear-charging-profile on the charge point
3. Set new charging-profile on the charge point
4. Verify if charging profile was successful implemented

Steps 1 to 3 were repeated multiple times to set different charging profiles on the chargers.

Impact of State of Charge Limitations on Trial Implementation

The EV charging infrastructure installed for the trial was compliant with Open Charge Point Protocol (OCPP) 1.6 standards. Throughout the trial period, State of Charge (SOC) data for electric vehicles was not accessible due to several structural limitations associated to OCPP 1.6J.

The inability to access SOC (State of Charge) data had notable implications for the comprehensive implementation of smart charging strategies, limiting the trial's capacity to optimise charging based on vehicle battery status. This constraint affected the full realisation of the smart charging potential within the established trial parameters.

To address this limitation in future implementations, upgrading to OCPP 2.0.1 (Open Charge Point Protocol) would be necessary. Unlike the current protocol version used in the trial, OCPP 2.0.1 natively supports SOC data capture from connected vehicles, enabling more sophisticated charging optimisations based on real time EV battery status information, which would significantly enhance smart charging effectiveness.

2.11. Smart Charging

Smart Charging utilised advanced communication networks to dynamically optimise EV charging in response to real time grid conditions. The system continuously modulates charging power levels and schedules by evaluating multiple variables, spot price and generation mix (solar panels, wind, coal).

It enabled EVs to consume power during periods of abundant renewable generation and low grid demand, creating a more sustainable and cost-effective charging infrastructure.

System Architecture

The implementation spanned across three distinct car park sites with varying scales. All charging stations connected to a centralised Smart Charging management system via OCPP (Open Charge Point Protocol) through CPMS (Charging Point Management System).

Smart Charging Process Flow

Data Collection & Analysis

The system continuously monitored two critical inputs: the electricity generation mix (showing proportions of solar, wind, gas, diesel, and battery storage) and real time spot pricing data. This created a comprehensive view of both the climate impact and economic cost of grid electricity at any given moment. Interstate inflows/outflows of electricity via interconnectors were not taken into account for smart charging implementation.

Intelligent Decision Making

The core algorithm evaluated the current electricity composition to determine how much power comes from renewable versus fossil fuel sources. Simultaneously, it compared current spot prices against a 90-day rolling average from the previous year, identifying whether electricity is relatively expensive or affordable compared to historical patterns.

Dynamic Charging Optimisation

Based on this analysis, the system calculated optimal charging power output for each charging station. When renewable generation is high and spot prices are low, the system increased charging rates (32amps) across all locations. Conversely, during peak demand periods with high fossil fuel generation and elevated prices, it reduced charging speeds (16 amps).

Real Time Implementation

The charging profiles are then pushed to individual stations through the Exploren API system using OCPP protocols, ensuring each charger operates at the calculated optimal power level.

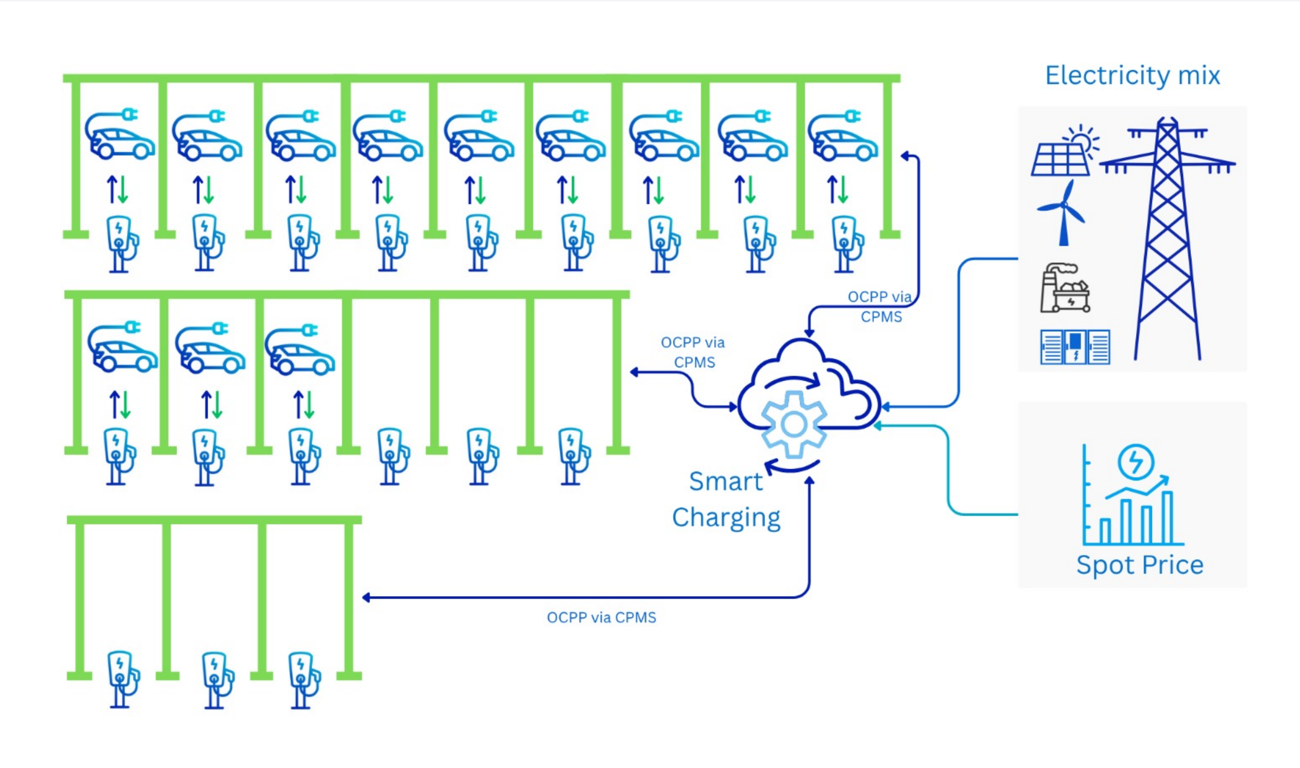


Figure 2.11: The Smart Charging implementation flow developed for this trial.

2.12. EV Charging Analysis Framework

During baseline period (October 2022 - May 2024), the charger management platform, was able to provide session, start time (plug-in time), stop time (plug-out time), duration, electricity consumed, ChargePoint name. for each session.

One significant limitation in the dataset was the absence of charging time (i.e. actual time taken for EV to full charge as opposed to total connection duration). To address this gap, we established a standardised estimate of 7 kWh/h as our baseline charging rate, which aligns with the typical capacity specifications of onboard EV chargers as detailed in (Section 2.5). This approximation allowed us to develop a more nuanced understanding of the charging dynamics.

For each individual charging session, we calculated a “synthetic charging timeline” through a methodical process. First, we determined the theoretical charging duration by dividing the actual recorded electricity consumption by our standardised 7 kWh/h power rate. This synthetic timeline was then distributed across hourly intervals according to a detailed algorithm:

- Initial hour: We calculated electricity delivery as the power rate multiplied by the available minutes remaining in that hour after connection
- Subsequent complete hours: The full hourly electricity delivery potential (7 kWh) was applied
- Final partial hour: We allocated precisely the remaining electricity required to match the documented total consumption for that session (ref Figure 2.12)

This approach assumed charging begins immediately after connection, which matched our baseline observations, employees and fleet manager confirmed this behaviour.

A particularly valuable insight from our analysis was the identification and quantification of ‘idle capacity’ – representing potential electricity delivery opportunities during periods when vehicles remained connected but were not actively charging. We calculated these idle periods by subtracting the synthetic charging duration from the total connection time. The untapped charging potential during these idle windows was then quantified by multiplying the idle hours by our standardised 7 kWh/h power rate.

This comprehensive analytical framework can be summarised through four fundamental equations:

1. Vehicle Connection Duration = Total time from plug-in to plug-out (complete session duration)
2. Active Charging Duration = Total electricity delivered ÷ Standardised charging power
3. Idle Duration = Connection duration - Active charging duration
4. Hourly Idle Capacity = Idle duration × Standardised charging power

An Example on how synthetic timeline calculation is performed:

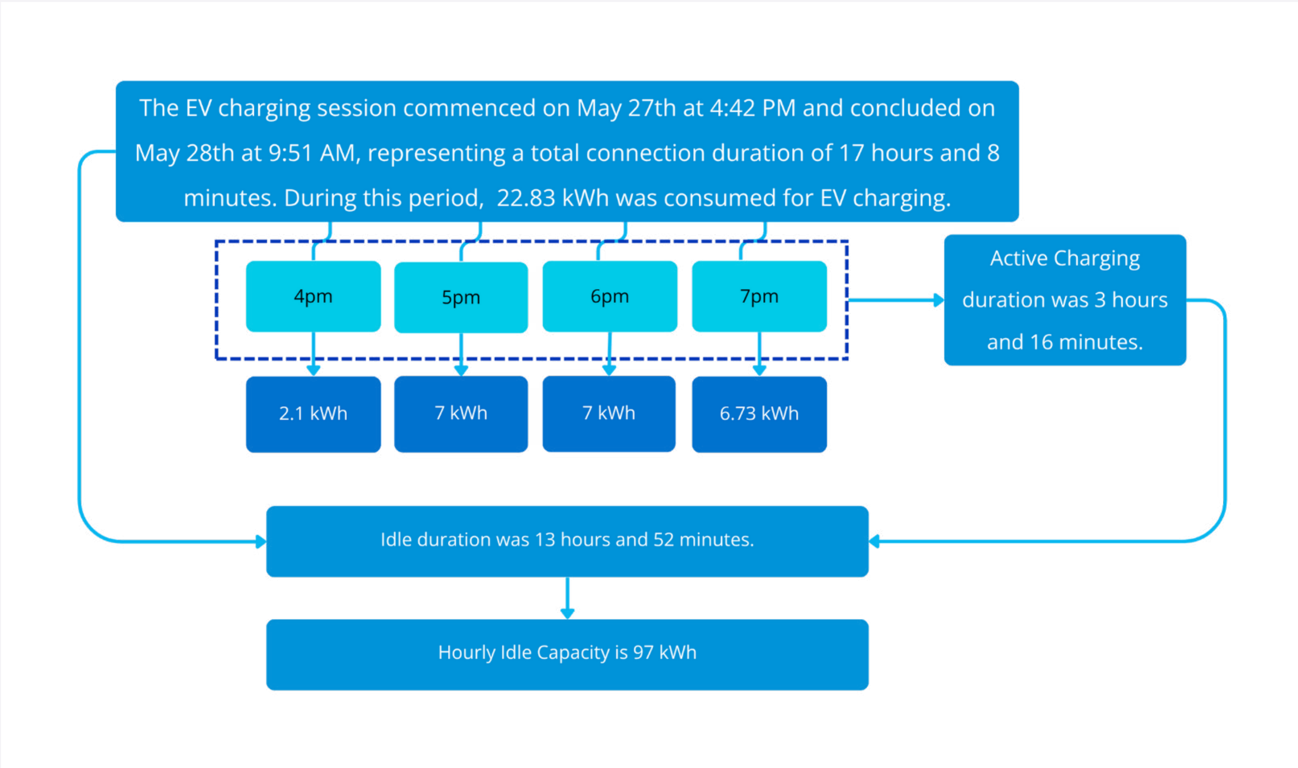


Figure 2.12 Electric vehicle charging session timeline with hourly breakdowns and electricity delivered per hour.

3. Innovative Bundle Proposition

The bundle offer represented a paradigm shift in how EV services are delivered. Rather than forcing customers to piece together a solution from multiple providers, this innovative proposition was created to provide a seamless, all-encompassing experience that addresses every aspect of EV ownership and usage.

At its core, the bundle offer recognised a fundamental truth: successful EV adoption requires more than just access to an EV - it demands a complete ecosystem of supporting services delivered with exceptional convenience and reliability. By combining Wilson Parking's established infrastructure with AGL's comprehensive energy solutions, the bundle proposition created a unified platform that eliminates the complexity traditionally associated with EV ownership.

3.1. Bundle Service Components

Dedicated Electrified Parking Bay

- Reserved parking space with integrated charging infrastructure
- Guaranteed availability during subscription periods
- Professional maintenance and technical support
- Strategic locations in high-demand urban areas

All-Inclusive EV Subscription from AGL

- Vehicle access through a subscription model
- Comprehensive insurance coverage
- Regular maintenance and servicing
- 24/7 customer support and roadside assistance
- Flexible EV upgrade options as new models are released into the market

Leasing Model

The introduction of flexible leasing arrangements addressed multiple market realities:

3-Month Options

- Trial Period: Allowed customers to test the service before longer commitments
- Seasonal Flexibility: Accommodated varying work patterns throughout the year
- Project-Based Usage: Suited temporary assignments or short-term office relocations

6-Month Arrangements

- Balanced Commitment: Provided cost savings while maintaining flexibility
- Seasonal Transitions: Aligned with common business planning cycles
- Relationship Building: Allowed trust development before longer-term commitments

12-Month Subscriptions

- Maximum Value: Offered best pricing for committed users
- Stability Benefits: Provided guaranteed access during high-demand periods
- Corporate Arrangements: Suited business fleet management requirements

Value Proposition

The bundle addressed multiple customer pain points simultaneously:

- Convenience: Single provider for all EV needs
- Cost Predictability: Fixed monthly pricing structure
- Infrastructure Assurance: Guaranteed access to charging facilities
- Risk Mitigation: Comprehensive support and maintenance included

3.2. Marketing Strategy Deep Dive

Customer Segmentation and Targeting

The campaign employed sophisticated data analytics to identify optimal prospects:

- Geographic Proximity Analysis: Customers located within a defined radius of trial locations
- Business Profile Assessment: Companies with sustainability initiatives or fleet requirements
- Electricity Usage Patterns: Businesses interested in renewable electricity solutions
- Size and Industry Factors: Organisations likely to influence employee EV adoption

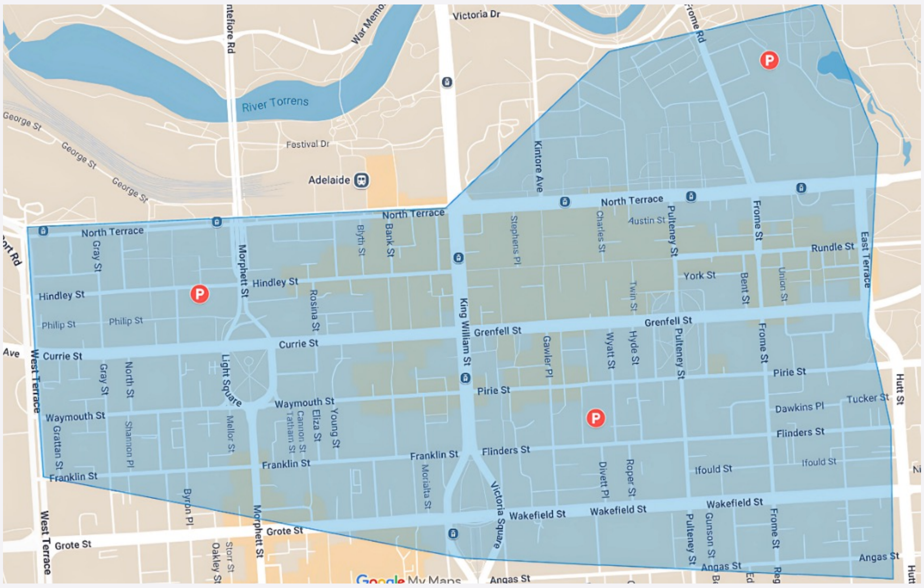


Figure 3.2 (a): Locations of chargers installed at Wilson Parking car parks.

Figure 3.2 (b): Locations of potential customers based on segmentation.

Multi-Channel Engagement Approach

- Personalised communications highlighting specific benefits relevant to each business segment were sent.
- Direct sales conversations to address specific concerns and customise offerings were conducted.
- Existing AGL business relationships were leveraged for warm introductions.

Wilson Parking In-Venue Strategy

Strategic positioning of promotional materials maximised visibility and engagement:

- Foyer Installations: High-impact displays at building entrances
- Elevator Advertising: Captive audience engagement during daily commutes
- Parking Level Signage: Point-of-service promotion when customers were actively parking
- Digital Integration: QR codes linking to detailed information and sign-up processes

3.3. Learnings and Market Insights

Post-COVID Workplace Transformation and Its Impact on EV Infrastructure

The COVID-19 pandemic fundamentally reshaped workplace dynamics, creating unexpected obstacles for the early adoption of EV parking infrastructure. As organisations implemented remote work policies, hybrid schedules became the new normal, traditional commuting patterns experienced a dramatic shift. This transformation significantly impacted the demand for dedicated EV parking bays and charging subscriptions.

The slow return to in-office work created a unique challenge for parking operators and EV infrastructure providers. With many employees working from home three to four days per week, the traditional Monday-to-Friday office parking model became less relevant. This reduced frequency of office visits meant that potential EV owners were hesitant to commit to long-term parking subscriptions for spaces they might only use sporadically.

Furthermore, uncertainty surrounding permanent return-to-office policies left both employers and employees in a state of flux. Companies were reluctant to invest in EV charging infrastructure for workforces that might not return to pre-pandemic office attendance levels. Similarly, individual EV owners found it difficult to justify the cost of dedicated parking subscriptions when their commuting schedules remained unpredictable.

This workplace transformation also coincided with a period of rapid EV adoption, creating a paradox where demand for EVs was increasing while the infrastructure to support workplace charging was struggling to find its footing. The result was a temporary misalignment between EV ownership growth and the utilisation of commercial charging facilities.

Changes to work habits post-COVID (i.e. hybrid WFH model) created challenges for selling EV carpark subscriptions & bundled offers.

Adaptive Flexibility: Redefining Subscription Models for Market Reality

Perhaps the most innovative aspect of Wilson Parking's strategy was its willingness to adapt traditional subscription models to meet evolving customer needs. Recognising that the conventional long-term subscription approach was creating barriers to adoption, the company introduced flexible leasing options that acknowledged the diverse circumstances of potential EV users.

The introduction of 3 to 12-month leasing periods represented a fundamental shift in how parking operators approached customer relationships. This flexibility addressed multiple customer concerns simultaneously: the uncertainty of post-pandemic work arrangements, the hesitation to commit to long-term contracts, and the varying needs of different EV ownership scenarios.

For customers who had already invested in EVs but lacked convenient charging options, these flexible terms provided an attractive solution. Rather than being forced into annual subscriptions that might not align with their actual usage patterns, these EV owners could access premium parking locations with charging capabilities on terms that matched their specific needs.

The leasing model also proved particularly valuable for businesses testing EV adoption among their employees. Companies could experiment with providing EV parking benefits without making long-term infrastructure commitments, allowing them to gauge employee interest and usage patterns before making more substantial investments.

The flexible approach also recognised the rapid evolution of EV technology and charging standards. By avoiding long-term lock-ins, customers could adapt their parking and charging arrangements as new technologies emerged, while Wilson Parking could upgrade its infrastructure without being constrained by legacy subscription commitments.

4. Charging Analysis by Users

There were 5 individual users and one fleet who occupied electrified parking bays, each user had a reason to taking up the parking bays. Below are the quantitative and qualitative insights based on charging behaviours and interviews with respective users.

4.1. User 1

This user drives about 20-30 km per day into the CBD for work and usually arrives at work with about 85% battery charge. On weekends after longer drives, might return home with as little as 30% charge and also uses the Wilson Parking occasionally for weekend shopping trips to the city. The user has a sophisticated home setup with solar panels, a Powerwall battery, and home EV charging capability. The user owns two Tesla vehicles (Model 3 and Model Y) and strategically optimises charging between home and workplace based on seasonal solar production. Prefers to maintain the EV battery at 100% charge when possible. A technology-motivated early adopter who values the convenience of not needing to visit petrol stations.

4.1.1. EV Utilisation

Began using the Wilson Parking Car Park charging facility in August 2023, showing evolving usage patterns over the baseline period (August 2023 – May 2024). Utilisation rate has generally increased from an initial 30% in August 2023 to consistently above 50% from September onwards, with peak usage of 71% in February 2024. This demonstrates strong adoption and consistent usage of the charging facility, with the user utilising it on average 60% of available business days.

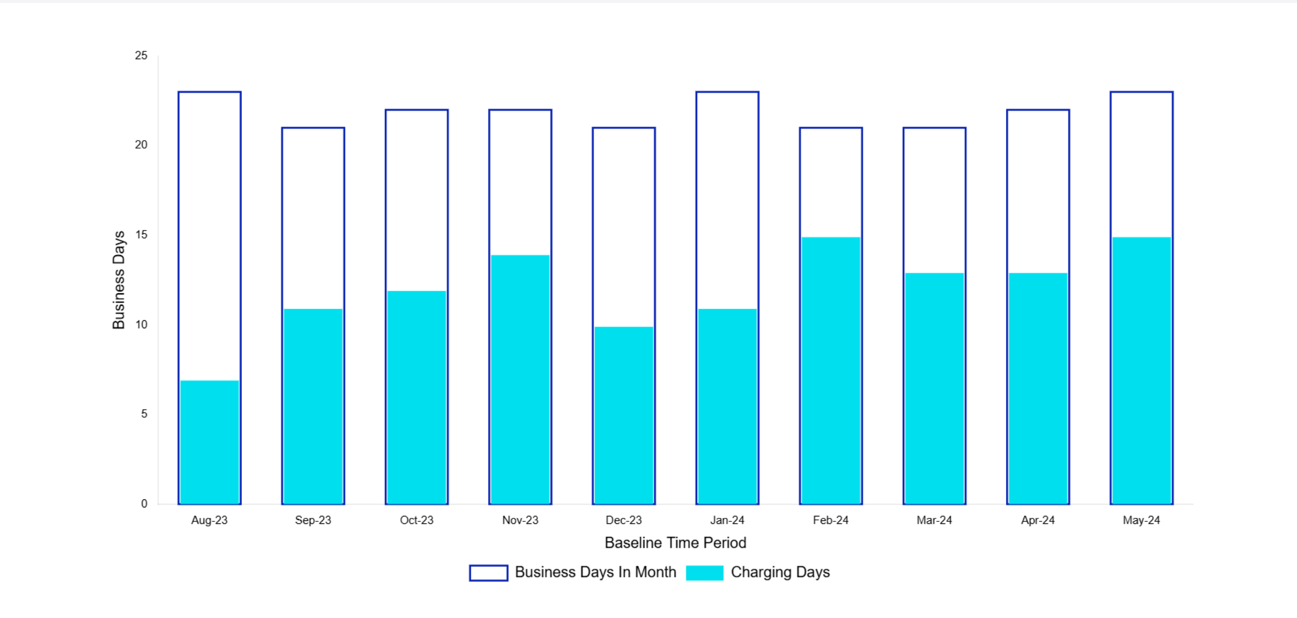


Figure 4.1.1: EV charger utilisation over time, showing monthly business days and days used.

4.1.2. Charging Patterns

During the baseline period this user demonstrated a remarkably consistent charging behaviour across all analysed weeks, charging sessions concentrate in a narrow 2–4-hour window between 8:00 AM and 2:00 PM, with peak activity consistently occurring at 9:00 AM across multiple weeks.

Morning Peak Contribution:

51% of charging occurs between 7:00 – 9:00 AM, adding to the grid's morning peak. Shifting this load to the 10:00 AM – 3:00 PM solar window would better align demand with renewable generation.

Electricity Consumption Range:

Weekly totals vary from 18 kWh to 71kWh, indicating variable electricity needs.

Routine-Driven:

The highly consistent timing suggests that the workplace routine drives charging behaviour.

Immediate Charging Preference:

The user plugs in immediately upon arrival.

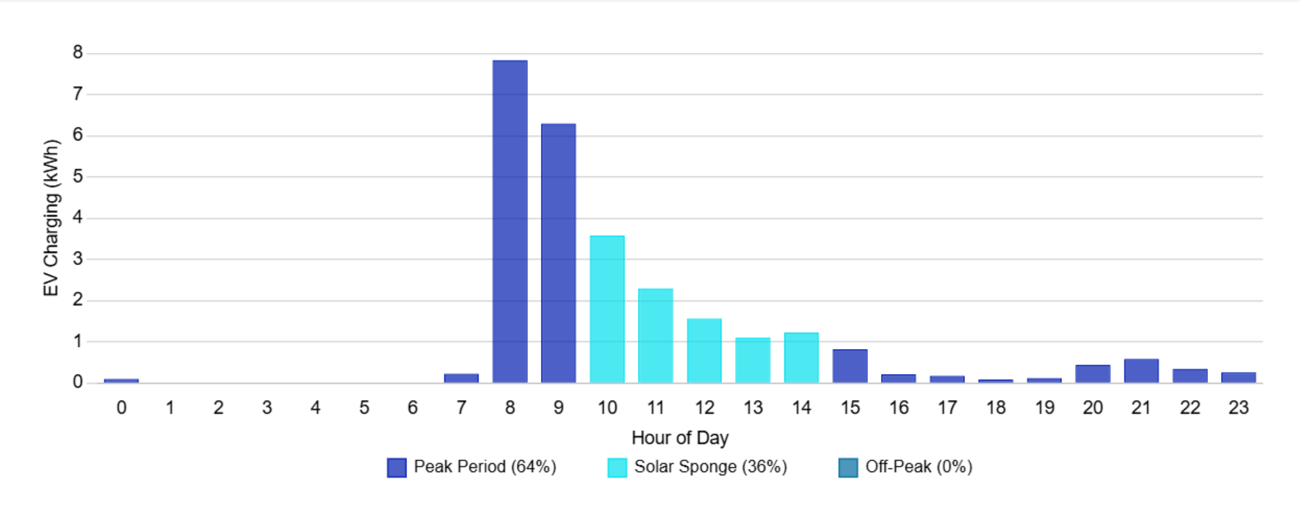


Figure 4.1.2: Uncontrolled EV charging (kWh) by hour of day with time-of-use periods.

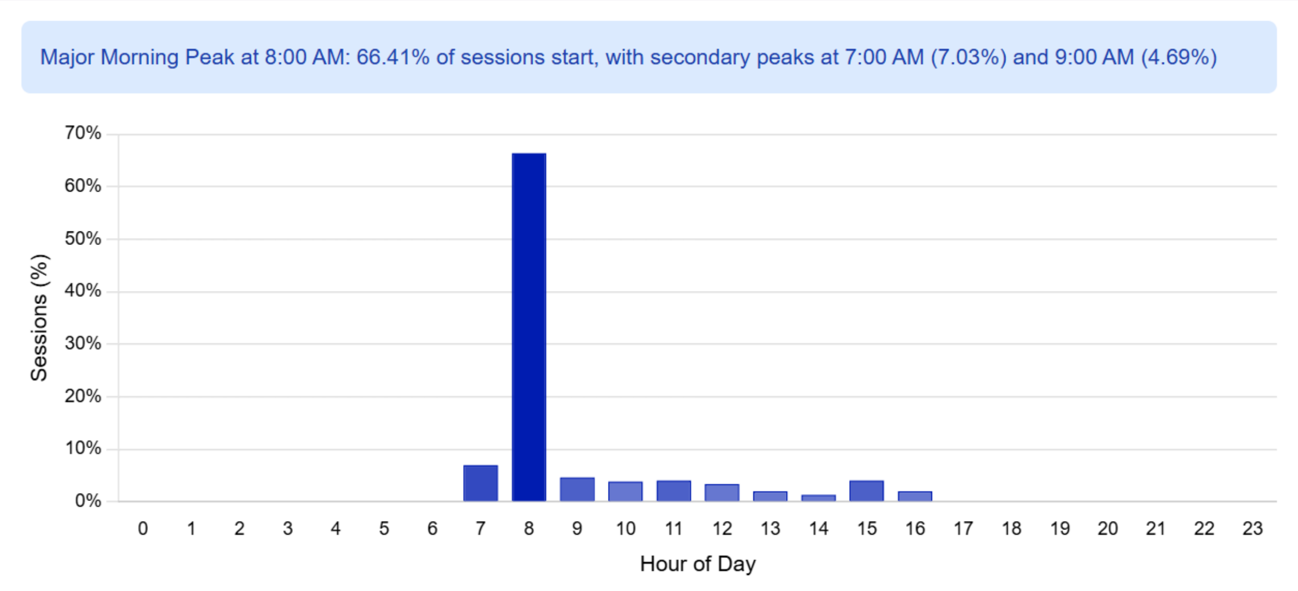
X-Axis (Hour of Day): Represents the 24-hour time periods from 0 (midnight) to 23 (11:00 PM), showing when charging sessions occurred throughout the day.

Y-Axis (Electricity kWh): Shows the average EV charging in kilowatt-hours (kWh) for each hour, calculated across 40 weeks.

Data Representation: Each bar represents the average electricity consumed for that specific hour. Colours indicate time-of-use periods: Peak Period (highest electricity rates), Solar Sponge (optimal renewable electricity window), and Off-Peak (lowest electricity rates).

4.1.3. Charging Session Analysis: Start Time and Departure Patterns

The start time and departure analysis reveal highly concentrated arrival patterns with 66% of charging sessions beginning between 8:00 AM – 9:00 AM, contrasted against more distributed departure times with dual peaks at 5:00 PM–6:00 PM (21%) and 6:00 PM–7:00 PM (30%).



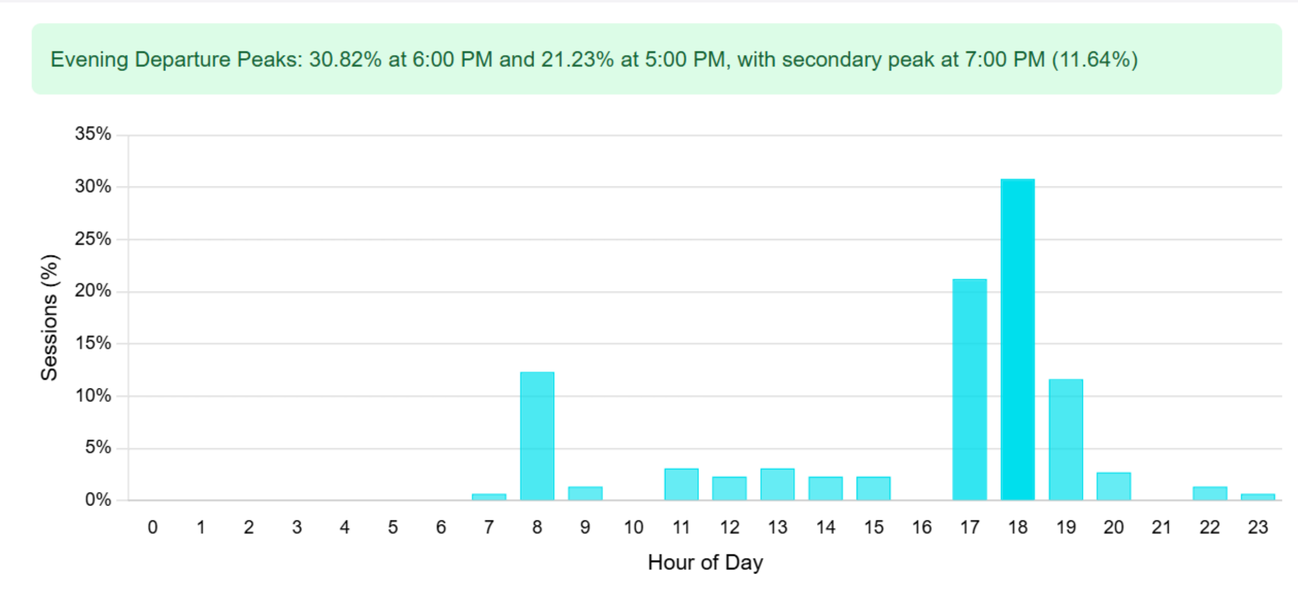


Figure 4.1.3: EV charging patterns showing major peaks.
Top graph: Morning arrival peak.
Bottom graph: Evening departure peak.

4.1.4. Predictable Charging Patterns Support Controlled Charging Implementation

The session analytics reveal a critical correlation between start times and total connected hours that provides powerful insights for predictive charging algorithms, controlled charging, and smart charging implementation. The data shows 66% of sessions between 8:00 AM and – 9:00 AM with a total of 749 hours, representing the dominant charging pattern that can be leveraged for charging optimisation strategies.

High Predictability Indicators

Routine-Based Charging (8:00 AM – 9:00 AM Start):

- Reliability: 66% probability of session start at 8:00 AM
- Duration predictability: 10 to 6-hour sessions with high consistency
- End time projection: Most sessions conclude between 5:00 PM – 7:00 PM
- Electricity forecasting: Enables accurate load prediction 16-24 hours in advance

Supporting Evidence:

- Low variance: Minimal activity outside 7:00 AM – 3:00 PM AM start window
- Concentrated behaviours: 83% of sessions start within 5-hour morning window

Charging Optimisation Strategies

Given the 66% of sessions starting between 8:00 AM and 9:00 AM, the below strategy was formulated

- Delayed initiation: Implement a 2 – 4 hour charging delay
- Solar alignment: Shift peak consumption to 10:00 AM–4:00 PM solar production window
- Grid optimisation: Reduce morning peak.

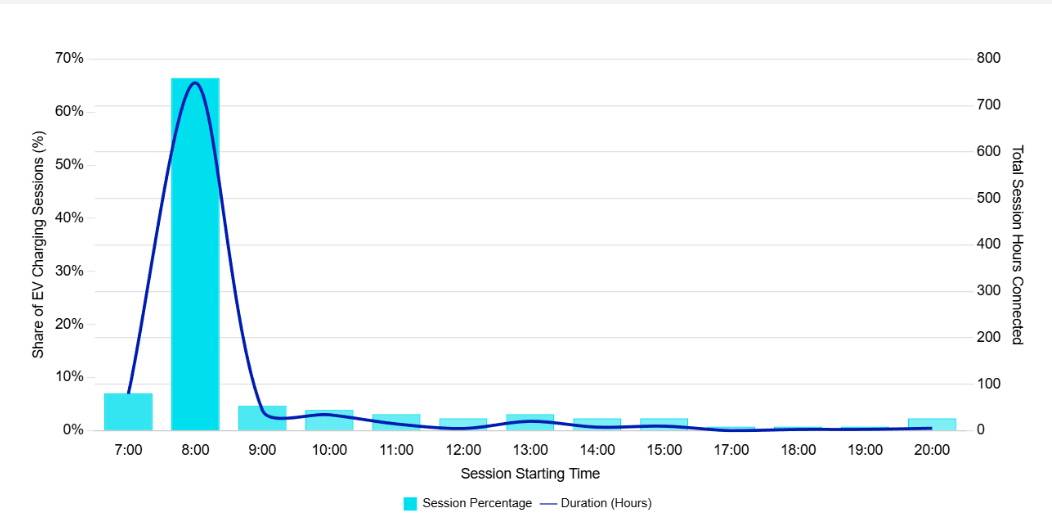


Figure 4.1.4: EV charging session start times and connection duration.

X-axis: Hour of day when sessions begin.

Left Y-axis: Share of sessions (%).

Right Y-axis: Total hours connected for sessions starting in that hour.

4.1.5. Controlled Charging Implementation

In the week commencing 5 August 2024, a charging schedule from **10:00 AM to 3:00 PM**, and **12:00 AM to 6:00 AM** with a **32amp maximum power output** was implemented.

The table below is comparing two different scenarios for EV charging: 'Controlled Charging' and 'Uncontrolled Charging'.

'Controlled Charging' represents data from the week of 5 August 2024.

'Uncontrolled Charging' represents data from the week of 6 May 2024.

Charging Type	Period	Electricity Consumption (kWh)	Solar Sponge Period (10:00 AM – 3:00 PM) (kWh)	Peak- Period (6:00 AM – 10:00 AM and 3:00 PM – 1:00 AM) (kWh)	Off-Peak Period (1:00 AM – 6:00 AM) (kWh)
Controlled Charging	Week 5 August 2024	62	62 (↑ 41pp*)	0	0
Uncontrolled Charging	Week 6 May 2024	61	36	25	0

* Percentage point

Analysing the results

Through precise timing control, Users charging behaviour was completely optimised to align with renewable electricity availability, achieving a 41percentage point increase in solar sponge period utilisation while eliminating all peak-period consumption. This optimisation delivered $4.89 weekly savings (potential savings of $254.28 annually) while showcasing the potential for scalable demand response programs.

This provides a compelling model for Car Park charging optimisation that preserves user convenience while maximising both economic and climate benefits. (ref: Figure 4.1.5 (b))

Uncontrolled Charging Baseline (6 May 2024):

The uncontrolled charging period represents Users natural charging behaviour without intervention. During this week, his charging pattern followed the previously analysed routine of early morning arrival and immediate charging initiation. The electricity consumption was distributed across multiple tariff periods, creating both grid stress and economic inefficiency.

- Total Weekly Electricity Consumption: 61 kWh
- Solar Sponge Period (10:00 AM - 3:00 PM): 36 kWh representing 59% of total consumption
  - Cost: 36 kWh × $0.31350 = $11.29
  - This partial utilisation of the optimal tariff period indicates missed opportunities for both cost savings and renewable energy integration
- Peak Period (6:00 AM - 10:00 AM and 3:00 PM - 1:00 AM): 25 kWh representing 41% of total consumption
  - Cost: 25 kWh × $0.52151 = $13.04

- This consumption during premium rate periods directly contributed to both grid stress and higher user costs
- Off-Peak Period (1:00 AM - 6:00 AM):
  - No utilisation of the lowest-cost overnight period
- Total Weekly Charging Cost: $24.32

Controlled Charging Optimisation (August 5, 2024):

This controlled charging implementation demonstrates the power of smart grid technologies. Using advanced algorithms and controls, we seamlessly redirected user charging to optimal periods, maintaining both daily routine and charging reliability.

- Total Weekly Energy Consumption: 62 kWh (consistent with baseline needs)
- Solar Sponge Period (10:00 AM – 3:00 PM): 62 kWh representing 100% of total consumption
  - Cost: 62 kWh × $0.31350 = $19.44
- Peak Period (6:00 AM – 10:00 AM and 3:00 PM – 1:00 AM): 0 kWh representing 0% of total consumption
  - Cost: $0.00
  - Complete elimination of expensive peak-period charging, removing grid stress contribution
- Off-Peak Period (1:00 AM – 6:00 AM): 0 kWh representing 0% of total consumption
  - Cost: $0.00
  - Strategic focus on solar sponge period rather than off-peak for renewable electricity alignment
- Total Weekly Charging Cost: $19.44

Behavioural Integration Success:

By leveraging Users predictable arrival patterns and long session durations, the controlled charging system maximised flexibility without disrupting established routines.

- User Routine Preservation: No change required in arrival or departure patterns
- Charging Reliability: Full electricity needs met within existing schedule constraints
- Transparent Operation: Optimisation achieved without user intervention or awareness
- Convenience Maintenance: No compromise in charging accessibility or reliability

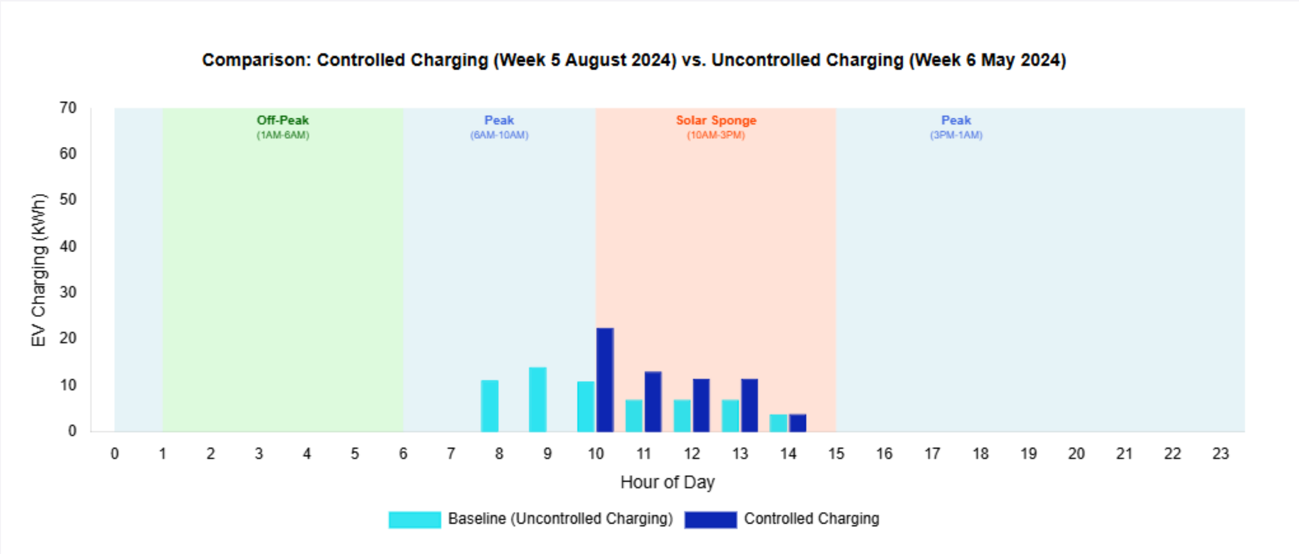


Figure 4.1.5 (a): Power consumption (kWh) over a 24-hour period for two scenarios:
Week starting 6 May 2024 – uncontrolled charging (immediate charging).
Week starting 5 August 2024 – controlled charging with defined profile.
X-axis: Time of day.
Y-axis: Power consumption (kWh).

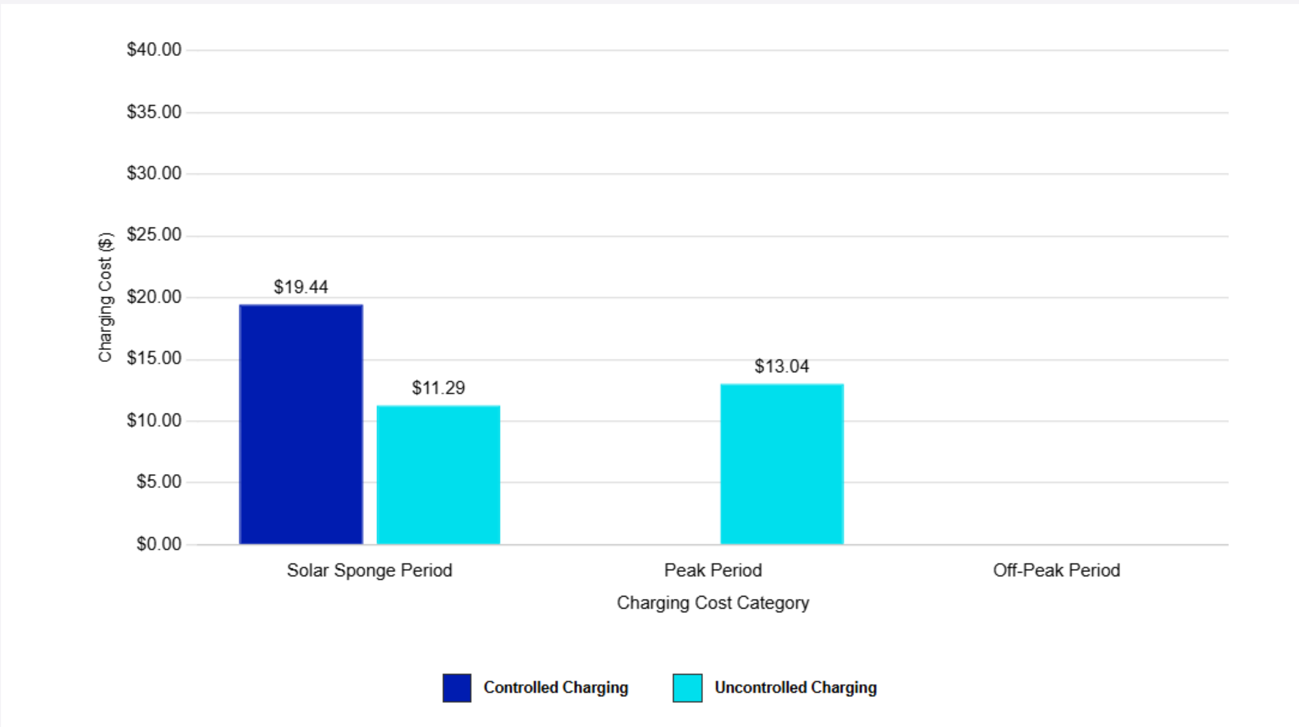


Figure 4.1.5 (b): Comparison of costs between controlled and uncontrolled EV charging across three different time periods.

4.1.6. Controlled Charging Over Multiple Weeks

Controlled charging was implemented over multiple periods mentioned in the graphs.

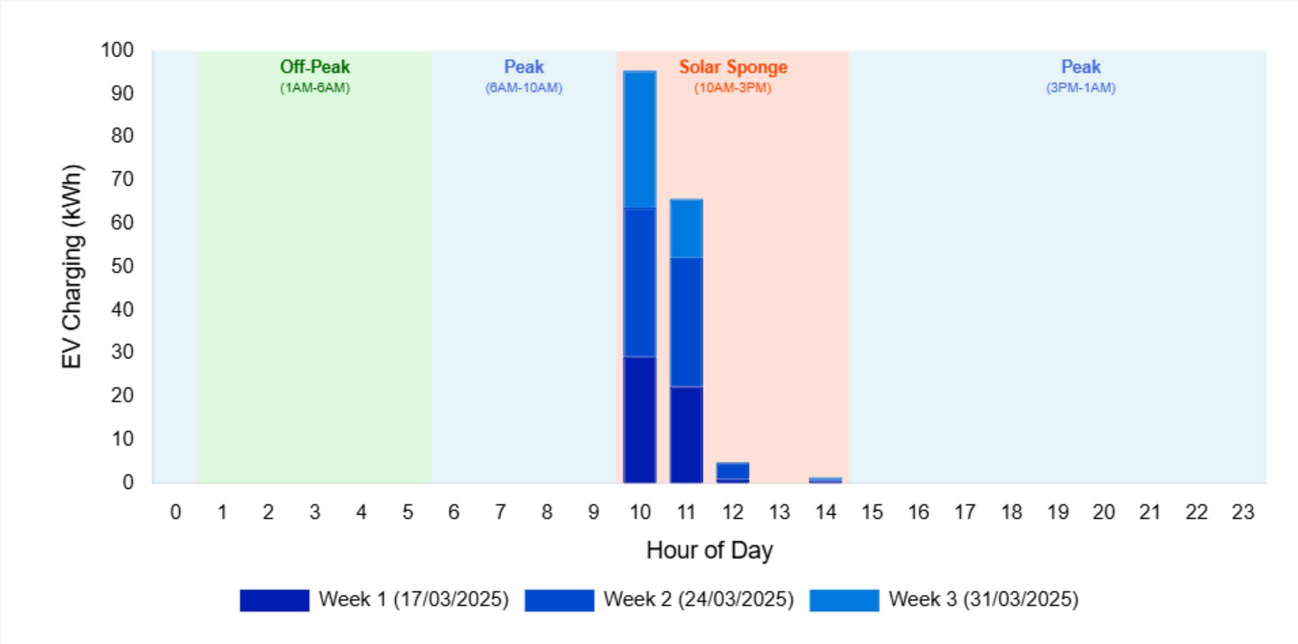


Figure 4.1.6a: Power consumption (kWh) over 24 hours over multiple weeks with controlled charging profile (10:00 AM – 3:00 PM; 1:00 AM – 6:00 AM) at 32-amp maximum output. The x-axis represents the time of day, while the y-axis represents the power consumption in kilowatt-hours (kWh).

Charging Type	Period	Electricity Consumption (kWh)	Solar Sponge Period (10:00 AM – 3:00 PM) (kWh)	Peak- Period (6:00 AM – 10:00 AM and 3:00 PM – 1:00 AM) (kWh)	Off-Peak Period (1:00 AM – 6:00 AM) (kWh)
Controlled Charging	Week 17 March 2025	53	53(100%)	0	0
Controlled Charging	Week 24 March 2025	68	68(100%)	0	0
Controlled Charging	Week 31 March 2025	46	46(100%)	0	0

Table 4.1.6b: shows the electricity consumption over three weeks.

4.1.7. User Feedback:

While there has been success in controlled charging implementation, the user expressed a request to remove the controlled/smart charging profiles due to a change in driving needs. This meant that charging needed commence immediately after plugging in.

Quotes:

> "Could you please change my profile such that the charging works at any time the car is plugged in.

> "I sometimes leave for site visits during the day, and return to my park late in the afternoon, so I miss out on the charging window currently being set. This can leave me with an unexpected result for how much charge status I have available in the car."

4.1.8. User 1: Qualitative Insights and Participant Feedback

Theme 1: User Experience and Technical Challenges

User discussed the initial difficulties he faced with the chargers. The connection was not seamless compared to Tesla's own charging network, requiring the user to plug the cable in very quickly to avoid the system tripping or faulting. This initial "handshake" issue between the car and the wall unit created friction and uncertainty.

Insights:

- The feedback revealed a significant gap between the seamless, integrated experience of a proprietary network like Tesla's and the more fragile "handshake" of third-party chargers.
- A less technically-minded user would likely interpret the connection failure as a broken charger, which could damage confidence in the reliability of public charging infrastructure.

Quotes:

> "The charging connection process was less seamless than comparable systems such as Tesla Superchargers. Initial connection attempts occasionally failed to initiate charging immediately upon plugging in."

> "These particular charging units required rapid insertion of the connector to ensure proper electrical contact was established."

> "Maintaining a minimum current flow of 5-6 amps is preferable to allowing the system to drop to 0 amps, as this prevents the vehicle from registering a loss of power availability and potentially disconnecting."

Theme 2: Charging Habits, Needs, and Value Perception

User provided a detailed look into charging behavior. Owns both home solar and a Powerwall battery, preferring to use free charging at the car park to preserve his home battery during winter. Distinguishes between a patient 'trickle charge' over the day and the occasional need for a guaranteed, fast top-up, suggesting willing to pay a premium for the latter.

Insights:

- User's charging decisions were heavily influenced by existing home setup, which included solar panels and a Powerwall battery.
- Charging needs were not uniform; they change based on daily travel and circumstances, such as needing a more significant charge on a Monday after a long weekend drive.
- The distinction between charging speeds and convenience pointed to a potential business model offering tiered pricing. A standard fee could have covered low-cost charging, while a premium fee could have unlocked immediate, on-demand charging at full speed.

Quotes:

> "Am I willing to pay a premium for that convenience, knowing it's definitely charging as fast as possible? Or am I happy for it to trickle charge throughout the day as solar production increases??"

> "I have a Powerwall and solar at home, but obviously I'd rather minimise costs. In winter, I wouldn't bother with this approach."

Theme 3: Motivations for EV Adoption and Evolving Perspectives

The users initial motivation for acquiring an EV was an interest in technology and the vehicle's performance, specifically its responsiveness. However, after ownership, appreciation expanded to include benefits like improved air quality, quietness, and smoothness. The decision was also heavily influenced by financial incentives, namely the Fringe Benefits Tax exemption for EVs.

Insights:

- The initial draw was technology and performance ('responsiveness of acceleration'), but long-term appreciation grew to include quality-of-life benefits like smoothness, quietness, and better air quality.
- The Fringe Benefits Tax (FBT) exemption for EVs was the explicit financial trigger to lease the vehicle.
- This highlighted that government policies and incentives were a powerful and direct lever for accelerating EV adoption.

Quotes:

> "My interest in technology and technical aspects of vehicles made this the next logical progression. It wasn't about the environment initially; it was more about the responsiveness and acceleration. "

> "Since owning it, I've come to appreciate the air quality benefits as well—the absence of exhaust smell, the smoothness of operation, and how quiet it is."

> "The fringe benefits tax exemption for electric vehicles was a significant factor in my decision to pursue this option."

Theme 4: Broader EV Adoption Barriers and Infrastructure

The user reflected on what prevents wider EV adoption, particularly at a corporate level. The user identified employee hesitation, fueled by negative press and a lack of firsthand experience, as a major hurdle for their own employer. Also touched on practical infrastructure challenges like confusing signage for EV bays leading to non-EVs parking there, and notes public discourse around fire safety in parking structures.

Insights:

- The biggest barrier to wider corporate adoption was employee hesitation, which was fueled by negative media and a simple lack of personal experience.
- “Try before you buy” programs or week-long EV loans would have been highly effective at converting skeptics.
- The success of charging infrastructure depended on more than the charger itself. Practical details like confusing signage could lead to EV-dedicated bays being occupied by other vehicles, rendering the service useless.

Quotes:

> “The way this is signposted, there’s so much signage that it’s difficult to distinguish whether it’s a reserved park. As a result, you get other people parking there anyway, electric vehicle or not.”

4.2. User 2

This user is a strategic EV adopter who recently purchased a BYD Atto 3 as a long-term investment, representing the growing “garage orphan” segment—EV owners living in apartments where home charging installation is not feasible.

Working in the Lot 14 Innovation Precinct with a short 10-kilometre daily commute, leveraged the existing workplace parking routine to address charging needs. The proximity and familiarity of the location made the Wilson Parking charging facility a natural temporary solution until home charging is in place. When not coming into work regularly, the user relies on alternative charging options, specifically utilising charging facilities at local shopping centres, demonstrating the multi-location charging behaviour typical of apartment-dwelling EV owners who must piece together a charging network from various public facilities.

4.2.1. EV Utilisation

The user began using the Wilson Parking charging facility in September 2023 as a temporary solution while awaiting home charging installation capability. Usage patterns show irregular engagement with the facility, starting with minimal utilisation of 5% in September 2023, increasing to peak usage of 41% in October 2023, before declining to sporadic usage in subsequent months. The user’s utilisation averaged 20% across the baseline period, reflecting a pragmatic approach to charging only, when necessary, given their short 10-kilometre daily commute and access to alternative charging at local shopping centres such as Churchill Road when not attending work regularly.

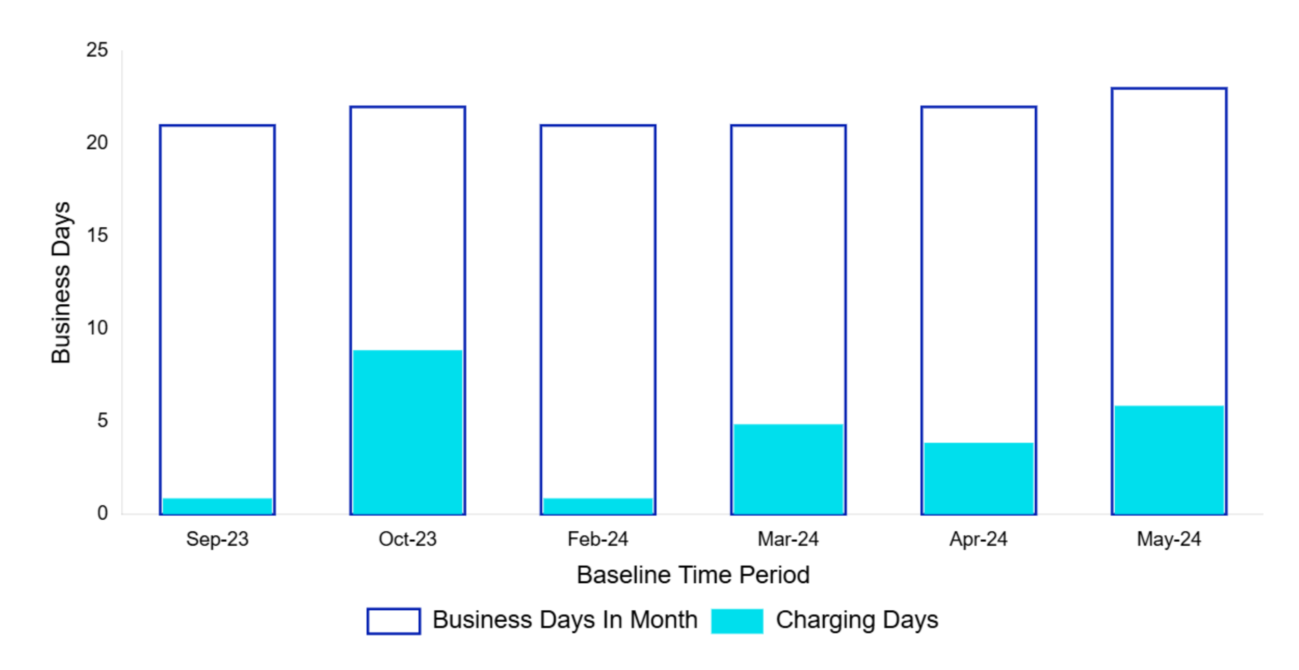


Figure 4.2.1: Utilisation of EV chargers over time. The x-axis represents the time period (month and year), while the y-axis shows the number of days. The light blue bars represent the number of days EV chargers were utilised, and the white sections indicate the business days available in each month.

4.2.2. Charging Patterns

During the baseline period (September 2023 – May 2024), the user demonstrated sporadic but strategically aligned charging behaviour across analysed weeks, with charging sessions concentrated in a 6 – 8 hour window between 9:00 AM – 4:00 PM. Peak activity consistently occurred during 10:00 AM – 1:00 PM across multiple weeks.

Charging Distribution by Time Period:

- 78% occurred during the solar production window (10:00 AM – 3:00 PM)
- 22% occurred during peak periods
  - 16% during morning peak hours (9:00 AM – 10:00 AM)
  - 6% during afternoon/evening (after 3:00 PM)

Weekly electricity consumption varied from 17 kWh to 57 kWh, reflecting variable driving patterns and preference for alternative charging locations during non-essential work periods. This intermittent usage and low energy consumption pattern align with multiple charging locations and short 10-kilometer daily commute.

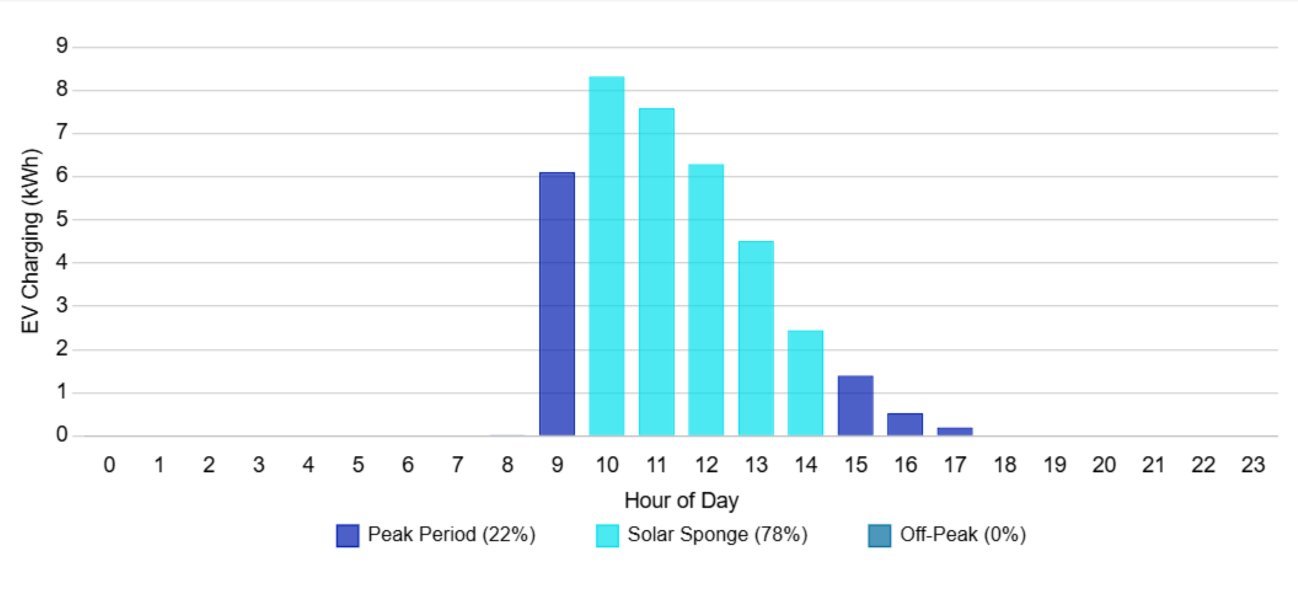


Figure 4.2.2: Uncontrolled EV charging (in kWh).

X-Axis (Hour of Day): Represents the 24-hour time periods from 0:00 (midnight) to 23:00 (11:00 PM), showing when charging sessions occurred throughout the day.

Y-Axis (Electricity kWh): Shows the average EV charging in kilowatt-hours (kWh) for each hour, calculated across all 18 weeks of data where charging occurred.

Data Representation: Each bar represents the average electricity consumed for that specific hour. Colours indicate time-of-use periods: Peak Period (highest electricity rates), Solar Sponge (optimal renewable electricity window), and Off-Peak (lowest electricity rates).

4.2.3. Charging Session Analysis: Start Time and Departure Patterns

The start time and departure analysis reveal strategically concentrated arrival patterns with 81% of charging sessions beginning from 9:00 AM – 10:00 AM. Departure patterns show dual peaks at 5:00 PM 6:00 PM (50%) and at 6:00 PM–7:00 PM (23%), creating an 8-9 hour charging window that effectively overlaps with peak solar production periods.

Optimisation Potential:

Based on the moderate session durations of 8 – 9 hours and strategic timing alignment, the following charging optimisation was identified:

- Delayed charging: Start charging at 10:00 AM to align with solar production and avoid morning peak demand periods.
- Load shaping: Distribute charging power across the session duration.

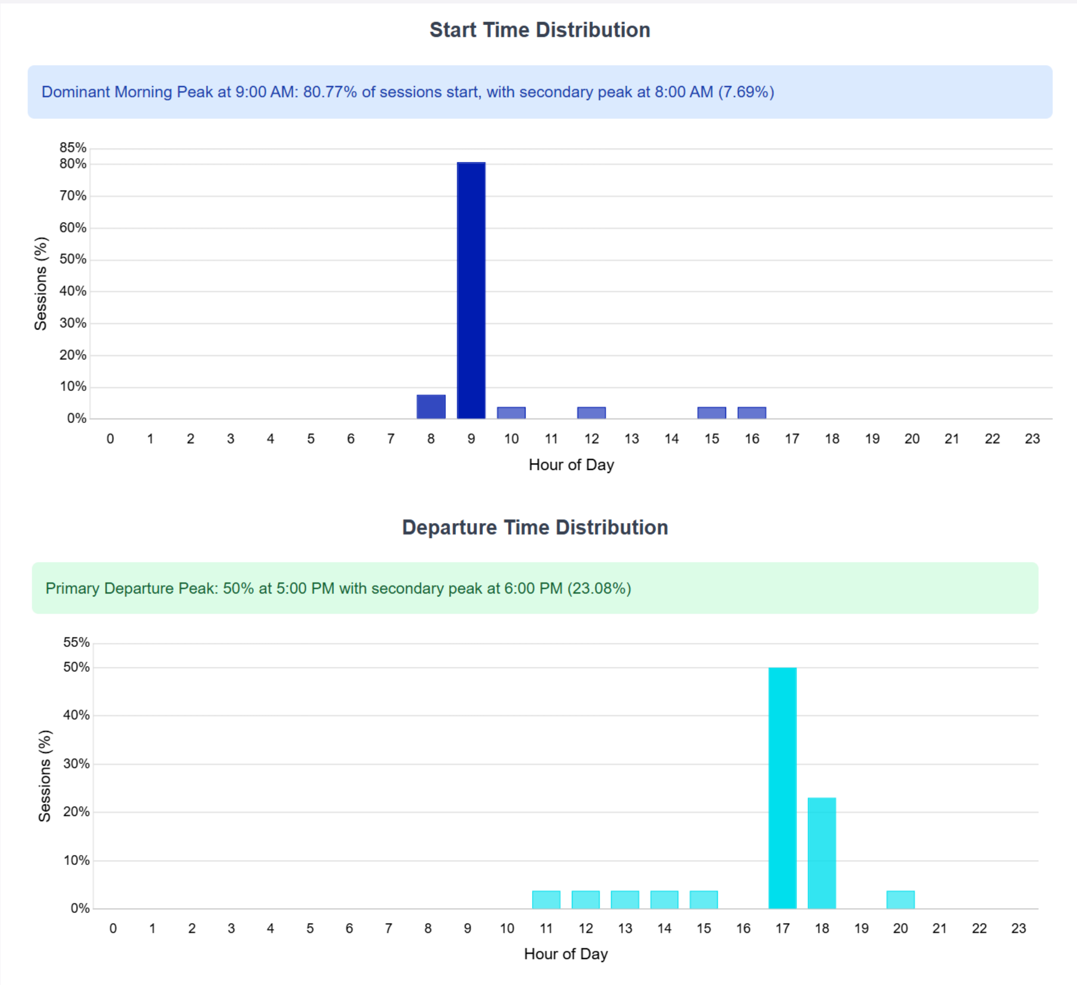


Figure 4.2.3: Distribution of sessions based on Start and Departure Times.

Top graph: Morning arrival peak.

Bottom graph: Evening departure peak.

4.2.4. Predictable Charging Patterns to Support Controlled and Smart Charging Implementation

The baseline session analytics revealed consistent charging behaviour that demonstrated significant potential for controlled and smart charging optimisation.

Baseline Behaviour (Immediate Charging at 9:00 AM):

- Predictable Timing: 81% probability of session starting between 9:00 AM – 10:00 AM.

Supporting Evidence:

- Routine-Based Arrival: Activity concentrated around the workplace schedule demonstrates high predictability.
- Long Session Duration: 8–9-hour parking windows provide flexibility for a delayed charging start.

Controlled and Smart Charging Opportunities:

Given the 170 hours of charging sessions starting between 9:00 AM and 10:00 AM:

- Delayed Initiation Potential: Implement 1-2 hour charging delay to shift from 9:00 AM to maximise the 10:00 AM – 3:00 PM solar production window.
- Grid Optimisation: Reduce morning demand contribution and enhance renewable electricity utilisation.
- Behavioural Adaptation: The routine-based pattern suggests the user would adapt well to smart charging schedules.

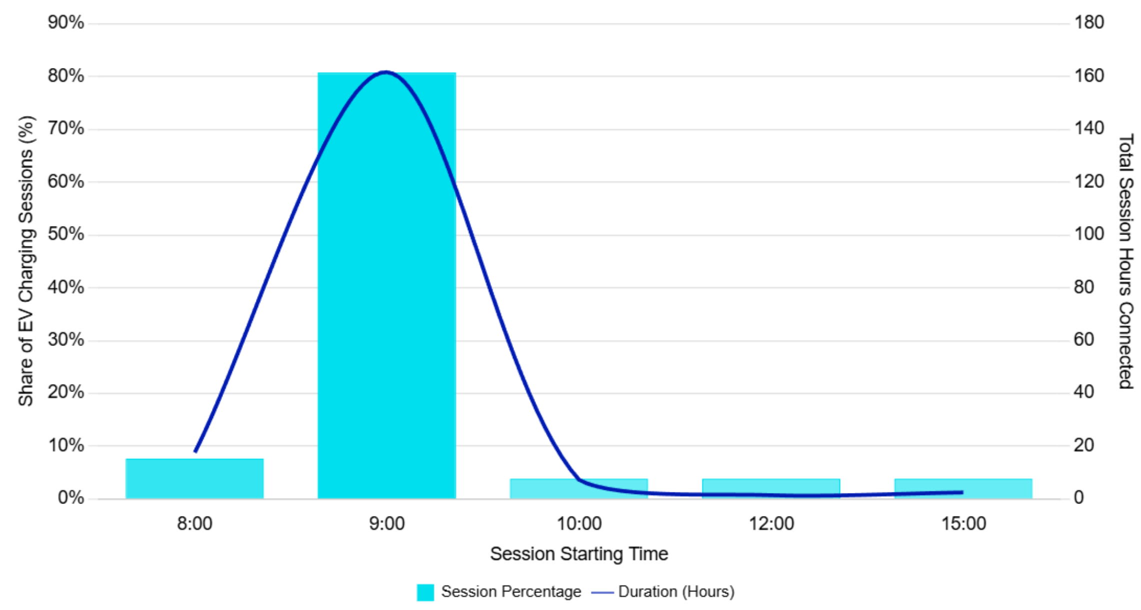


Figure 4.2.4: X-axis (Session start time): Hour of day when sessions begin.
Left Y-axis (Share of sessions, %): Percentage of all sessions that start in that hour.
Right Y-axis (Total hours connected): Sum of hours EVs remained connected for sessions starting in that hour

4.2.5. Controlled Charging Implementation

In the week commencing 26 August 2024, a charging schedule from **10:00 AM to 3:00 PM**, and **1:00 AM to 6:00 AM** with a **32amp maximum power output** was implemented.

The table below is comparing two different scenarios for EV charging: 'Controlled Charging' and 'Uncontrolled Charging'.

'Controlled Charging' represents data from the week of 26 August 2024 (whole week).

'Uncontrolled Charging' represents data from the week of 6 May 2024 (whole week).

Charging Type	Period	Electricity Consumption (kWh)	Solar Sponge Period (10:00 AM – 3:00 PM) (kWh)	Peak- Period (6:00 AM – 10:00 AM and 3:00 PM – 1:00 AM) (kWh)	Off-Peak Period (1:00 AM – 6:00 AM) (kWh)
Controlled Charging	Week 26 August 2024	55	55 (↑ 21pp*)	0	0
Uncontrolled Charging	Week 6 May 2024	52	41	11	0

* Percentage point

Analysing the results

Through strategic timing adjustments, the user's charging behaviour was optimised to concentrate electricity consumption during solar production periods, achieving improved renewable electricity utilisation while reducing peak-period grid stress. This optimisation delivered $1.35 weekly savings (potential savings of $70.20 annual).

The results validated the effectiveness of controlled charging in optimising available usage patterns, with successfully elimination of peak-period consumption and concentration of electricity use during optimal solar production windows. However, the participant's overall low utilisation rate (20% average across baseline period) limited the full potential of workplace charging, even when charging optimisation was successful.

Uncontrolled Charging Baseline (Week May 6, 2024):

The uncontrolled charging period represents the participant's natural charging behaviour without intervention. During this period, charging pattern followed immediate charging upon 9:00 AM arrival.

- Total Electricity Consumption: 51.5 kWh
- Solar Sponge Period (10:00 AM – 3:00 PM): 33.6 kWh representing 65% of consumption
- Peak Period (Morning): 18 kWh representing 35% of consumption
- Total Weekly Charging Cost: $18.59

Controlled Charging Optimisation (Week 26 August 2024):

Through advanced algorithms and timing controls, the users EV charging was successfully redirected to optimal periods while accommodating their intermittent usage.

- Total Electricity Consumption: 54.9 kWh (consistent with baseline session needs)
- Solar Sponge Period (10:00 AM – 3:00 PM): 54.9 kWh representing 100% of consumption
  - Cost: 54.9 kWh × $0.31350 = $17.24
- Optimisation Success: 1-hour delay from 9:00 AM to 10:00 AM start time achieved complete solar window alignment while maintaining compatibility with the user's workplace routine.

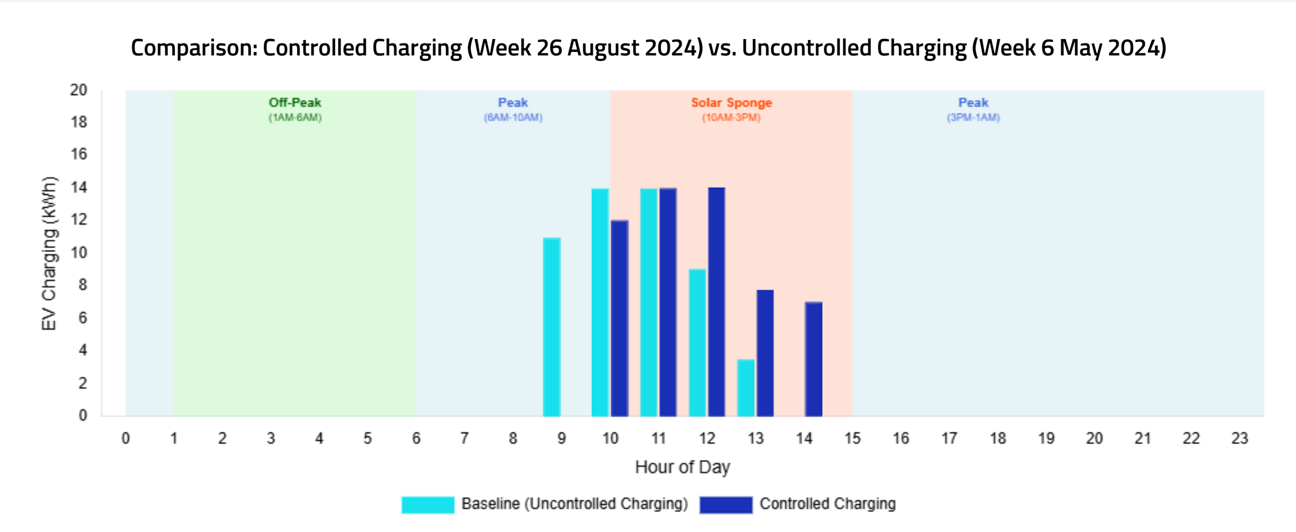


Figure 4.2.5. (a): Power consumption (in kWh) over a 24hour period over two time periods Week starting 6 May 2024 where EV happened in an uncontrolled manner (Immediate charging) and Week starting 26 August 2024 Controlled EV charging, where a charging profile was defined on EV charger. The x-axis represents the time of day, while the y-axis represents the power consumption in kilowatt-hours (kWh).

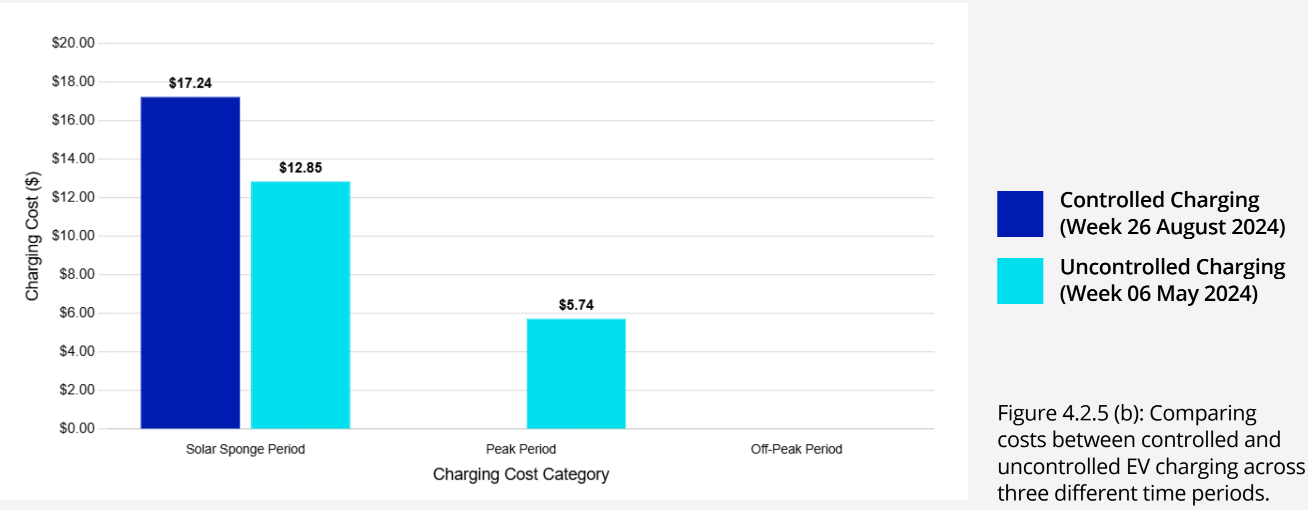


Figure 4.2.5 (b): Comparing costs between controlled and uncontrolled EV charging across three different time periods.

4.2.6. Controlled Charging Over Multiple Weeks

Controlled charging was implemented over 19 weeks from September 2024 to February 2025.This was achieved by communicating with the charger management software APIs to optimise charging timing. The stacked bar visualisation demonstrated consistent load shifting across all weeks, with charging operations successfully concentrated within the Solar Sponge period (10:00 AM – 3:00 PM) regardless of weekly consumption variations.

Weekly electricity consumption ranged from 20 kWh to 52 kWh, yet the controlled charging enabled maintained optimal timing discipline throughout this period. The data revealed excellent grid compatibility with zero charging activity during critical peak hours (3:00 PM – 1:00 AM and 6:00 AM – 10:00 AM), while maximising solar generation utilisation during midday hours. This 19-week dataset demonstrated that intelligent load management can be consistently maintained across seasonal variations and different operational demands.

Even with controlled charging, the user didn't notice any difference. EV was always charged and ready to go, showing that this Controlled charging could work in the background without causing any inconvenience.

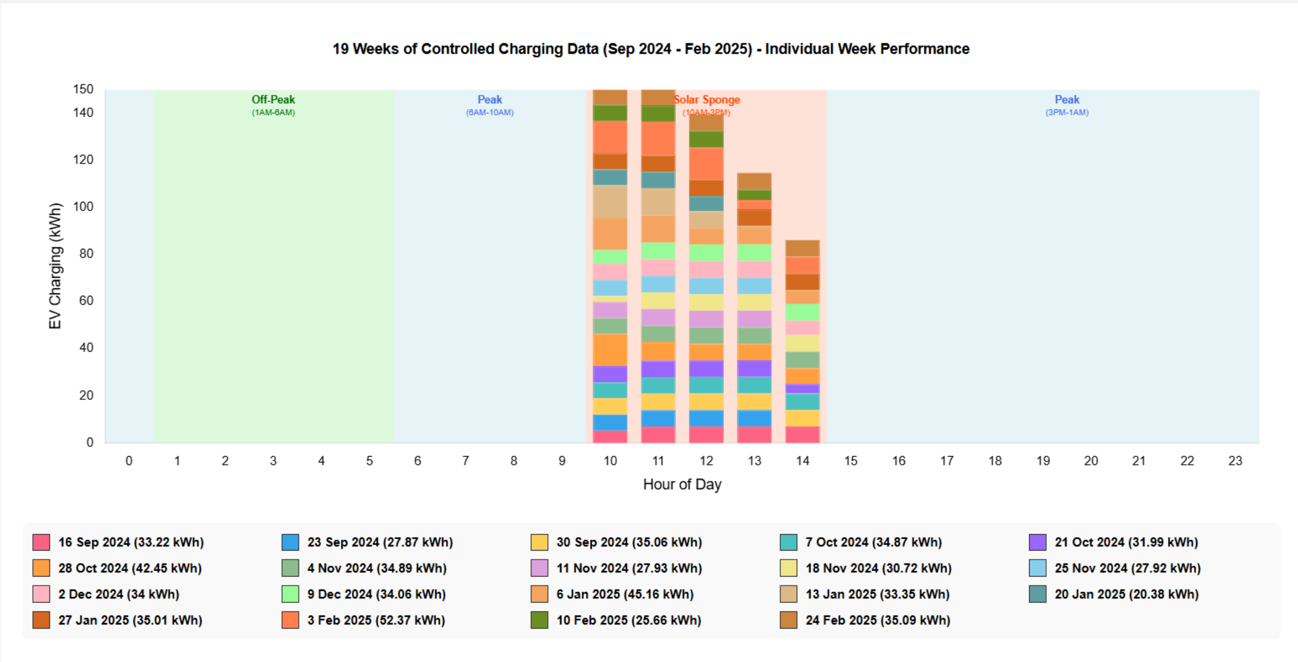


Figure 4.2.6: Controlled charging implementation across 19 weeks.

4.2.7. User 2: Qualitative Insights and Participant Feedback

Theme 1: Pragmatic EV Adoption Strategy

This user decision to purchase an EV was driven by long-term strategic thinking rather than climate enthusiasm or early adopter excitement. Viewed EV adoption as an inevitable future necessity and made a purchase decision based on practical longevity considerations.

Insights:

- This revealed a rational, future-focused consumer mindset that prioritised practical value over novelty.
- The user demonstrated careful consideration of long-term market trends and made purchasing decisions based on anticipated future needs rather than current convenience.

Quotes:

> "I like to buy cars for the long term. I had my previous car for 15 years."

> "My mom and I thought, 'What car do I want to be driving in 20 to 30 years?' It's probably not going to be one with a combustion engine."

Theme 2: Proximity and Commuting Efficiency

User charging pattern is fundamentally shaped by their short commute distance and existing workplace parking routine. The 10-kilometer round trip represents an ideal use case for workplace charging, where daily travel distances align well with Level 2 charging capabilities and work schedule patterns.

Insights:

- The short commute distance made workplace charging particularly practical and cost-effective, as the vehicle didn't require daily charging to maintain adequate range.
- This suggested workplace charging was most suitable for users with moderate daily driving distances who could leverage existing parking habits.
- The proximity also reduced range anxiety and made the charging facility a natural extension of their work routine rather than requiring route modifications or additional travel.

Quotes:

> "This is going great. I'm aware it's typically just between my house and here, which is about 10 kilometres."

> "So, it made sense to use this as the stopover solution until I could get my own charger installed."

Theme 3: Convenience and Reliability Concerns

While the charging facility provides essential convenience for someone without home charging, this user identified several reliability and user experience issues, particularly around the charging features.

Insights:

- The user valued the guaranteed availability but was frustrated by the lack of transparency in the charging system.
- This highlights a critical user experience gap where technical functionality (different codes listed on chargers) operated without clear communication to user.
- This led to confusion and additional effort to understand the system.

Quotes:

> "Sometimes it doesn't charge immediately. I assume that's because it's programmed to charge during daytime hours, which is somewhat better for grid management."

> "The device itself is not very transparent in terms of its operation."

> "I went to the point of looking up exactly what model of charger it is and what that error code means."

Theme 4: Cost Sensitivity and Value Perception

Pricing emerged as a significant concern, with the user viewing the current charging costs as expensive compared to anticipated home charging alternatives. The cost structure appears to be a barrier to broader adoption among potential users.

Insights:

- The pricing model appeared to be limiting utilisation despite demonstrated demand (20-30 EVs in the car park).
- Pricing elasticity issue where the convenience premium was too high for most users, indicating potential for broader adoption with more competitive pricing structures.
- This also revealed a significant market sizing opportunity - high EV concentration but low charging utilisation suggested demand existed, but current offerings didn't meet market needs in terms of pricing or value proposition.
- The user's choice of this facility over competitors due to ICE vehicle blocking issues also highlighted the importance of dedicated, enforced EV-only spaces.

Quotes:

> "Probably just the price."

> "The cost for the privilege of parking and charging here is high. I was paying a lot for parking before anyway, but when I get a home charger, it's definitely going to be half the price."

> "I think the fact that I'm probably one of only two people who regularly park in these bays speaks to how expensive they are. There are plenty of EVs in the car park, but none of them charge here."

4.3. User 3

This user is a highly engaged and analytically minded EV adopter living in rural South Australia, commuting daily to a workplace at Lot 14 in Adelaide's CBD. The diverse vehicle portfolio reflected varied transportation needs, with the primary commuter being a Tesla Model 3, complemented by a mix of ICE vehicles. This user's intensive usage pattern is remarkable, having accumulated 25,000 km in approximately eight months with a daily round-trip commute of 86 kms, demonstrating high engagement with EV technology. The financial structure consisted of a $750 pre-tax fortnightly novated lease for the EV, combined with a single monthly fee for dedicated city parking and charging.

4.3.1. EV Utilisation

User 3 began using the Wilson Parking charging facility in October 2023, demonstrating rapid adoption and evolving usage patterns throughout the trial period. During the base line period (October 2023- May 2024) user's utilisation rate showed significant variation, starting with exceptional engagement at 78% in October 2023, dropping to 28% in February 2024, then recovering strongly to achieve 71% in March 2024, 59% in April 2024, and culminating in perfect 100% utilisation in May 2024.

The user's charging behaviour demonstrated a strong reliance on their workplace facility. This is evidenced by an average utilisation rate of 67%. This consistent use highlighted the user's strategic preference for the convenience and lower cost of workplace charging over public networks. By bundling parking with charging, the user has established an efficient daily routine that fully supported their 86 km commute, representing a successful model of workplace charging adoption.

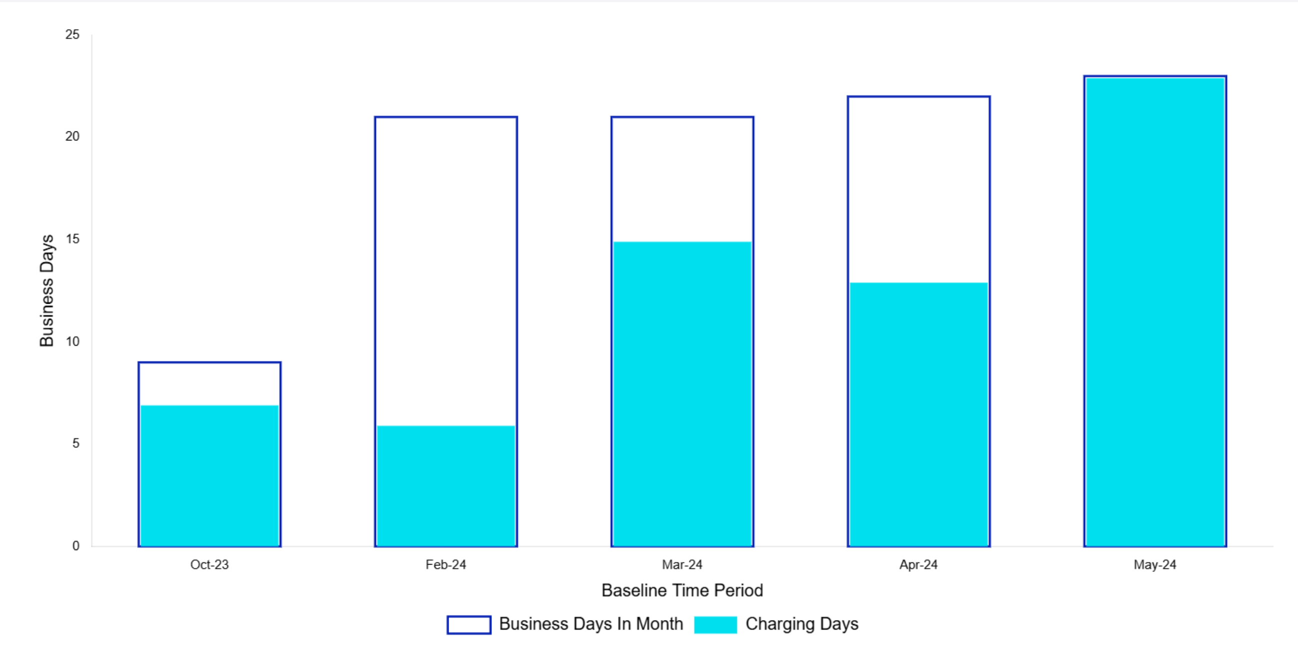


Figure 4.3.1: Utilisation of EV chargers over time. The x-axis represents the time period (month and year), while the y-axis shows the number of days. The light blue bars represent the number of days EV chargers were utilised, and the white sections indicate the business days available in each month.

4.3.2. Charging Patterns

During the baseline period (October 2023 – May 2024), the user demonstrated remarkably consistent early morning charging behaviour across all analysed weeks, with charging sessions concentrated primarily in a 4–5-hour window between 7:00 AM and1:00 PM, with peak activity consistently occurring between 8:00 AM – 9:00 AM across multiple weeks.

Morning Peak Contribution: By concentrating 50% of charging during 7:00 AM – 10:00 AM, the user's usage pattern significantly contributed to morning grid peak demand, occurring well before the optimal solar production window (10:00 AM – 3:00 PM). This represented a key opportunity to shift charging behaviour towards midday solar generation periods through smart charging controls.

High Electricity Consumption Range: The weekly electricity totals, ranging from 50.0 kWh to 107.7 kWh, indicated significant consumption. This usage level was consistent with the user's substantial 86 km daily commute, supported primarily by strategic charging at the workplace.

Routine-Driven Early Arrival: Highly consistent daily charging sessions between 8:00 AM and 12:00 PM showed that the user arrives at the workplace before 8:00 AM. This routine schedule directly supported their strategy of leveraging workplace charging for both convenience and cost optimisation.

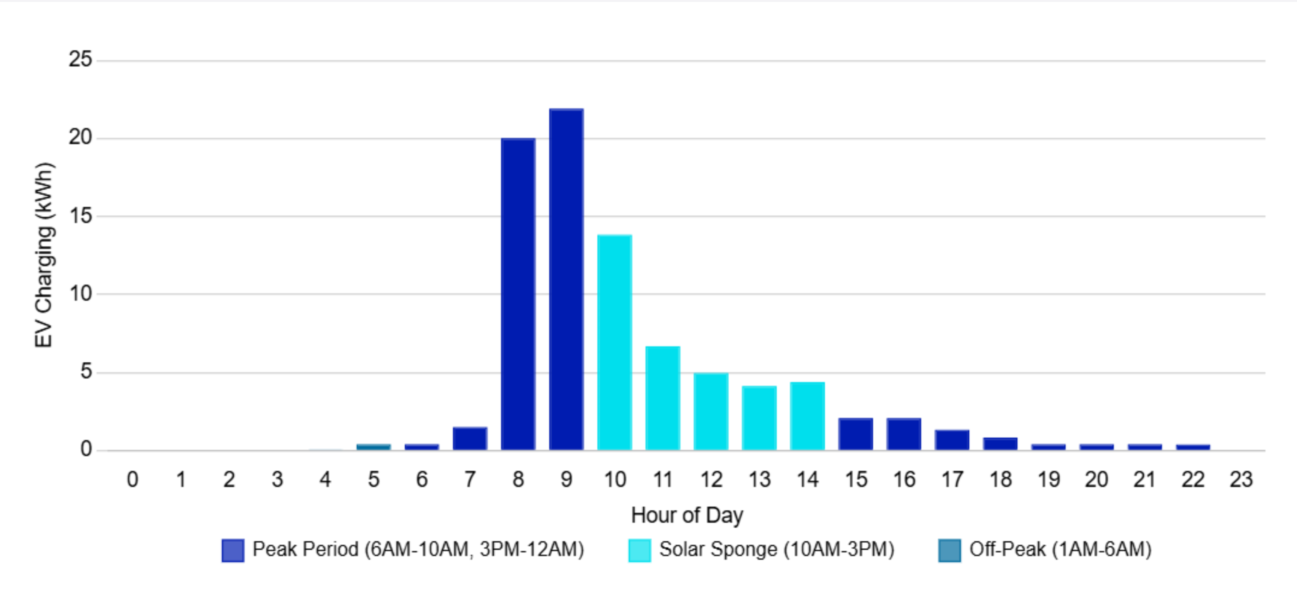


Figure 4.3.2: Uncontrolled EV charging (in kWh)

X-Axis (Hour of Day): Represents the 24-hour time periods from 0 (midnight) to 23 (11:00 PM), showing when charging sessions occurred throughout the day.

Y-Axis (Electricity kWh): Shows the average EV charging in kilowatt-hours (kWh) for each hour, calculated across period October 2023 – May 2024.Data Representation: Each bar represents the average electricity consumed for that specific hour. Colours indicate time-of-use periods: Peak Period (highest electricity rates), Solar Sponge (optimal renewable electricity window), and Off-Peak (lowest electricity rates).

4.3.3. Charging Session Analysis: Start Time and Departure Patterns

The start time and departure analysis revealed highly concentrated early morning arrival patterns with 78% of charging sessions beginning between 7:00 AM and 9:00 AM (48% at 7:00 AM – 8:00 AM, 30% at 8:00 AM–9:00 AM), contrasted against more distributed afternoon departure times with dual peaks at 4:00 PM (22%) and 5:00 PM (46%). This pattern helped us understand the user's arrival and departure times, which in turn helped in identifying opportunities for controlled and smart charging strategies.

Opportunities for Charging Optimisation

The user's consistent 8 – 10-hour parking duration created a significant window for optimisation. The following strategies were planned for implementation without compromising the electricity needed for their 86 km daily commute:

- Solar Alignment (Delayed Start): By delaying the charge start time from the current 7:00 AM –8:00 AM arrival to mid-morning (e.g., 10:00 AM), the session can align perfectly with peak solar generation, maximising the use of renewable electricity.
- Load Shaping: The extended parking time allows the user's high weekly consumption (90 – 107 kWh) to be intelligently distributed throughout the day. This supports grid stability by absorbing solar during the day and responding to demand management signals.
- Peak Demand Avoidance: Controlled charging can ensure the EV's daily electricity needs are met well before the evening grid peak (typically 4:00 PM – 8:00 PM), reducing strain on the network and avoiding peak demand periods.

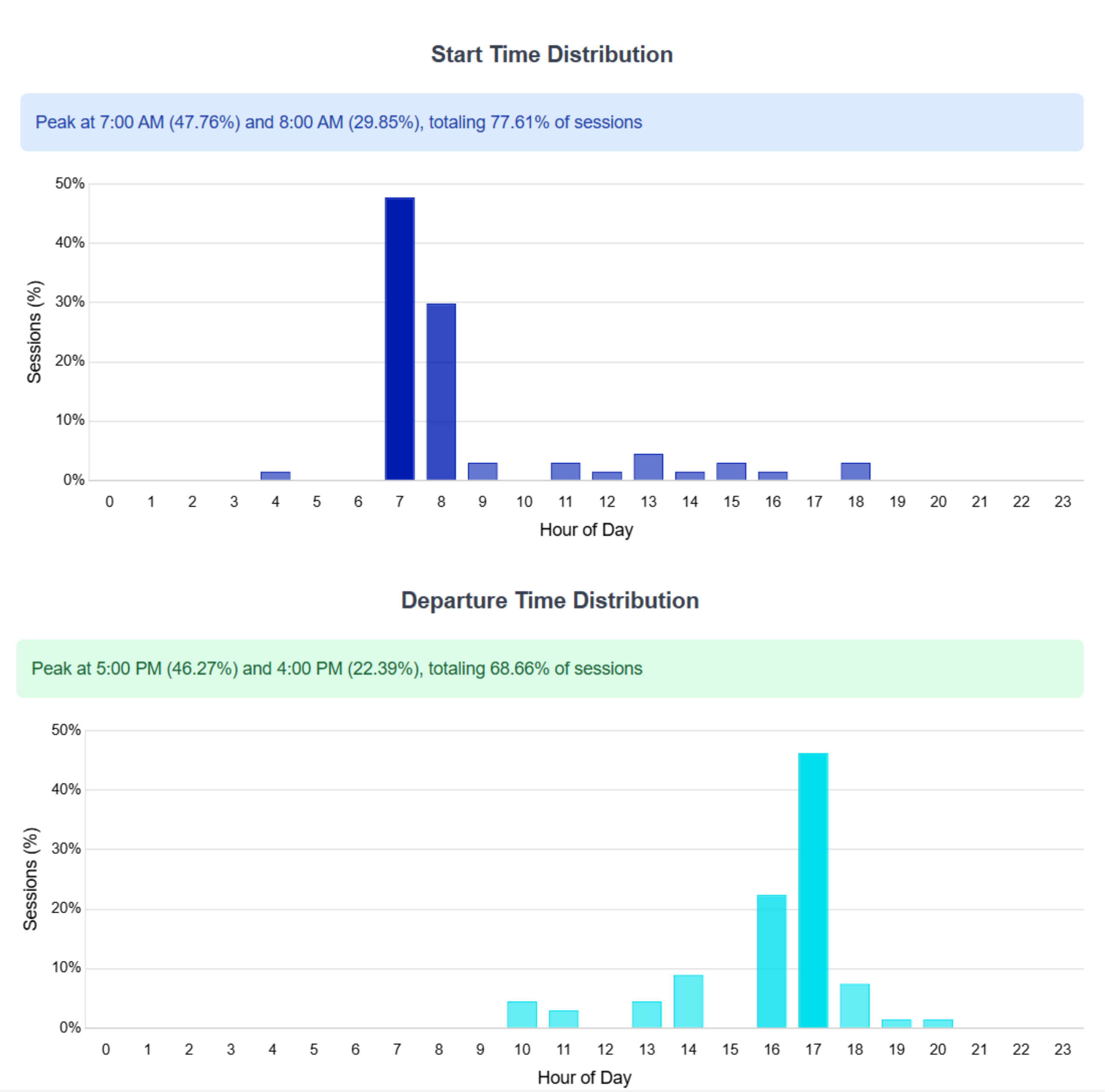


Figure 4.3.3: Distribution of sessions based on Start and Departure Times.
Top graph: Morning arrival peak.
Bottom graph: Evening departure peak.

4.3.4. Predictable Charging Patterns Support Controlled Charging Implementation

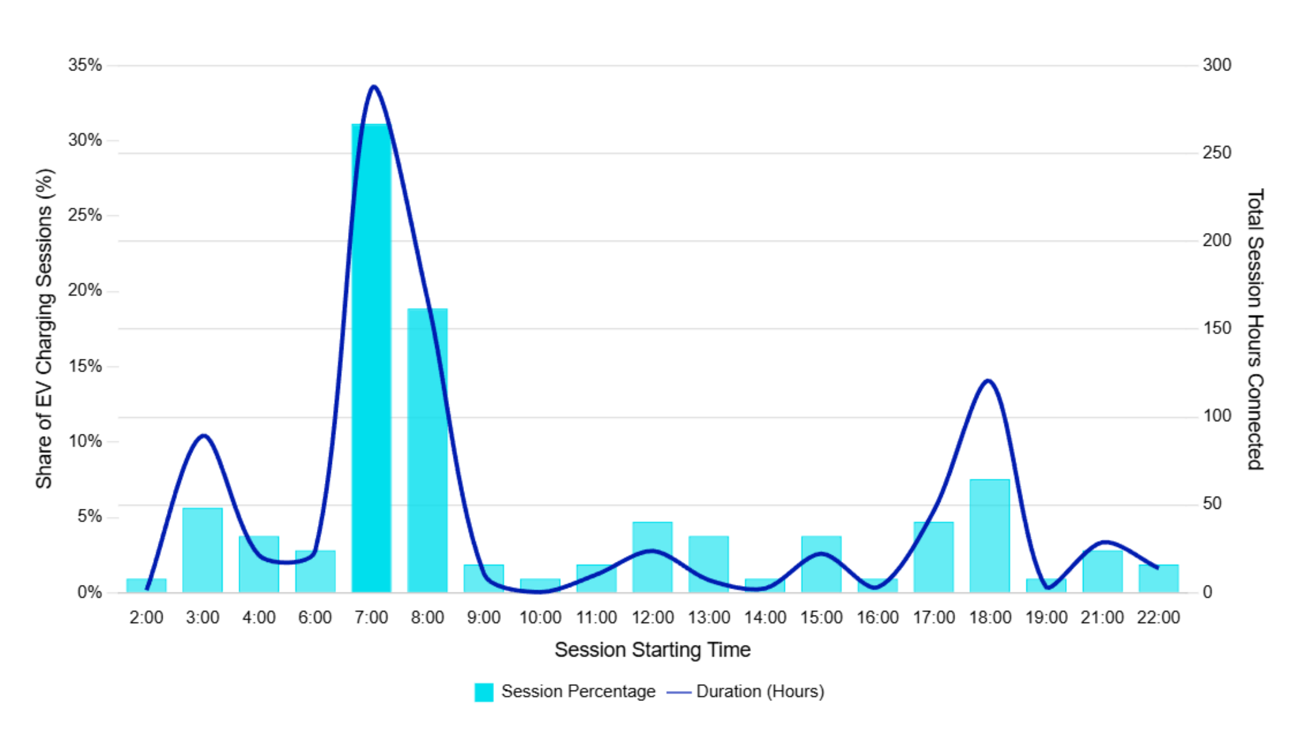


Figure 4.3.4:
X-axis (Session start time): Hour of day when sessions begin.
Left Y-axis (Share of sessions, %): Percentage of all sessions that start in that hour.
Right Y-axis (Total hours connected): Sum of hours EVs remained connected for sessions starting in that hour.

High Predictability Indicators

- Session analysis revealed a remarkably consistent user charging pattern, which formed a reliable foundation for implementing controlled and smart charging strategies.
- Consistent Start Time: With 78% of sessions initiated in the 7:00 AM – 9:00 AM window, the daily start time is highly reliable.
- Extended Connection Duration: Sessions consistently last 8–10 hours, creating a large and flexible window to manage when the electricity is delivered.
- Predictable Departure Time: Most sessions concluded between 4:00 PM and 6:00 PM, aligning with standard business hours and providing a clear deadline for charge completion.
- Forecastable Energy Demand: The stable weekly consumption of 90-107 kWh allowed for precise energy and load forecasting.

Actionable Optimisation Strategies

This predictable behaviour allowed for the deployment of intelligent charging protocols that would benefit both the user and the grid, without compromising the electricity needed for the daily 86 km commute.

Shift Charging to Align with Solar Production:

- The long connection duration makes it easy to delay the start of charging by 2–3 hours. This shifts the vehicle's primary electricity consumption from the 7:00 AM morning peak to the 10:00 AM – 3:00 PM peak solar window, maximising clean electricity utilisation.

Optimise for Grid and Cost Savings:

- By actively managing the charge within the 8–10-hour window, controlled and smart charging can reduce contributions to morning peak demand, support grid stability, and automatically respond to price signals to lower charging costs, all while respecting the user's need for convenience.

4.3.5. Controlled Charging Implementation

In the week commencing 1 July 2024, a charging schedule from **10:00 AM to 3:00 PM**, and **12:00 AM to 6:00 AM** with a **32 amp maximum power output** was implemented.

The table below is comparing two different scenarios for EV charging: 'Controlled Charging' and 'Uncontrolled Charging'.

'Controlled Charging' represents data from the week of 1 July 2024 (whole week).

'Uncontrolled Charging' represents data from the week of 29 April 2024 (whole week).

Charging Type	Period	Electricity Consumption (kWh)	Solar Sponge Period (10:00 AM – 3:00 PM) (kWh)	Peak- Period (6:00 AM – 10:00 AM and 3:00 PM – 1:00 AM) (kWh)	Off-Peak Period (1:00 AM – 6:00 AM) (kWh)
Controlled Charging	Week 1 July 2024	88	88 (↑ 69pp*)	0	0
Uncontrolled Charging	Week 29 April 2024	89	28	61	0

* Percentage point

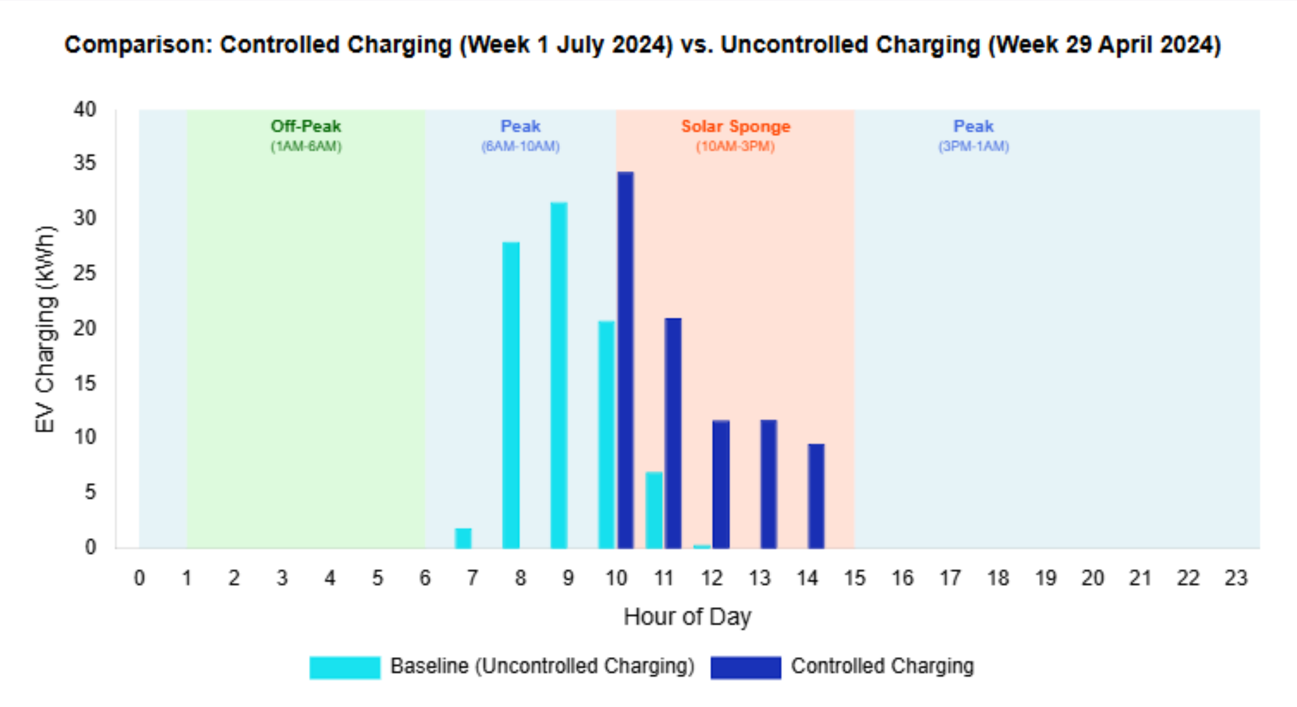


Figure 4.3.5 (a): Power consumption (in kWh) over a 24hour period over two time periods Week starting 29 April 2024 where EV happened in an uncontrolled manner (Immediate charging) and Week starting 1 July 2024, where a charging profile defined on EV charger (Controlled EV charging). The x-axis represents the time of day, while the y-axis represents the power consumption in kilowatt-hours (kWh).

By strategically shifting 100% of the user's charging to the low-cost 'solar sponge' period, this optimisation eliminated all consumption during peak hours and generated $13.00 in weekly savings (potential savings of $676 annually). These results provide a compelling validation for controlled charging, demonstrating how time-of-use tariffs can drive behaviour that delivers significant economic benefits for high-consumption users and stability for the grid.

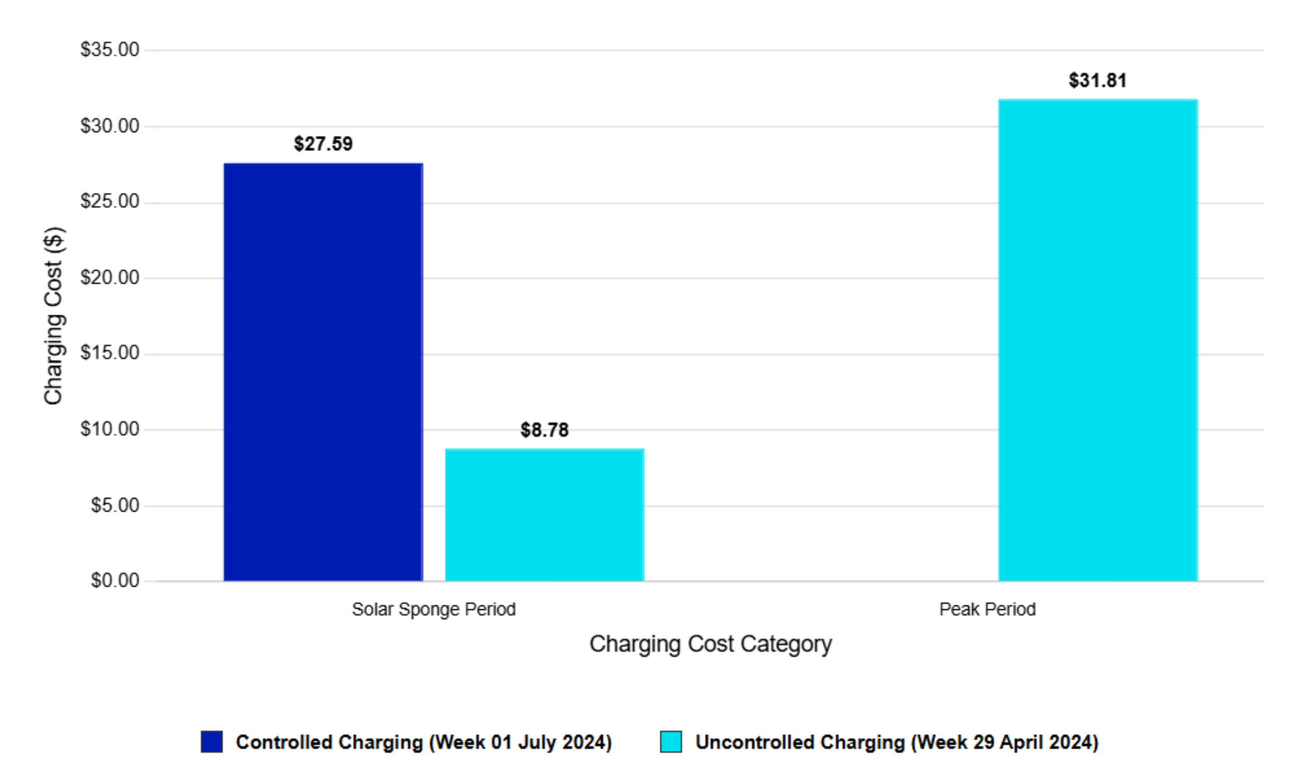


Figure 4.3.5 (b): Comparing costs between controlled and uncontrolled EV charging across three different time periods.

4.3.6. Controlled Charging over multiple weeks

Over an eight-week period (July–September 2024), controlled charging was deployed. The implementation proved highly effective, consistently confining all charging sessions to the 10:00 AM – 3:00 PM solar window throughout the period.

Crucially, the system demonstrated remarkable adaptability, managing fluctuating weekly electricity demands—ranging from 69 kWh to 114 kWh—while maintaining perfect solar alignment. This was accomplished without any compromise to user convenience or charging reliability, confirming the technical feasibility of this approach.

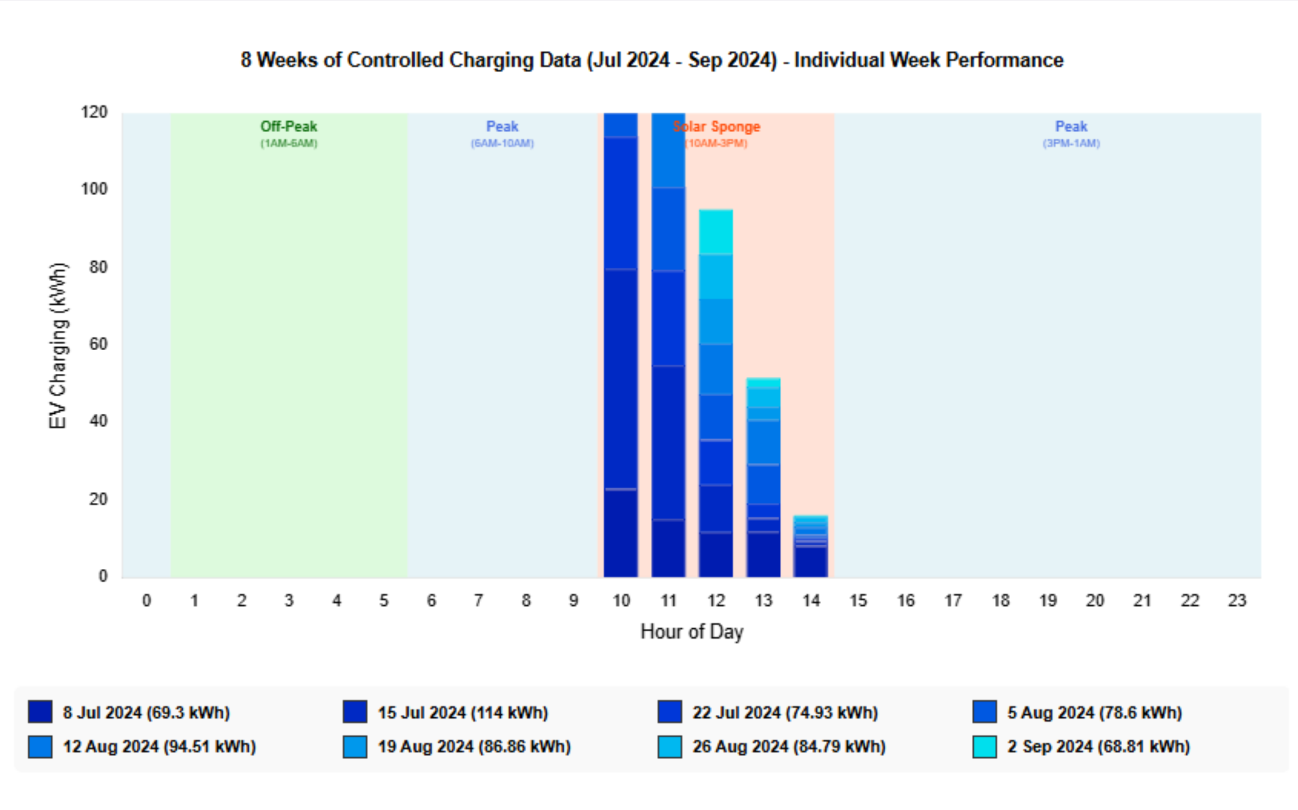


Figure 4.3.6: Power consumption (in kWh) over a 24hour period over multiple Weeks when a charging profile was defined on EV charger. The x-axis represents the time of day, while the y-axis represents the power consumption in kilowatt-hours (kWh). Charging profile from 10:00 AM to 3:00 PM, and 12:00 AM to 6:00 AM with a 32amp maximum power output was implemented for the periods depicted.

4.3.7. User 3: Qualitative Insights and Participant Feedback

Theme 1: Financial Decision-Making and Incentive Impact

The user's EV adoption was primarily driven by financial calculations, combining government incentives, lease benefits, and operational cost savings. This decision represents a convergence of multiple economic factors rather than climate motivation alone.

Insights:

- The user's adoption demonstrated the critical role of financial incentives in EV uptake.
- Their analytical approach to cost-benefit analysis suggested that clear, stable financial benefits are essential for mainstream adoption.
- The removal of government incentives created uncertainty that may hinder future adoption decisions.

Quotes:

> "At the time, the South Australian government was offering a $3,000 rebate. So, it was a new car with $3,000 back in my hand."

> "If you take away petrol costs, service costs, repair costs—the cambelt replacements and everything else that needs doing—and look at what you have with a Tesla, you've got virtually zero maintenance."

Theme 2: Infrastructure Convenience and Reliability

The Wilson Parking charging infrastructure provided the user with a seamless daily charging experience. The reliability and convenience of dedicated workplace charging is a key success factor.

Insights:

- The user's experience highlighted that when charging infrastructure worked reliably, it becomes virtually invisible to the user experience.
- Seamless integration into daily routine demonstrated the importance of convenience in EV adoption success.

Quotes:

> "The charging units have never let me down. Whenever I've tapped and plugged in, it all works."

> "There's so much convenience for me. I just park, walk away, do a day's work, and come back. I'm not standing at a petrol station or waiting at a Supercharger."

> "I plug it in, unplug it—it's perfect. What, 30 seconds added to my day?"

Theme 3: Smart Charging Acceptance and Grid Benefits

This user demonstrated strong understanding and acceptance of smart charging concepts, recognising both grid benefits and solar utilisation opportunities. Technical background enables appreciation of demand management strategies.

Insights:

- The user's acceptance of smart charging demonstrated
that educated users understood the mutual benefits.
- Distinction between permanently parked vehicles versus transient charging needs shows sophisticated understanding of use case variations.
- Their technical background facilitated appreciation of demand management strategies and grid optimisation benefits.

Quotes:

> "If your average person is working in a city context and their car is going to be in the car park because they have to go to work, then it makes sense that they should charge the car when solar is available in the network."

> "Most EV drivers would be absolutely open to smart charging, as it's not an inconvenience in the normal context of a permanently parked situation."

Theme 4: User Experience Complexity and Learning Curve

The user described the complexity of navigating different charging networks and payment systems, highlighting the fragmentation in the current EV charging ecosystem.

Insights:

- The complexity of charging network management created barriers for less technical users.
- The user's preference for simple tap-to-charge over app-based systems suggests the need for standardised, simplified user interfaces across networks.
- Charging reliability issues on other networks highlights the importance of consistent infrastructure quality.

Quotes:

> "The sequencing and how you do it can be really confusing. The first thing I did when I started out was get an account with ChargeFox and have them send me the RFID cards."

> "I think I've landed in a place where it makes more sense to just tap. You get more success than trying to use the app to work out what's going on."

> "I haven't experienced problems with your chargers, but I've certainly had situations where a charger has started charging and stopped for no reason, and situations where I just can't get the charger to start at all on other networks."

Theme 5: Privacy and Data Concerns

The user expresses sophisticated views on data privacy, distinguishing between acceptable charging-related data sharing and broader vehicle API access that could expose driving behaviour.

Insights:

- The user's nuanced privacy stance suggests that users would accept functional data sharing for charging optimisation but resist broader vehicle data access.
- This indicated the need for clearly defined purpose-limited data sharing protocols.
- Their technical understanding enabled sophisticated privacy considerations around different types of data access.

Quotes:

> "If we were going down the road where you wanted API integration to the car, I would be opposed to that from a privacy perspective."

> "My driving habits being exposed through the API for the benefit of charging would be a concern, particularly regarding any potential insurance company access."

> "Communication over the CCS2 cable, I would assume, is relevant to the activity of charging. Therefore, sharing my VIN, my state of charge, and receiving information about how much power you can provide sounds like an appropriate conversation to have over a CCS2 cable."

Theme 6: Government Policy and Market Stability

The user emphasised the importance of consistent, long-term government policy for building confidence in EV adoption, criticising policy volatility and short-term thinking.

Insights:

- Policy uncertainty creates adoption hesitation among potential EV buyers.
- The user's emphasis on planning predictability suggested that inconsistent government support may harm long-term adoption by creating market uncertainty.
- Stable, long-term policy frameworks are essential for building consumer confidence in EV investments.

Quotes:

> "The government more recently pulled the EV incentives for no clear reason. They just kind of withdrew them without much explanation."

> "Having stability in the context of everything to do with EVs is important to build confidence, I would suggest."

> "If the government was going to offer the money, they should have offered it until the allocated funds ran out."

Theme 7: Infrastructure Scaling and Industry Standardisation

The user envisioned a future with standardised, branded charging experiences like Tesla Superchargers, emphasising the need for consistency and reliability across networks.

Insights:

- The user's vision for standardised charging experiences reflected the need for industry-wide coordination.
- Tesla Supercharger comparison suggested that reliability and simplicity should be prioritised over feature complexity in charging network design.
- Branded, consistent charging experiences could drive greater user adoption and confidence in public charging infrastructure.

Quotes:

> "If Wilson Parking and you guys were branded together,' You'd know you're going to have a charging experience, you'd know it's going to be consistent across Australia. That would be very strong."

> "If you think about what makes Tesla Superchargers so powerful—they work, right? You arrive, plug it in, and you're done."

> "If there was a consistent way of doing what Tesla does with the other charger infrastructures, that would be awesome—easy to find, with a consistent experience."

4.4. User 4

One of the parking bays was occupied by car-sharing service provider. They operate approximately 700 vehicles across Australia, allowing users to book cars by the hour or day through a mobile app. The vehicles are equipped with telematics that enable keyless entry and monitoring of vehicle status, including battery levels for EVs. The company's business model relies heavily on renting dedicated parking bays, with 90-95% of their bays leased from local councils. They purchase their fleet vehicles, keep them for about three years, and then they are sold to wholesalers.

4.4.1. EV Utilisation

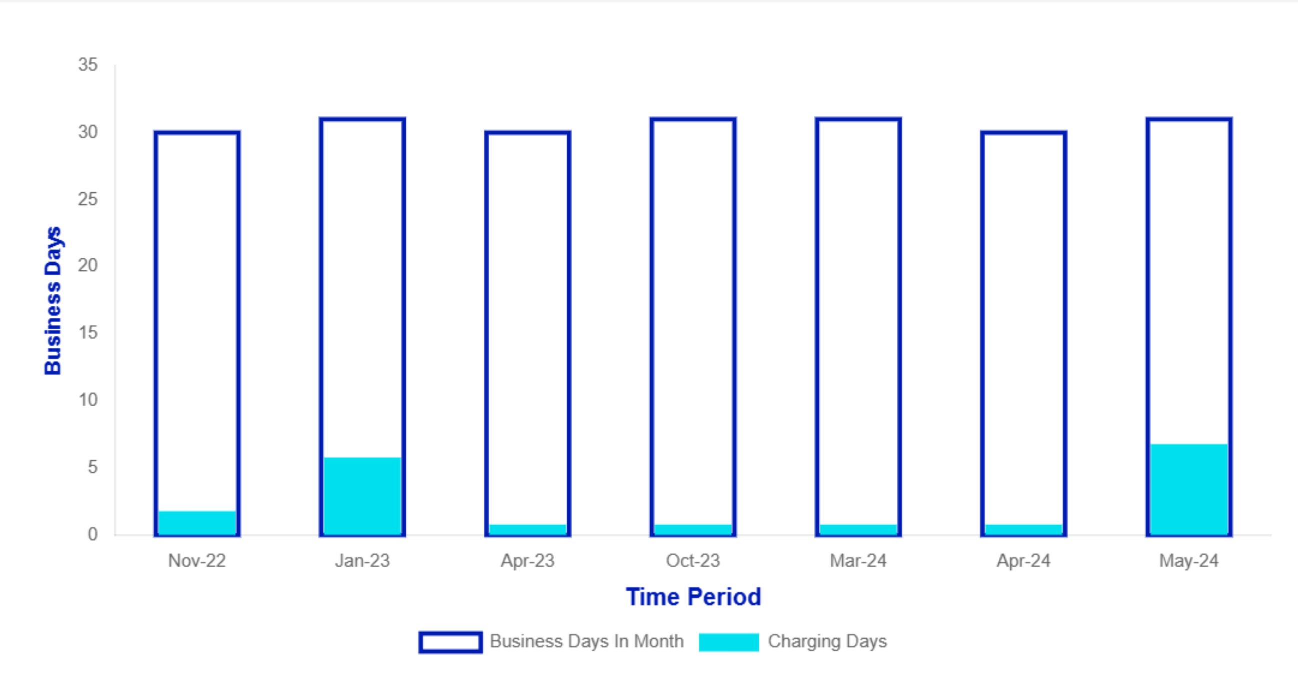


Figure 4.4.1: Utilisation of EV chargers over time. The x-axis represents the time (month and year), while the y-axis shows the number of days. The light blue bars represent the number of days EV chargers were utilised, and the white sections indicate the total days available in each month.

Car share operator began using one of the Wilson Parking Car Park charging facility from November 2022, showing sporadic and low utilisation patterns throughout the baseline period (November 2022 – May 2024). The usage was inconsistent with significant gaps between active periods, averaging only 9% utilisation across the total available days. Peak usage occurred in May 2024 at 23%, with January 2023 showing the second-highest engagement at 19%. Most months recorded minimal activity with utilisation rates below 7%.

This low utilisation pattern aligns with the fleet manager's stated operational challenges, including the off-street location being "a little off the beaten track" and "hard to get to," which impacts customer accessibility and booking frequency. The sporadic usage reflects the business model constraints where EVs are 'a little bit more expensive' resulting in only 'three or four bookings a week at the most.' The data supported fleet manager's preference for on-street council bays over off-street parking, as customers find street-level locations 'easier to find' and more convenient, avoiding the need to 'go climbing up three levels in a building'.

The intermittent charging patterns, with several months showing no activity, demonstrate the infrastructure placement challenges discussed in the interview, where location accessibility directly impacted fleet utilisation rates and customer adoption of EV options within the car-sharing service. The extremely low utilisation rates across most months (3-7%) underscore the significant barriers that off-street charging infrastructure creates for car-sharing operations, validating the fleet manager's assertion that on-street locations are 'definitely a preference' for optimal customer experience and fleet performance.

4.4.2. Baseline Charging Behaviour

During the baseline period, the charging bay used by the car-sharing service provider demonstrated highly variable and operationally driven charging behaviour, with charging sessions scattered throughout different time periods from early morning (6:00 AM) to late evening (10:00 PM), reflecting the unpredictable nature of car-sharing vehicle returns rather than personal routine-driven patterns.

Fleet Operations Impact: Unlike personal EV users, charging timing was determined by customer return schedules and fleet management requirements, with sessions starting whenever vehicles were returned or when the battery levels drop below the 60% threshold mentioned by the fleet manager. This operational necessity meant charging could not be optimised for solar production or off-peak periods.

Electricity Consumption Range: Weekly totals varied dramatically from 4 kWh to 70 kWh, indicating highly variable utilisation consistent with the fleet manager's observation of 'three or four bookings a week at most' for EVs. The wide variation reflected the sporadic usage patterns and seasonal demand fluctuations in car-sharing services.

Demand-Driven Operations: Charging patterns were entirely driven by customer demand and vehicle availability requirements rather than routine, supporting the fleet manager's description of using telematics to monitor battery levels and blocking vehicles when battery State of Charge (SOC) dropped below operational thresholds.

Operational Charging Strategy: Fleet vehicles were charged immediately upon return or when the battery levels are low, prioritising vehicle availability over optimal charging times. This reflected the business model constraint where vehicle downtime directly impacted revenue, making grid optimisation secondary to operational requirements.

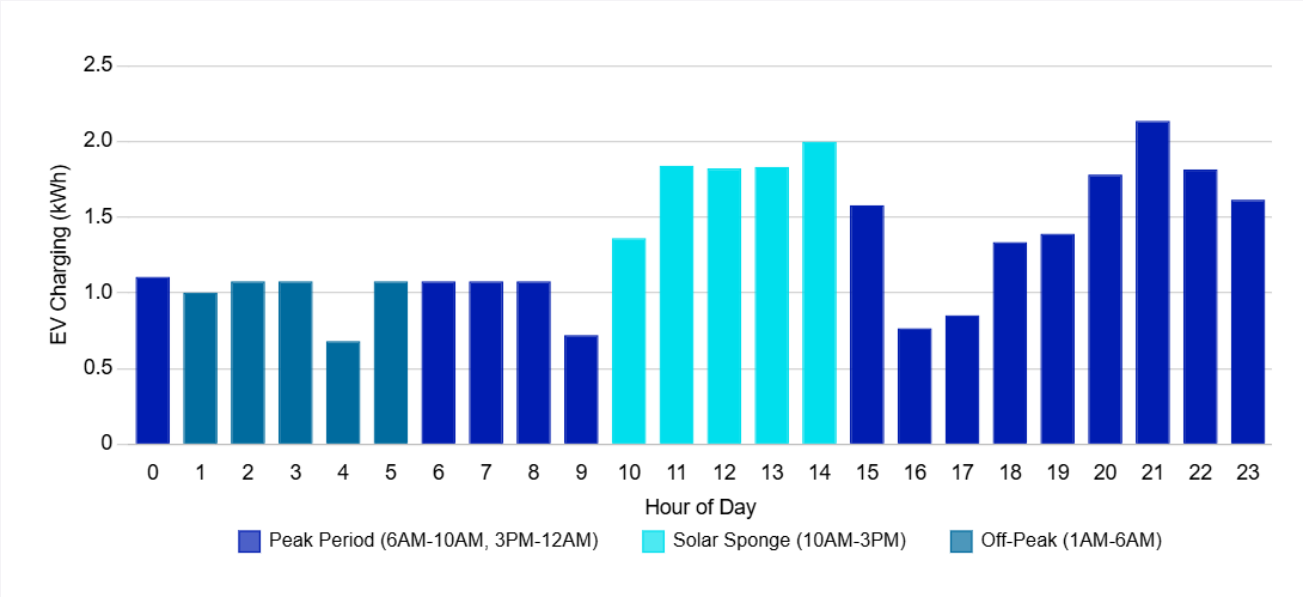


Figure 4.4.2: Uncontrolled EV charging (in kWh).

X-Axis (Hour of Day): Represents the 24-hour time periods from 0 (midnight) to 23 (11:00 PM), showing when charging sessions occurred throughout the day. Y-Axis (Electricity kWh): Shows the average EV charging in kilowatt-hours (kWh)for each hour, calculated across period Nov 2022 – May 2024.

Data Representation: Each bar represents the average electricity consumed for that specific hour. Colours indicate time-of-use periods: Peak Period (highest electricity rates), Solar Sponge (optimal renewable electricity window), and Off-Peak (lowest electricity rates).

4.4.3. Charging Session Analysis: Start Time and Departure Patterns

The start time and departure analysis revealed a charging behaviour fundamentally different from typical commuter patterns, which was directly explained by the vehicle's use in a car-sharing fleet. The service allowed users to book the car by the hour or day, leading to unpredictable return times. The distribution of charging sessions with peaks at 9:00 AM, 11:00 AM, and 8:00 PM aligned with a model of short-term rentals, with an average booking lasting only 3.6 hours. The primary departure concentration at 4:00 PM likely represented the start of an evening rental. This pattern was not indicative of a single driver but rather the mixed usage inherent to a publicly shared vehicle.

Optimisation Constraints and Considerations

While the car-sharing model is suited for optimisation, several constraints must be addressed.

Vehicle Availability is Paramount: The primary business driver is maximising vehicle availability for rental. The fleet manager stated, 'the quicker, the faster the charger the better,' because it means the car can be rented out again sooner. Any optimisation strategy that delays charging must be intelligent enough to ensure the vehicle reaches a sufficient state of charge (e.g., 70-80%) before the next likely rental period.

User Awareness: Successful implementation requires educating the customers on how load shifting works and demonstrating that it will not negatively impact vehicle availability.

Need for Dynamic Systems: The unpredictable returns from hourly rentals make Controlled and Smart charging challenging. The scenario requires a real time adaptive charging system that can assess the vehicle's state of charge (SOC) upon return and schedule charging based on idle time predictions.

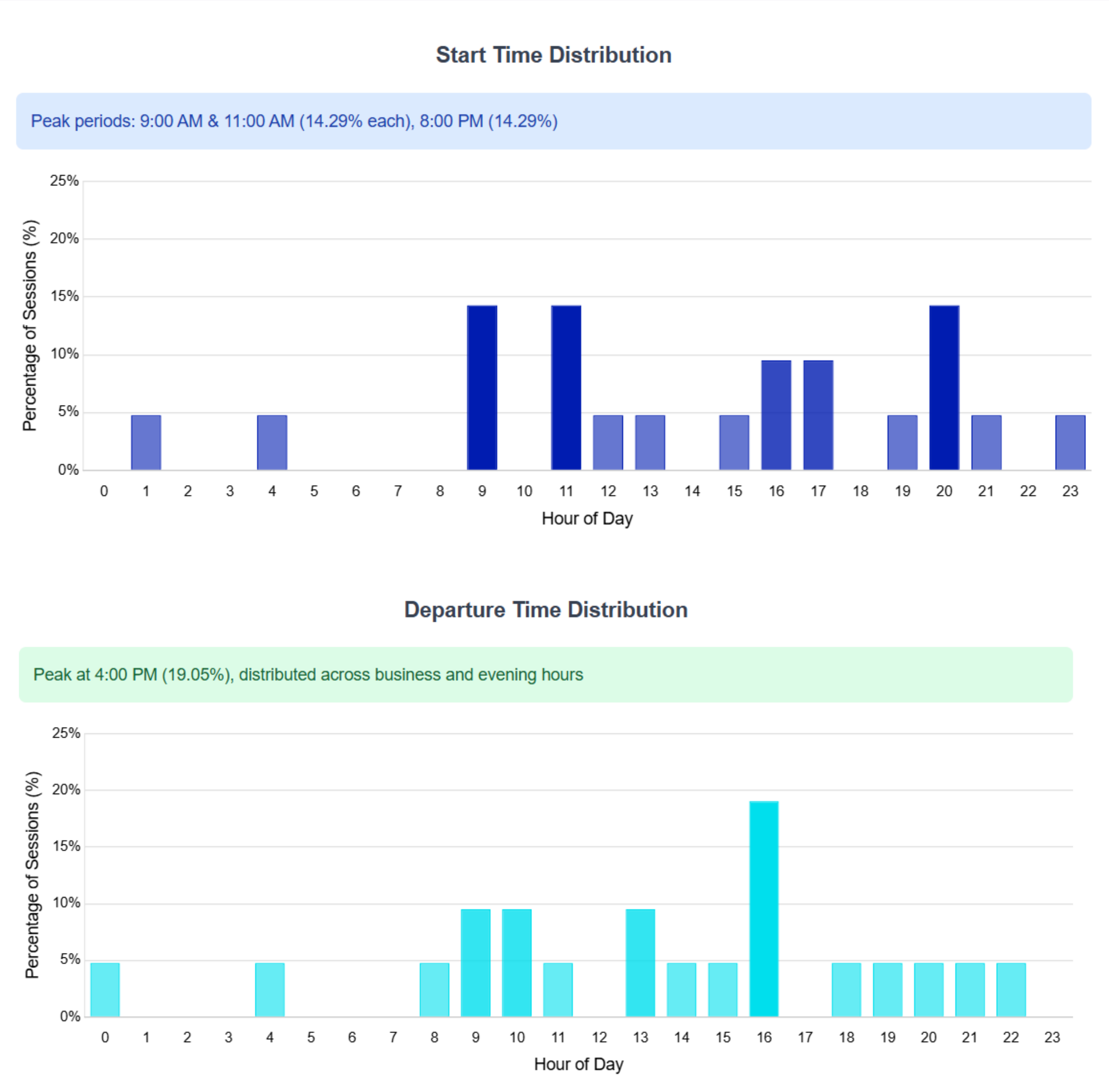


Figure 4.4.3: Distribution of sessions based on Start and Departure Times.
Top graph: Morning arrival peak.
Bottom graph: Evening departure peak.

4.4.4. Predictable Charging Patterns Support Controlled Charging Implementation

The session analysis revealed a charging pattern that is not predictable in a typical commuter sense but is operationally consistent with the variable demands of a car-sharing service. The distribution of sessions with peaks at 9:00 AM, 11:00 AM, and 8:00 PM is a direct result of vehicles being rented for short durations and returned throughout the day. This pattern, driven by multiple users with different schedules, creates a unique but reliable foundation for implementing controlled charging strategies that align with the fleet's operational needs.

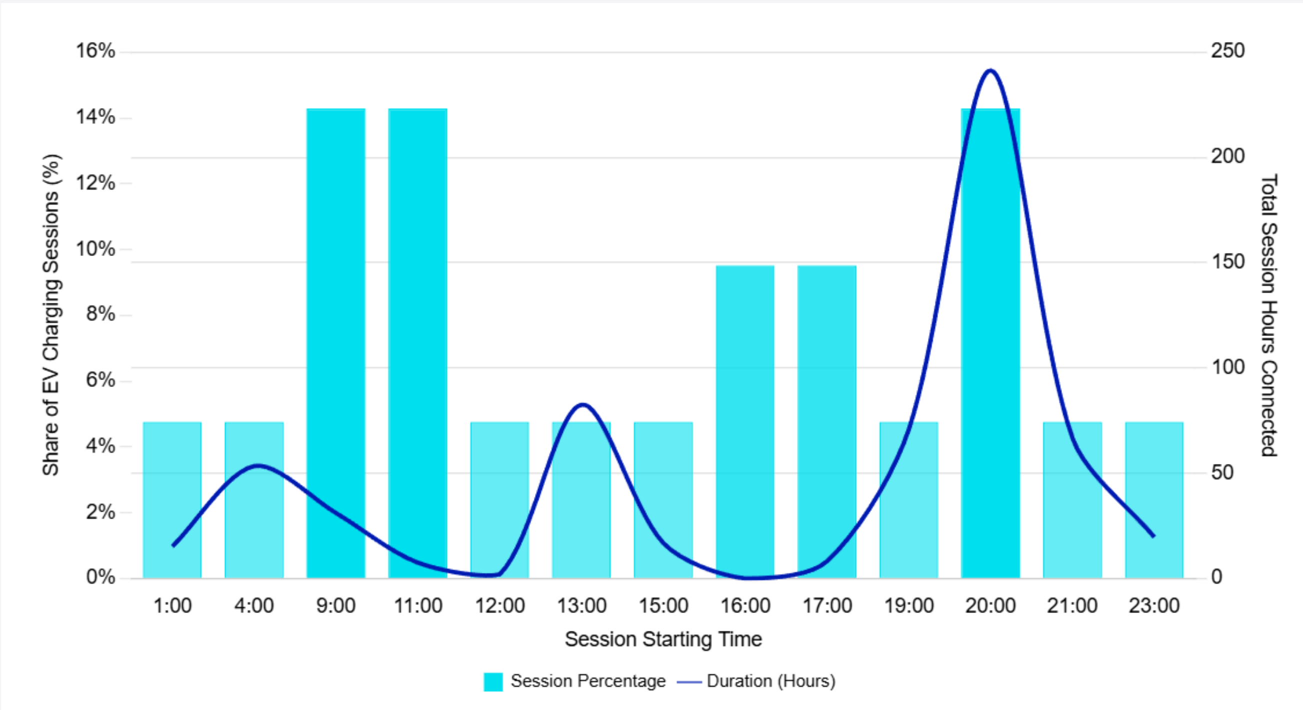


Figure 4.4.4:
X-axis (Session start time): Hour of day when sessions begin.
Left Y-axis (Share of sessions, %): Percentage of all sessions that start in that hour.
Right Y-axis (Total hours connected): Sum of hours EVs remained connected for sessions starting in that hour.

Controlled/Smart Charging Implementation Barriers

The primary barrier to implementing controlled or smart charging for this fleet was not the charging pattern itself, but a combination of operational priorities and a critical communication gap. The fleet manager's primary goal is maximising vehicle availability, leading to a preference for the fastest possible charging to get the vehicle back in service.

With State of Charge (SOC) not available and idle time prediction challenges across this distributed operational pattern, controlled charging or Smart charging was not implemented on this fleet EV charger.

4.4.5. User 4: Qualitative Insights and Participant Feedback

Theme 1: Infrastructure Scarcity and Geographic Disparities

The Fleet manager highlights significant challenges in securing adequate charging infrastructure across different Australian cities, with Adelaide being the notable exception where they have found a viable solution through Wilson's car parks.

Insights:

- Critical infrastructure gap creates operational inefficiencies and limits EV deployment.
- Geographic disparity suggests policy and infrastructure development varies significantly between states.
- South Australia potentially ahead in supporting commercial EV operations.

Quotes:

> "There aren't many charging bay options at the moment, apart from this one. This one in Adelaide is one of the only ones that's affordable where we can put a car."

> "Melbourne and Sydney are a bit of a struggle, but the bay in Adelaide is doing really well."

> "We have other EVs around the country, but they don't have their own dedicated charging bay."

Theme 2: Operational Inefficiency Due to Charging Limitations

The lack of dedicated charging infrastructure forced the company to implement costly and inefficient workarounds, including remote monitoring and manual intervention when battery levels drop.

Insights:

- Infrastructure limitations create cascading operational costs and complexity.
- Constant monitoring and manual intervention significantly impact's business model efficiency.
- Scalability is severely compromised by current infrastructure constraints.

Quotes:

> "We use telematics to keep track of the battery level of the car from the backend. Once we see it's below around 60%, we just block it off and then go in and take it back to the charger. So, it's an inefficient way of doing it."

Theme 3: Council Relations and Regulatory Barriers

Most of their parking bays (90-95%) are leased from local councils, but councils are yet to provide charging infrastructure, creating a dependency on private off-street options.

Insights:

- Systemic policy gap where local governments aren't adequately supporting EV transition for commercial operators.
- Slow pace of council adoption is creating bottlenecks for businesses trying to electrify their fleets.
- Heavy dependency on council partnerships makes fleet electrification vulnerable to policy delays.

Quotes:

> "We rent about 90 to 95% of our bays from local councils. None of those bays really have chargers, and councils really don't want to provide them."

> "We might have 20 or 30 councils, and we might have two that are going to give us one bay each with chargers. So it's just very slow going at this point."

Theme 4: Customer Experience and Vehicle Preference

Customer adoption and satisfaction vary significantly based on vehicle type, with newer models of EV's, more appealing and performing better than earlier models.

Insights:

- Vehicle appeal and attractiveness significantly impacted consumer adoption rates.
- Premium, sporty EVs drive better utilisation than basic models.
- Range anxiety and charging concerns continue to limit longer booking durations.
- Customer perception of EV quality directly affects business viability.

Quotes:

> "One of the EV we had initially wasn't very popular among customers. People just weren't using it, so we had low utilisation. Now we've put one of the newer models in—it's much more popular as it's more of a sporty car."

> "We're finding people a little reluctant to do those longer bookings because they're somewhat worried about charging."

Theme 5: On-Street vs Off-Street Parking Tradeoffs

On street council bays provide better customer experience and accessibility, creating a complex decision matrix for fleet placement. Furthermore, council-policed on-street bays suffer less from unauthorised parking compared to off-street bays where other drivers often occupy the space. Although off-street parks offer slightly better security against vehicle damage like sideswipes, the lower cost and superior customer convenience of on-street bays make them the preferred choice.

Insights:

- Tension exists between operational needs (charging) and customer convenience (accessibility).
- Location and ease of access significantly impact utilisation rates.
- Charging infrastructure placement is as important as its availability.
- Customer convenience and cost-effectiveness outweigh the marginal security benefits of off-street parking.

Quotes:

> "On-street locations are a lot better for customers. It's easier for them to find the car for starters—they don't have to go climbing up three levels in a building."

> "It's kind of hard to get to the car park. We would much prefer the charging bay to be in the CBD."

Theme 6: Policy Recommendations and Future Needs

The Fleet manager provided clear recommendations for government and council intervention to support EV adoption in commercial fleets.

Insights:

- Carsharing is positioned as democratising force for EV access.
- Supporting fleet operators could have broader social and climate benefits.
- Policy intervention needed to accelerate commercial EV adoption.

Quotes:

> "Minimum charging bays in all car parks would be a good initiative and having some available for car share operators like ourselves would be beneficial."

> "Not everyone can afford a car, so that's where we come in. People use car share instead of buying a car, so it would be good if we could offer them an EV option."

4.5. User 5

This user commenced utilising the Wilson Parking car park EV charging infrastructure in June 2023, operating a Mitsubishi i-MiEV with a 16kWh battery capacity. The charging data reveals active usage patterns from March 2023 through January 2024.

Despite multiple outreach attempts during the trial period, direct contact with this user was not established, limiting our understanding of their specific charging motivations, satisfaction levels, and operational feedback regarding the deployed charging infrastructure. However, the comprehensive charging data provides valuable insights into their usage patterns and behaviour.

4.5.1. EV Utilisation

During the 11-month analysis period from June 2023 to May 2024, the user demonstrated highly variable charging engagement patterns with significant seasonal and monthly fluctuations in EV charging station utilisation.

Utilisation Variability: Monthly utilisation rates vary dramatically from a low of 9% (October 2023, November 2023, and April 2024) to a peak of 43% (July 2023), indicating inconsistent charging routine establishment and potential seasonal or work pattern influences.

Low Engagement Periods: Three months show critically low utilisation at 9%, with only 2-3 charging sessions per month.

Seasonal Patterns: Summer months (June-August 2023) show generally higher engagement with utilisation rates of 14%, 43%, and 22% respectively, compared to fall/winter months which trend lower.

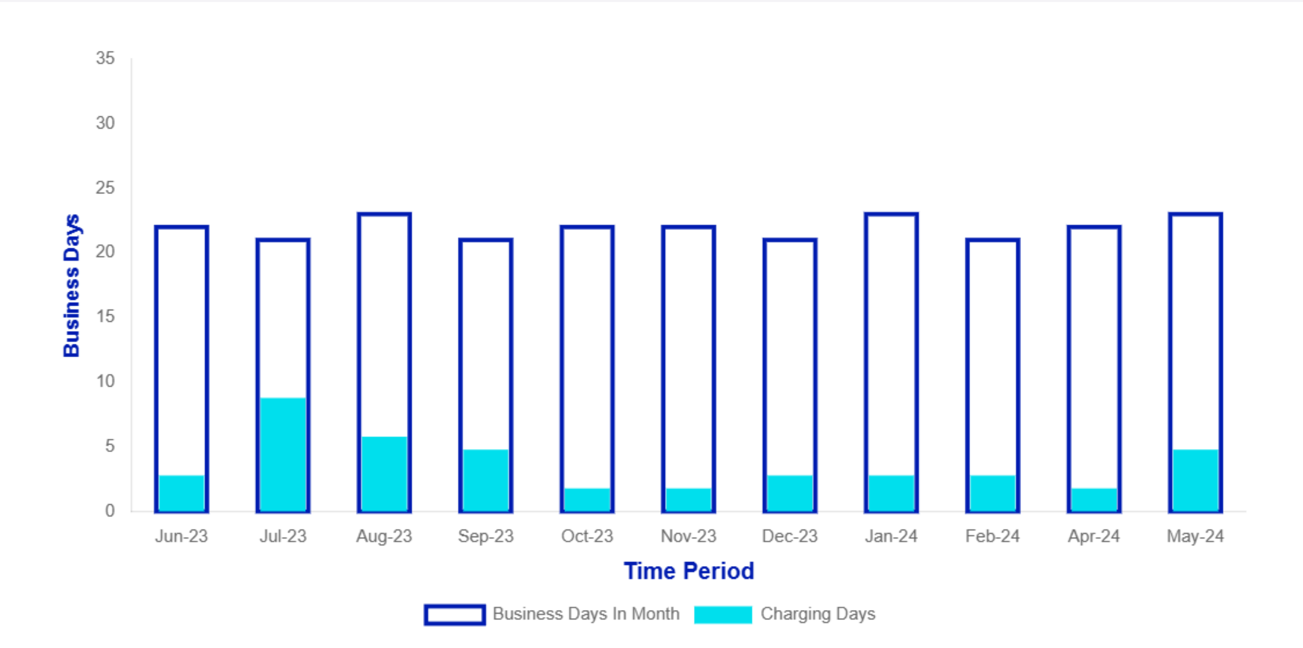


Figure 4.5.1: Utilisation of EV chargers over time. The x-axis represents the time (month and year), while the y-axis shows the number of days. The light blue bars represent the number of days EV chargers were utilised, and the white sections indicate the total days available in each month

4.5.2. Charging Pattern Analysis

Based on the comprehensive 32-week charging pattern analysis from March 2023 to May 2024, with 26 weeks showing active charging behaviour, the analysis revealed the following patterns.

The user demonstrated highly adaptive and variable charging behaviour throughout the analysis period. Charging sessions were distributed across daytime hours from 8:00 AM to 6:00 PM, with peak activity varying significantly between morning (9:00 AM – 12:00 PM), midday (12:00 PM – 3:00 PM), and afternoon (3:00 PM – 6:00 PM) periods, rather than following consistent patterns.

Weekly electricity consumption showed moderate variation, ranging from 0.05 kWh to 15.76 kWh across active weeks. Most weeks (20 out of 26) consumed between 3 – 12 kWh. Given the i-MiEV's 16kWh battery capacity, this consumption pattern indicated primarily partial charging or top-up behaviour rather than full discharge-recharge cycles. This suggested the user likely relied on supplementary charging at other locations to meet their total electricity needs.

Peak Period (41%): During the baseline period 41% of charging happened during peak demand hours (6:00 AM – 10:00 AM, 4:00 PM – 1:00 AM)

Solar Sponge (67%): 59% utilisation of optimal renewable electricity window (10:00 AM – 3:00 PM).

Off-Peak (0%): no usage during periods of lower electricity prices and reduced grid demand (1:00 AM – 6:00 AM).

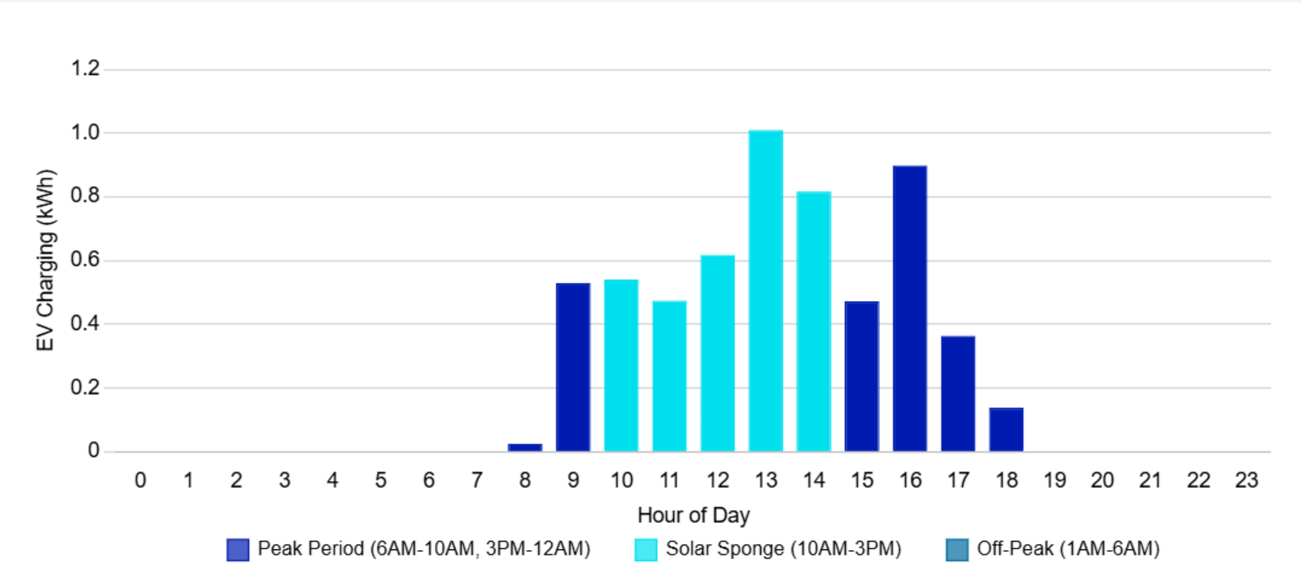


Figure 4.5.2: Uncontrolled EV charging (in kWh)

X-Axis (Hour of Day): Represents the 24-hour time periods from 0 (midnight) to 23 (11:00 PM), showing when charging sessions occurred throughout the day.

Y-Axis (Energy kWh): Shows the average EV charging in kilowatt-hours (kWh) for each hour, calculated across all weeks of data where charging occurred.

Data Representation: Each bar represents the average electricity consumed for that specific hour. Colours indicate time-of-use periods: Peak Period (highest electricity rates), Solar Sponge (optimal renewable electricity window), and Off-Peak (lowest electricity rates).

4.5.3. Charging Session Analysis: Start Time and Departure Patterns

The start and departure time analysis revealed identical peak patterns, with both arrival and departure concentrations occurring at 9:00 AM and 12:00 PM (16-16.67% each). This overlap made it challenging to establish predictable charging patterns or define a controlled charging profile.

The overlapping arrival and departure distributions indicated highly variable session durations, ranging from very short top-up sessions (where arrivals and departures occurred within the same hour) to potentially longer parking periods. This variability created operational challenges:

Limited Load Management Opportunities: Without clear session duration patterns, implementing delayed start protocols or load shifting strategies was challenging, as there was insufficient time to optimise charging windows.

Absence of Baseline Charging Profiles: The overlapping patterns prevented clear identification of typical user behaviour, making it difficult to develop effective controlled or smart charging optimisation strategies tailored to this user's needs.

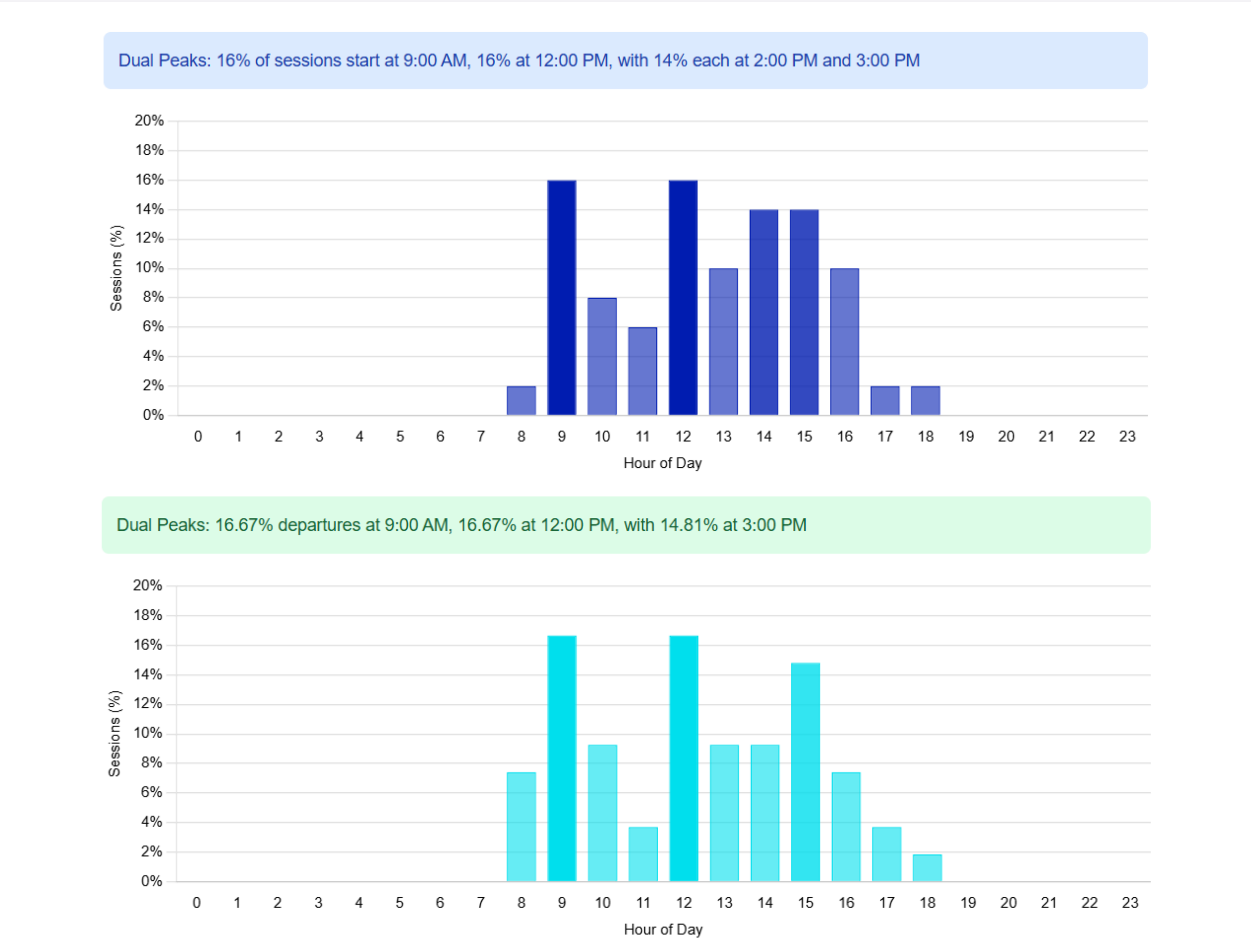


Figure 4.5.3: Distribution of sessions based on Start and Departure Times. Top graph: Morning arrival peak. Bottom graph: Evening departure peak.

4.6. User 6

The South Australian Department of Infrastructure and Transport (DIT) occupied 7 parking bays at Wilson Parking as part of their fleet electrification initiative. This decision was driven by critical infrastructure constraints at their primary office location, where the building had reached electrical capacity limits. The building owners determined that a distribution board upgrade would be required to install additional EV charging stations, creating a significant barrier to on-site fleet expansion.

Strategic Location Selection

The Wilson Parking location was selected based on strict proximity requirements established by DIT management, who mandated that charging infrastructure must be within 'two or three blocks' of their office. This proximity criterion was essential for operational efficiency, particularly for after-hours vehicle access when staff safety concerns about walking distances in the dark became a factor.

Fleet Composition and Vehicle Allocation

The 7 charging bays accommodated a diverse mix of vehicles including:

- BYD Atos (selected initially for cost-effectiveness but later found to have charging limitations at only 7kW capacity)
- Kia Niro
- Hyundai Kona
- Mitsubishi Outlander PHEV

Each bay was allocated to a specific vehicle registration rather than operating as a pooled charging resource, ensuring dedicated access for assigned vehicles while preventing conflicts over charging availability.

4.6.1. EV Utilisation

The SA Department of Infrastructure and Transport began utilising the Wilson Parking charging facility in August 2023, demonstrating evolving fleet usage patterns throughout the baseline monitoring period. Utilisation rates showed initial adoption challenges at 48% in August 2023, followed by sustained improvement with rates consistently above 60% from October 2023 onwards, achieving peak utilisation of 90% in February 2024.

Fleet users demonstrated strong operational adoption and systematic usage of the workplace charging infrastructure, utilising the facility on average 66% of the available business days. This high utilisation rate reflected what fleet manager mentioned on proactive fleet management approach, including the implementation of charging etiquette policies requiring drivers to ‘charge when the vehicle is not being driven’ and strategic allocation of specific charging bays to individual vehicles.

The sustained 60%+ utilisation rates from October 2023 onwards indicated successful integration of EVs into daily fleet operations, supporting DIT’s broader electrification strategy towards their goal of 31 EVs in the CBD.

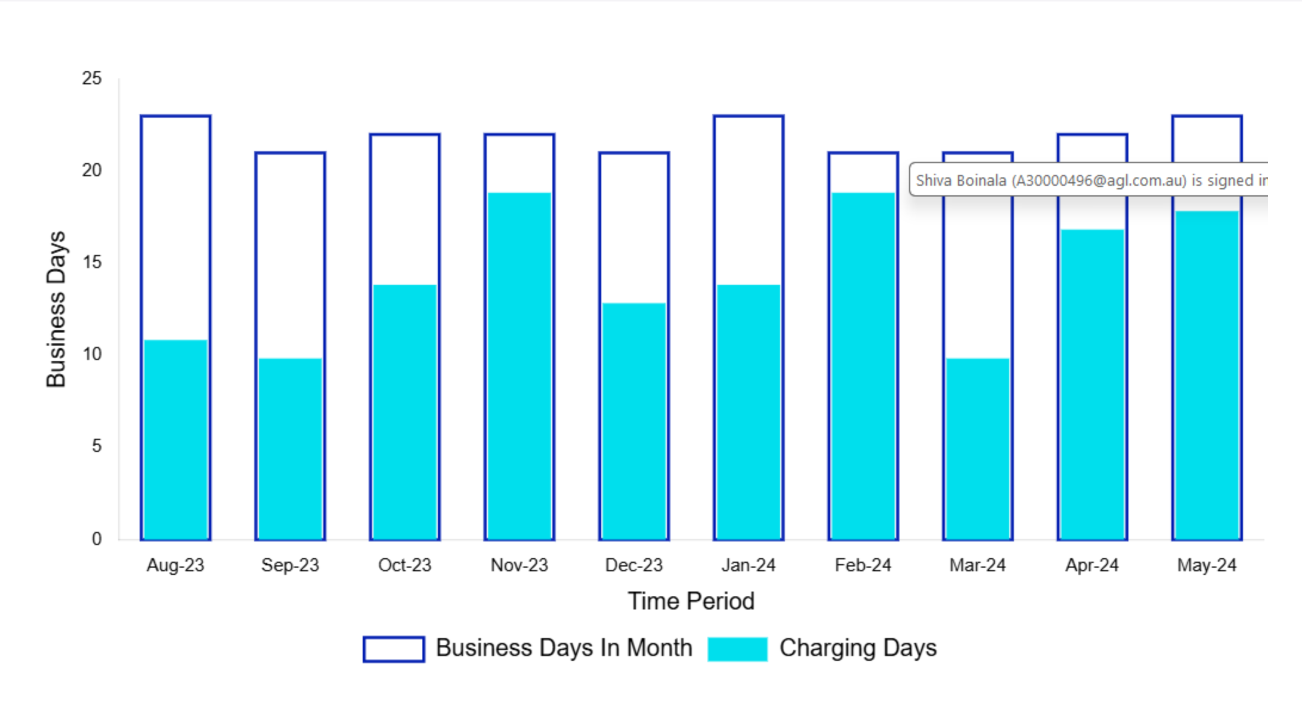


Figure 4.6.1: Utilisation of EV chargers over time. The x-axis represents the time (month and year), while the y-axis shows the number of days. The light blue bars represent the number of days EV chargers were utilised, and the white sections indicate the business days available in each month.

4.6.2. Charging Patterns

During the baseline period, the DIT fleet of 7 vehicles demonstrated charging sessions concentrated in a 4–6-hour afternoon window between 2:00 PM-6:00 PM, with peak activity consistently occurring during 3:00 -4:00 PM, coinciding with higher electricity price periods when grid demand is elevated.

Sub-Optimal Solar Utilisation: Only 43% of fleet charging occurred during the optimal solar sponge period (10:00 AM – 3:00 PM), while the remaining 57% of charging happened during peak electricity demand periods (6:00 AM – 10:00 AM and 3:00 PM – 1:00 AM).

Variable Fleet Electricity Consumption: Weekly totals demonstrate significant variation from 41 kWh to 141 kWh across the 7-bay facility, indicating adaptive fleet electricity management driven by varying daily operational requirements, seasonal travel patterns, and diverse vehicle usage.

Operational Charging Optimisation Opportunity: The consistent afternoon charging pattern (2:00 PM –6:00 PM) reflected DIT's operational model where the vehicles are returned from daily field work to be parked overnight at Wilson Parking. This operational structure presents a significant opportunity to implement controlled or smart charging schedules, shifting electricity consumption to off-peak periods (1:00 AM – 6:00 AM) when electricity prices are substantially lower and grid demand is minimal, while maintaining full vehicle readiness for next-day operations.

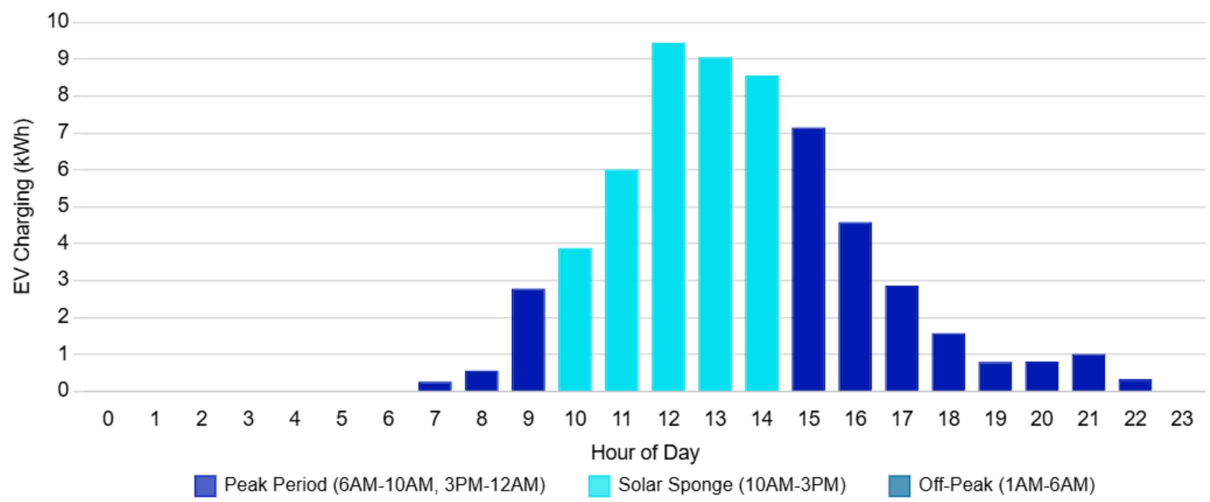


Figure 4.6.2: Uncontrolled EV charging (in kWh).

X-Axis (Hour of Day): Represents the 24-hour time periods from 0 (midnight) to 23 (11:00 PM), showing when charging sessions occurred throughout the day.

Y-Axis (Electricity kWh): Shows the average EV charging in kilowatt-hours (kWh) for each hour, calculated across all 43 weeks of data where charging occurred.

Data Representation: Each bar represents the average electricity consumed for that specific hour. Colours indicate time-of-use periods: Peak Period (highest electricity rates), Solar Sponge (optimal renewable electricity window), and Off-Peak (lowest electricity rates).

4.6.3. Charging Session Analysis: Start Time and Departure Patterns

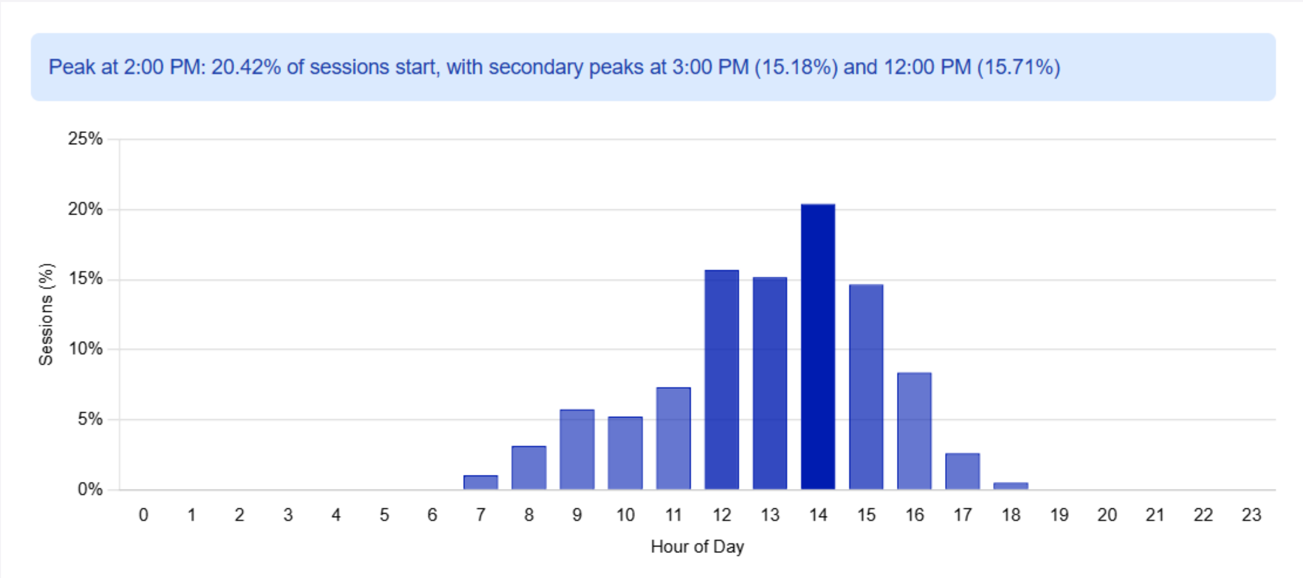


Figure 4.6.3 (a): Start time distribution showing start time peak

Start Time Distribution Analysis:

The DIT fleet demonstrated a concentrated afternoon charging initiation pattern, with the highest activity occurring at 2:00 PM (20% of all sessions), followed by secondary peaks at 1:00 PM (15%) and 12:00 PM (16%). This created a distinct afternoon charging window where 51% of all charging sessions commence between 12:00 PM and 3:00 PM.

Operational Significance:

This afternoon-heavy charging pattern reflects the natural rhythm of fleet operations where vehicles complete morning field work before returning to Wilson Parking. Aligning with Fleet Manager observation that vehicles are 'taken out throughout the day' and return for overnight parking.

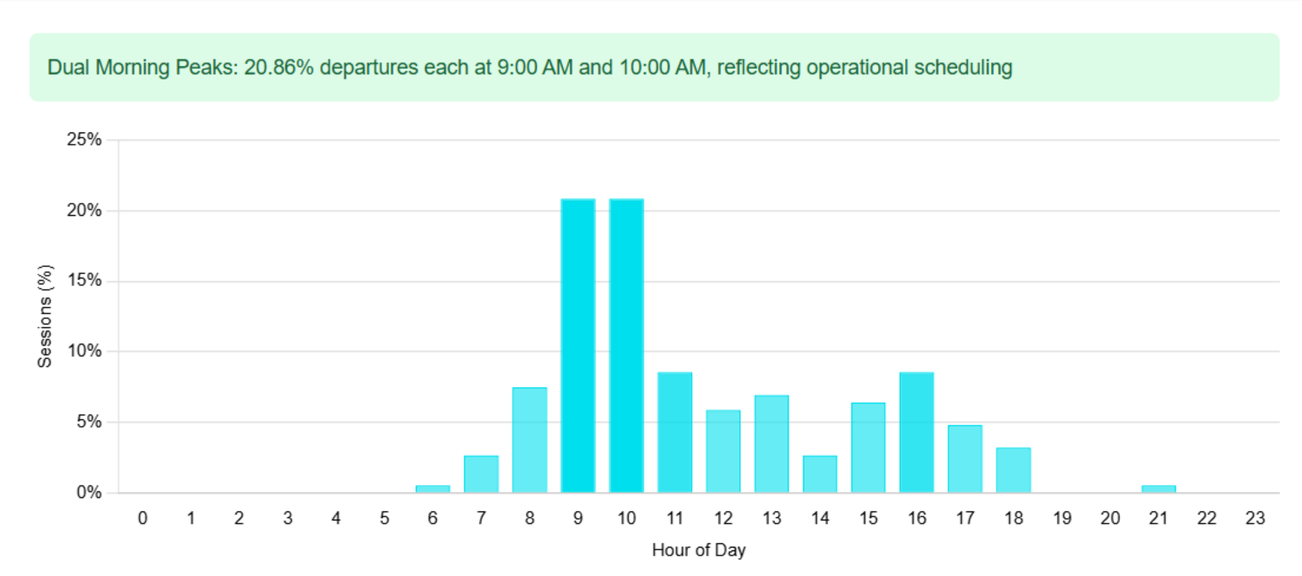


Figure 4.6.3 (b): Departure time distribution showing departure peak

Departure Time Distribution Analysis:

The departure pattern reveals highly coordinated morning operations with dual peaks at 9:00 AM and 10:00 AM (21% each), representing 42% of all departures within this two-hour window.

Operational Cycle Implications:

The combination of afternoon arrival (2:00 PM peak) and morning departure (9:00 AM – 10:00 AM peaks) presented an extended parking window of approximately 19-20 hours, providing substantial opportunity for optimised charging strategies. This extended dwell time supports DIT policy requiring drivers to 'charge when the vehicle is not being driven' while enabling controlled and smart charging implementation.

Infrastructure Utilisation:

The departure analysis showed continued activity through 6:00 PM (9% departures at 4:00 PM), indicating that not all vehicles follow the standard 9:00 AM – 10:00 AM deployment pattern. This reflects Fleet Manager description of 'multiple site inspections' and varying operational requirements across different government departments utilising the fleet.

Strategic Optimisation Opportunities:

The 19–20-hour parking duration between afternoon return and morning departure creates significant potential for load shifting to overnight periods (1:00 AM – 6:00 AM) when electricity costs are lowest and grid demand is low, while the current afternoon arrival timing provides partial solar capture that could be enhanced through minor charging scheduling adjustments to maximise renewable electricity utilisation.

4.6.4. Predictable Charging Patterns Support Controlled Charging Implementation

The session analytics revealed critical patterns in DIT fleet operations that provide insights for predictive charging algorithms and controlled charging and smart charging implementation across the 7 parking bays. The data shows 20% of fleet sessions start at 2:00 PM with 1,852 total hours, representing the dominant operational pattern where vehicles return from morning government field work and can be leveraged for strategic charging optimisation.

High Predictability Indicators

- Operational Reliability: 51% probability of fleet sessions starting during peak solar window (12:00-3:00 PM).
- Duration Predictability: Extended overnight parking sessions (19-20 hours) with high consistency reflecting government operational schedules.
- Departure Projection: Coordinated morning deployment at 9:00 – 10:00 AM for daily government operations.

Smart Fleet Charging Opportunities

Given the 1,852 total hours concentrated at 2:00 PM and extended overnight parking:

- Load Shifting Implementation: Leverage 19 – 20-hour dwell time to shift charging to off-peak periods (1:00 – 6:00 AM) when electricity costs are lowest.
- Solar Optimisation: Enhance the existing 51% solar window utilisation by fine-tuning afternoon arrival scheduling to maximise 12:00 – 3:00 PM charging initiation.
- Cost Reduction Strategy: Implement time-of-use charging protocols that align with Fleet operational requirements while achieving cost savings through off-peak electricity utilisation for Wilson Parking.

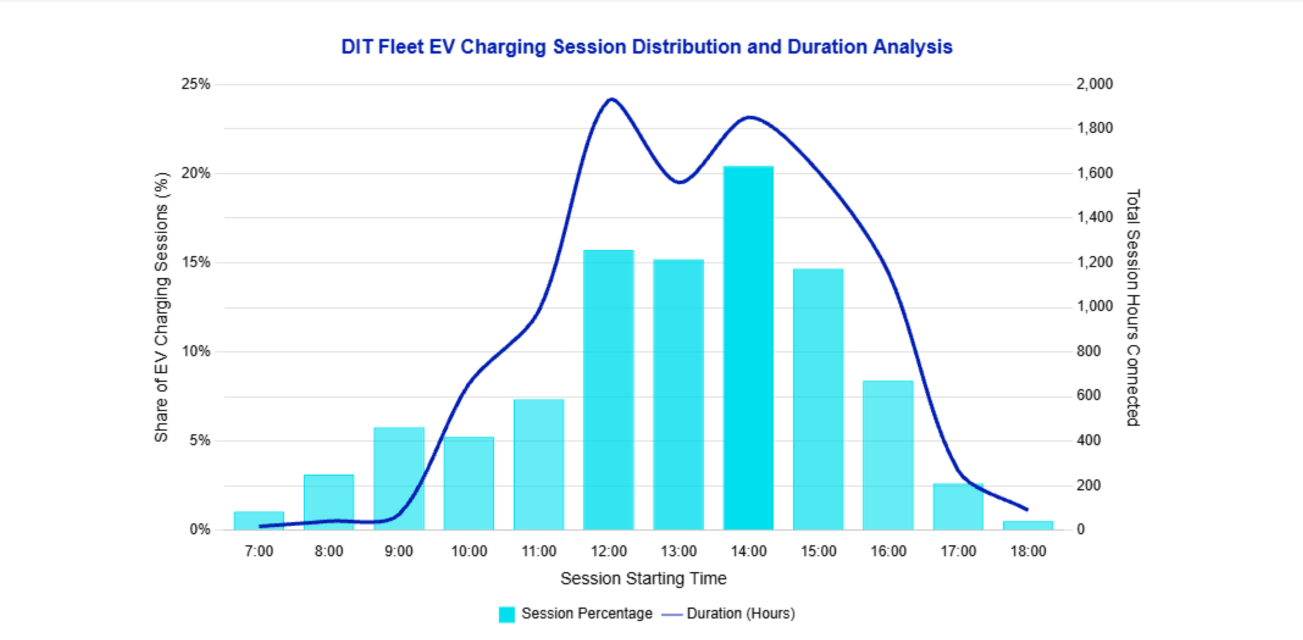


Figure 4.6.4: X-axis (Session start time): Hour of day when sessions begin.
Left Y-axis (Share of sessions, %): Percentage of all sessions that start in that hour.
Right Y-axis (Total hours connected): Sum of hours EVs remained connected for sessions starting in that hour.

4.6.5. Controlled Charging Implementation 1

In August 2024, a charging schedule from **10:00 AM to 3:00 PM**, and **9:00 PM to 7:00 AM** with a **32amp maximum power output** was implemented.

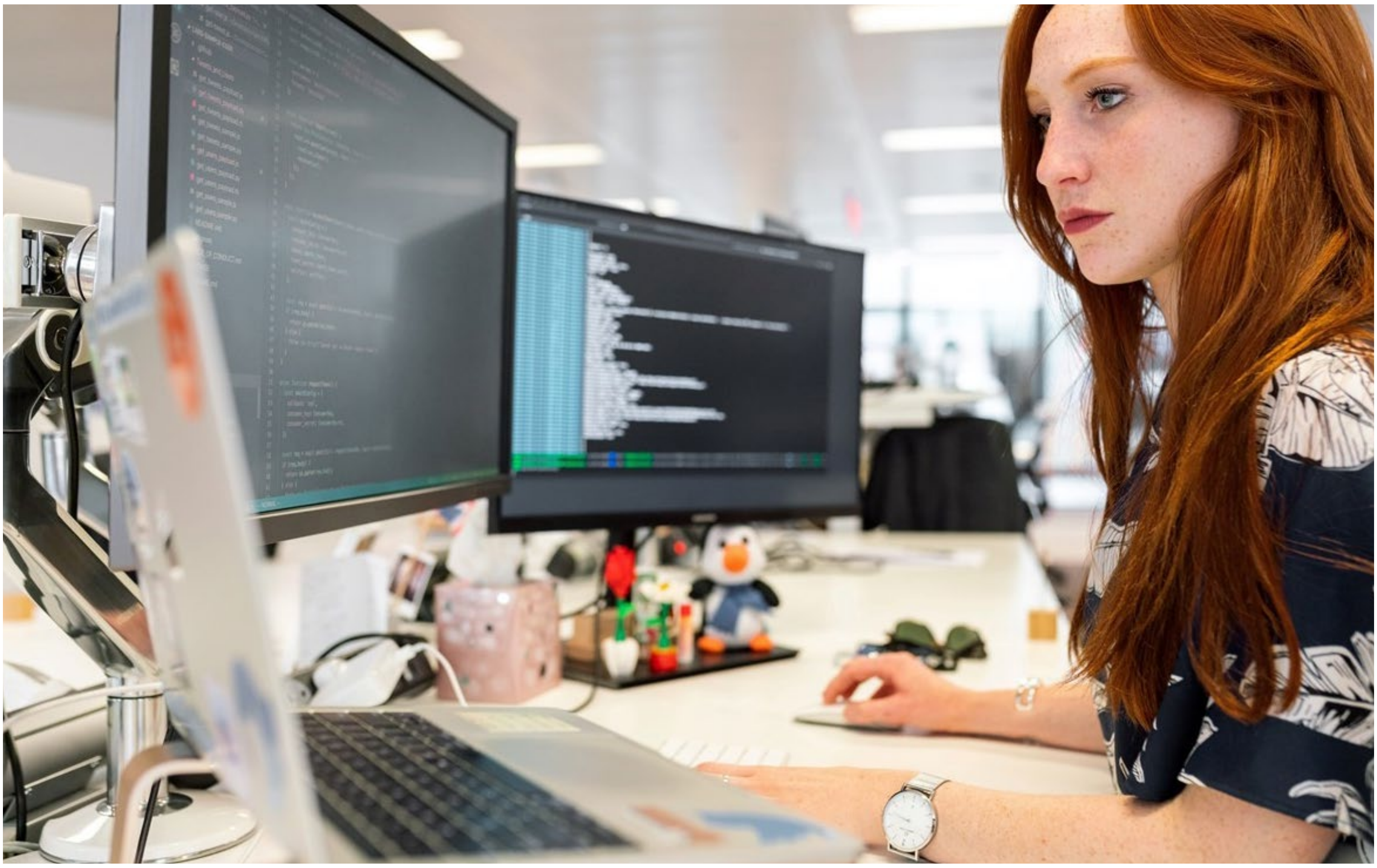
The table below is comparing two different scenarios for EV charging: 'Controlled Charging' and 'Uncontrolled Charging'.

'Controlled Charging' represents data for the month August 2024.

'Uncontrolled Charging' represents data for the month October 2023.

Charging Type	Period	Electricity Consumption (kWh)	Solar Sponge Period (10:00 AM – 3:00 PM) (kWh)	Peak- Period (6:00 AM – 10:00 AM and 3:00 PM – 1:00 AM) (kWh)	Off-Peak Period (1:00 AM – 6:00 AM) (kWh)
Controlled Charging	August 2024	346	149	134 (↓ 20.0 pp*)	63
Uncontrolled Charging	October 2023	368	152	216	0

* Percentage point



The controlled charging implementation demonstrated how advanced load management can simultaneously deliver economic benefits while supporting grid stability goals. Through strategic timing control, the fleet's charging behaviour was substantially optimised to align with renewable electricity availability and off-peak periods. As a result, 18% of charging occurred during the off-peak window, compared with 0 % during uncontrolled charging period, while still maintaining operational efficiency. By leveraging the 19–20-hour parking duration at Wilson Parking, the control system maximised charging efficiency without disrupting fleet operations.

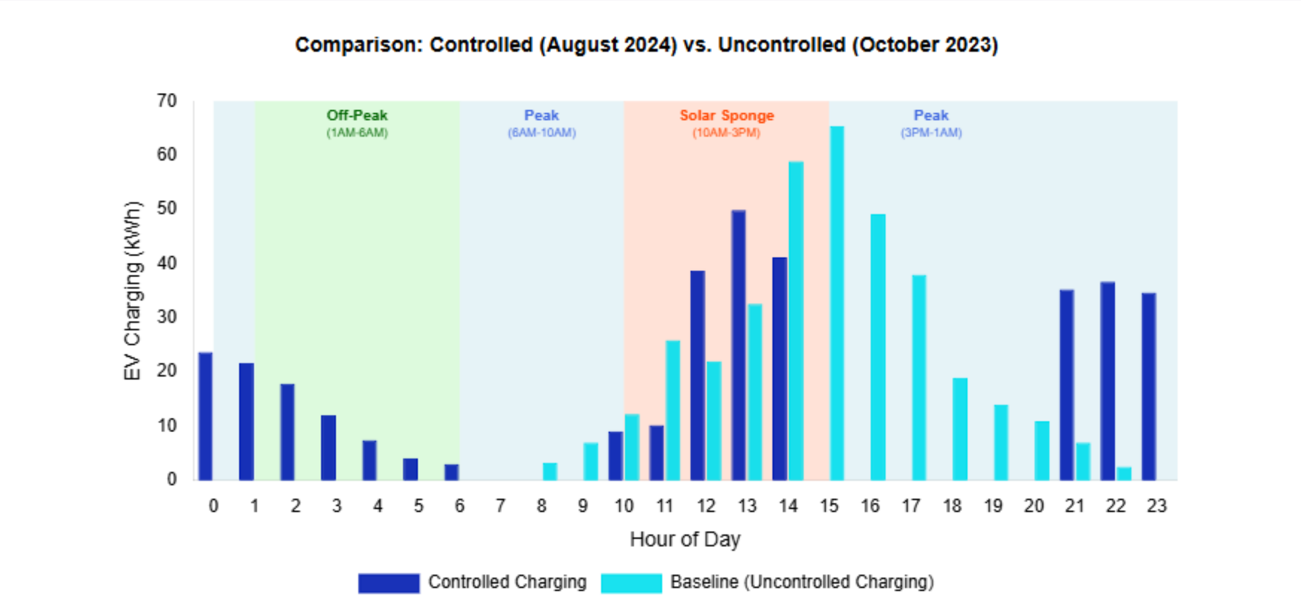


Figure 4.6.5 (a) represents the power consumption (in kWh) over a 24hour period over two time periods October 2023 where charging happened in an uncontrolled manner (EV's parked back at the office and plugged in for charging) and August 2024, where charging profile defined on EV charger (controlled EV charging). The x-axis represents the time of day, while the y-axis represents the power consumption in kilowatt-hours (kWh).

Uncontrolled Charging Baseline (October 2023):

The uncontrolled charging period represents DIT's natural fleet operations without charging intervention. During this period, vehicles followed established operational pattern of afternoon return from field work with immediate charging initiation at Wilson Parking. The electricity consumption was concentrated in expensive afternoon peak periods, creating both grid stress and economic inefficiency.

Electricity Distribution Analysis:

- Total Electricity Consumption: 368 kWh across 7 charging bays
- Solar Sponge Period (10:00 AM – 3:00 PM): 152 kWh representing 41% of total consumption
- Cost: $47.65 (shoulder period rate)
  - This partial utilisation of the optimal tariff period indicates missed opportunities for cost savings and renewable electricity integration across the fleet
- Peak Period (6:00 AM – 10:00 AM and 3:00 PM – 1:00 AM): 216 kWh representing 59% of total fleet consumption

- Cost: $112.65 (times of highest demand and when electricity costs the most)
  - This consumption during peak periods directly contributes to grid stress and significantly higher operational costs for Wilson Parking.
- Off-Peak Period (1:00 AM – 6:00 AM): 0 kWh representing 0% of total consumption
  - No Utilisation of the lowest-cost overnight period despite 19 – 20-hour parking duration at Wilson Parking
- Total Charging Cost: $160.30

Controlled Charging Optimisation (August 2024):

- Through advanced algorithms leveraging the fleet's extended overnight parking at Wilson Parking, vehicle charging was strategically redistributed to optimal periods without compromising operational readiness for morning fleet operations.

Optimised Electricity Distribution:

- Total Electricity Consumption: 346 kWh
- Solar Sponge Period (10:00 AM – 3:00 PM): 149 kWh representing 43% of total consumption
- Cost: $46.71 (shoulder period rate)
  - Enhanced utilisation of optimal tariff periods while supporting renewable electricity integration goals
- Peak Period (6:00 AM – 10:00 AM and 3:00 PM – 1:00 AM): 134 kWh representing 39% of total consumption
- Cost: $69.88 (38% reduction from uncontrolled baseline)
  - Significant reduction in expensive peak-period charging while maintaining operational flexibility
- Off-Peak Period (1:00 AM – 6:00 AM): 63 kWh representing 18% of total consumption
- Cost: $22.89
  - Strategic utilisation of overnight low-cost periods leveraging extended parking duration at Wilson Parking
- Total Charging Cost: $139.48 (13% overall cost reduction)

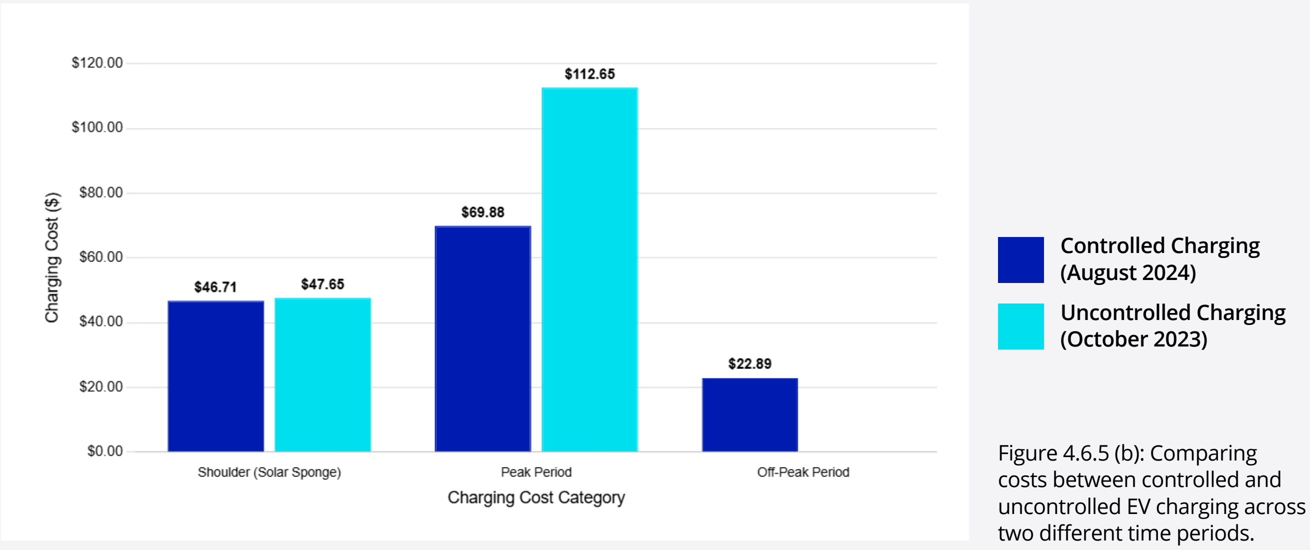


Figure 4.6.5 (b): Comparing costs between controlled and uncontrolled EV charging across two different time periods.

4.6.6. Controlled Charging Implementation 2

In September 2024, a charging schedule from 12:00 AM to 5:00 PM with a 32amp maximum power output was implemented.

The table below is comparing two different scenarios for EV charging: 'Controlled Charging' and 'Uncontrolled Charging'.

'Controlled Charging' represents data for the month September 2024.

'Uncontrolled Charging' represents data for the month October 2023.

Second Controlled Charging Profile Implementation

A second controlled charging profile was implemented to accommodate PHEV vehicles, which typically charge at lower rates compared to BEVs. This implementation achieved substantial optimisation results, peak electricity consumption fell from 216 kWh → 61 kWh, a 72% decrease and complete elimination of high-demand evening peak-period usage, and a significant increase in off-peak charging utilisation.

The charging pattern shown in the visualisation (4.6.6(a)) demonstrates optimal load management, with energy consumption tapering off as it approaches 9:00 AM, indicating vehicles reach full charge status before the morning operational deployment window. This timing ensured complete fleet readiness for DIT's structured 9:00 – 10:00 AM departure schedule.

Operational Validation and Extended Trial

Importantly, this controlled charging profile caused no operational disruption to fleet services. Based on this successful integration, the controlled charging profile remained operational through December 2024 to assess long-term effectiveness and user adaptation. Throughout the extended four-month period (September through December 2024), the system maintained seamless operation without causing any inconvenience to fleet users.

Charging Type	Period	Electricity Consumption (kWh)	Solar Sponge Period (10:00 AM – 3:00 PM) (kWh)	Peak- Period (6:00 AM – 10:00 AM and 3:00 PM – 1:00 AM) (kWh)	Off-Peak Period (1:00 AM – 6:00 AM) (kWh)
Controlled Charging	September 2024	332	94 (↓ 13 pp*)	61 (↓ 40 pp*)	177 (↑ 53 pp*)
Uncontrolled Charging	October 2023	368	152	216	0

* Percentage point

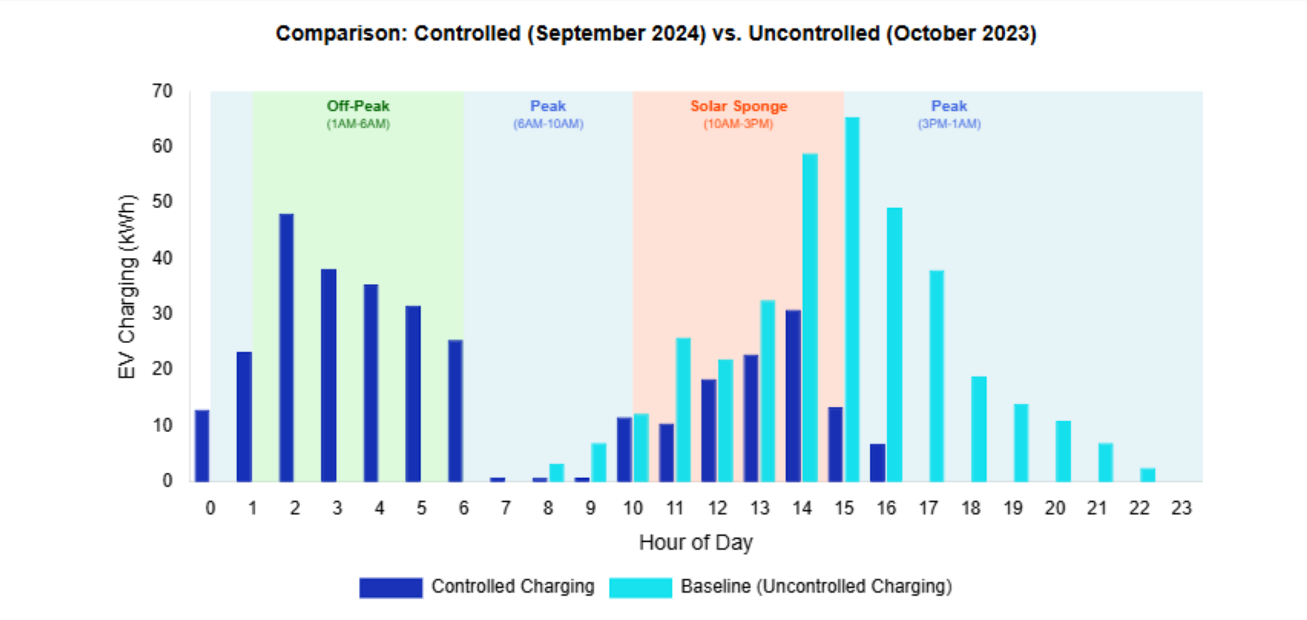


Figure 4.6.6 (a): Power consumption (in kWh) over a 24hour period over two time periods October 2023 where EV happened in an uncontrolled manner (EV's parked back at the office and plugged in for charging) and September 2024, where a charging profile defined on EV charger, controlled EV charging. The x-axis represents the time of day, while the y-axis represents the power consumption in kilowatt-hours (kWh).

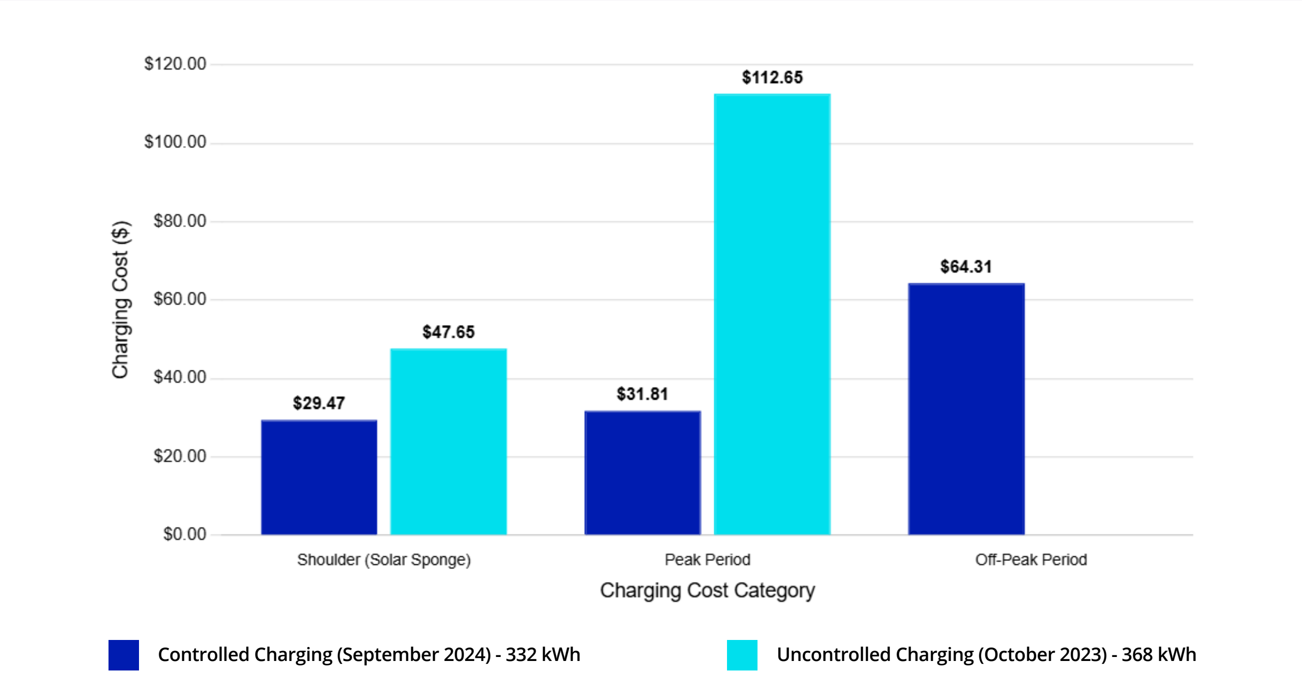


Figure 4.6.6 (b): Comparing costs between controlled and uncontrolled EV charging across two different time periods.

Key Results:

The second controlled charging implementation, operating from 12:00 AM to 5:00 PM with a 32-amp maximum power output, achieved a 10% reduction in total electricity costs and increased off-peak charging periods (1:00 AM – 6:00 AM) by 35% compared to the first controlled charging implementation.

4.6.7. User 6: Qualitative Insights and Participant Feedback

Theme 1: Infrastructure Constraints and Capacity Limitations

The interview with Fleet Manager revealed significant infrastructure challenges limiting EV fleet expansion. Building electrical capacity constraints, proximity requirements, and the lack of data-capable charging stations create operational bottlenecks.

Insights:

- The Fleet Manager expressed concern about infrastructure limitations that prevented fleet expansion despite the organisational willingness to adopt more EVs.
- Electrical capacity constraints revealed how legacy building infrastructure creates barriers to EV adoption.
- The absence of data collection from existing chargers indicated a gap in smart charging capabilities that limited optimisation opportunities.

Quotes:

> "Even if there are opportunities to get more electric vehicles, we can't because we won't be able to charge them."

> "The building owners have said that the building's at capacity in terms of electrical supply. I think they need a distribution board upgrade in order to increase the number of electric vehicle charging stations in the building."

> "The charging stations they have—they can't get any data from them. They're not collecting any data from those charging stations."

Theme 2: Operational Challenges and User Behaviour Management

Day-to-day operational issues include managing shared resources, enforcing charging etiquette, and dealing with public parking violations in allocated EV spaces.

Insights:

- The 'always charge' policy reflected a conservative approach that prioritised availability over optimal charging practices.

Quotes:

> "The only issue we've experienced is members of the public parking in our allocated spot, which means we can't charge our vehicle. That can then impact the next day if we haven't been able to charge up."

> "Our rule is when the vehicle is not being driven, we charge it."

Theme 3: Range Anxiety and Vehicle Performance Understanding

Concerns about EV range prediction accuracy, particularly with pooled vehicles where usage patterns vary significantly between users and trip types.

Insights:

- Range estimation issues with pooled vehicles revealed a significant operational challenge not commonly discussed in EV literature.
- Practical charging guidelines show evidence-based policy development.

Quotes:

> "We advise fleet users when they're charging at public charging infrastructure to only go to 80% if they can afford to—unless they need 100%, we tell them to charge up to 80%."

Theme 4: Staff Confidence and Change Management

Efforts to build staff confidence in EV technology through training, personal demonstration, and address misconceptions about range and reliability.

Insights:

- The approach of personally testing challenging routes shows commitment to evidence-based reassurance.
- Recognition that perceived range needs often exceed actual usage indicated successful change management through experiential learning.

Quotes:

> "A lot of people throughout the department were a little bit cautious, but when they start to drive the EVs, they become a lot more confident."

> "Recently, a colleague and I took an electric vehicle to Port Augusta and made use of the charging infrastructure, just to be able to tell our staff that yes, you can get to Port Augusta and back with an electric vehicle without any problems. I think we just have to increase people's confidence."

> "A lot of people thought there were going to be range issues, but I think they've since realized that they don't travel as many kilometres as they thought they did."

Theme 5: Vehicle Selection and Technology Considerations

Decision-making processes around EV model selection, focusing on charging capabilities, cost considerations, and the trade-offs between different vehicle specifications.

Insights:

- Evolution in procurement thinking moving from cost-focused to performance-focused decisions.
- Learning about charging capabilities indicated the importance of technical specifications in fleet selection.
- Preference for shorter lease terms reflected awareness of rapid technological advancement and a desire for flexibility.

Quotes:

> "In the past, a lot of the decisions have been made around cost—what the lease rate is etc. But we've since found, or learned, that EV can't charge at the same capacity as some of the other vehicles."

> "Being only able to charge at seven kilowatts is not ideal for us. So now we're looking at newer EV models, because they can charge at 11 kilowatts."

> "Because the technology is changing so rapidly, we don't like to enter into a lease term that's longer than three years or 60,000 kilometres."

Theme 6: Data and Monitoring Capabilities

Current limitations in vehicle tracking and monitoring, plans for telematics implementation, and the value of data for fleet optimisation.

Insights:

- Importance of data for fleet optimisation and sense of urgency to modernise tracking systems.
- Reliance on manual log sheets highlighted operational challenges of managing EVs without digital monitoring
- Planned telematics implementation shows forward-thinking approach to fleet management technology.

Quotes:

> "We're currently in the process of installing telematics in all of our vehicles, and we'll also be using the functionality to get the battery charge displayed in a dashboard for all of our vehicles."

> "That way we can monitor the charge of the batteries and see if we need to physically go down and plug a vehicle in or unplug a vehicle."

4.6.8. Smart Charging Implementation

Smart Charging Implementation for EV Chargers

Generation by Fuel

The first critical component of smart charging implementation involved comprehensive data collection of electricity generation categorised by fuel source. This process required establishing robust connections to data streams that provided real time information about how electricity is being produced across the grid.

The technical implementation required establishing API connections to the electricity dispatch systems, implementing data polling intervals that range from five to thirty minutes depending on the volatility of each generation source, and maintaining historical data storage capabilities for trend analysis.

Electricity Spot Price

The system collected Spot prices ($/MWh) in SA along with forecasted prices. The integration process required real time price feeds from Energy markets systems,

Evaluation of Energy Mix & Spot Price

The analytical engine of the smart charging system combined generation mix data with price information to create a comprehensive picture of grid conditions. This algorithm served as the decision-making brain that determined when charging should be prioritised or reduced.

Energy mix analysis involved calculating the real time percentage of electricity generated from renewable sources compared to fossil fuel sources.

Price comparison analysis involved calculating ninety-day rolling averages from the same period in the previous year to establish baseline price expectations. This historical comparison accounted for seasonal patterns in electricity pricing while identifying unusual market conditions that might represent either opportunities for cost savings or periods requiring more conservative charging approaches.

The decision logic weighed multiple factors through sophisticated scoring systems that balance cost optimisation with renewable electricity utilisation goals. Dynamic threshold adjustment allowed the system to adapt to changing market conditions and volatility levels, ensuring that charging decisions remain optimal even as market dynamics evolve.

Determine Charging Output

The optimisation engine calculated optimal charging power output for each EV charging station by processing all the analysed market and grid condition data. This complex calculation balanced multiple competing objectives while respecting both technical constraints and customer requirements.

Renewable maximisation strategies increased charging power when the grid has high percentages of solar and wind generation.

Cost minimisation involved reducing electricity consumption during periods of high spot prices, which typically occur during peak demand periods or when expensive peaking generators are operating. The system identified these periods and adjusted charging power downward when economically beneficial, while ensuring that customer charging needs are still met.

The calculation process determined a base load level (16 amps) representing the minimum charging power needed to meet customer departure time requirements, then added a variable component that can be increased during favourable grid conditions or decreased during less optimal periods.

Charger Configuration

The final implementation step involved translating optimised charging profiles into actual control commands sent to charging stations through the Exploren API system. This process required robust communication protocols and comprehensive monitoring capabilities to ensure reliable operation.

API integration established secure connections with proper authentication credentials and encryption protocols to protect sensitive operational data.

Comprehensive error handling included detection, logging, and automatic recovery mechanisms to maintain system reliability even when individual components experience temporary failures.

Charging profile implementation involved sending specific amp output instructions to each charging station along with scheduling parameters that define start and stop times.

The result is an intelligent charging infrastructure that operated as a sophisticated grid asset, automatically optimising for cost, climate impact, and grid stability while maintaining the high-quality customer service that EV drivers expect from public charging facilities.

4.6.9. Smart Charging Implementation Results

Smart Charging on 5 May 2025

Renewable electricity sources were higher than non-renewable electricity sources for the whole day. In response to this favorable generation mix and lower spot price compared to baseline price, the smart charging system automatically configured charging output to operate at maximum capacity (32 amps), effectively utilising the abundant renewable electricity available.

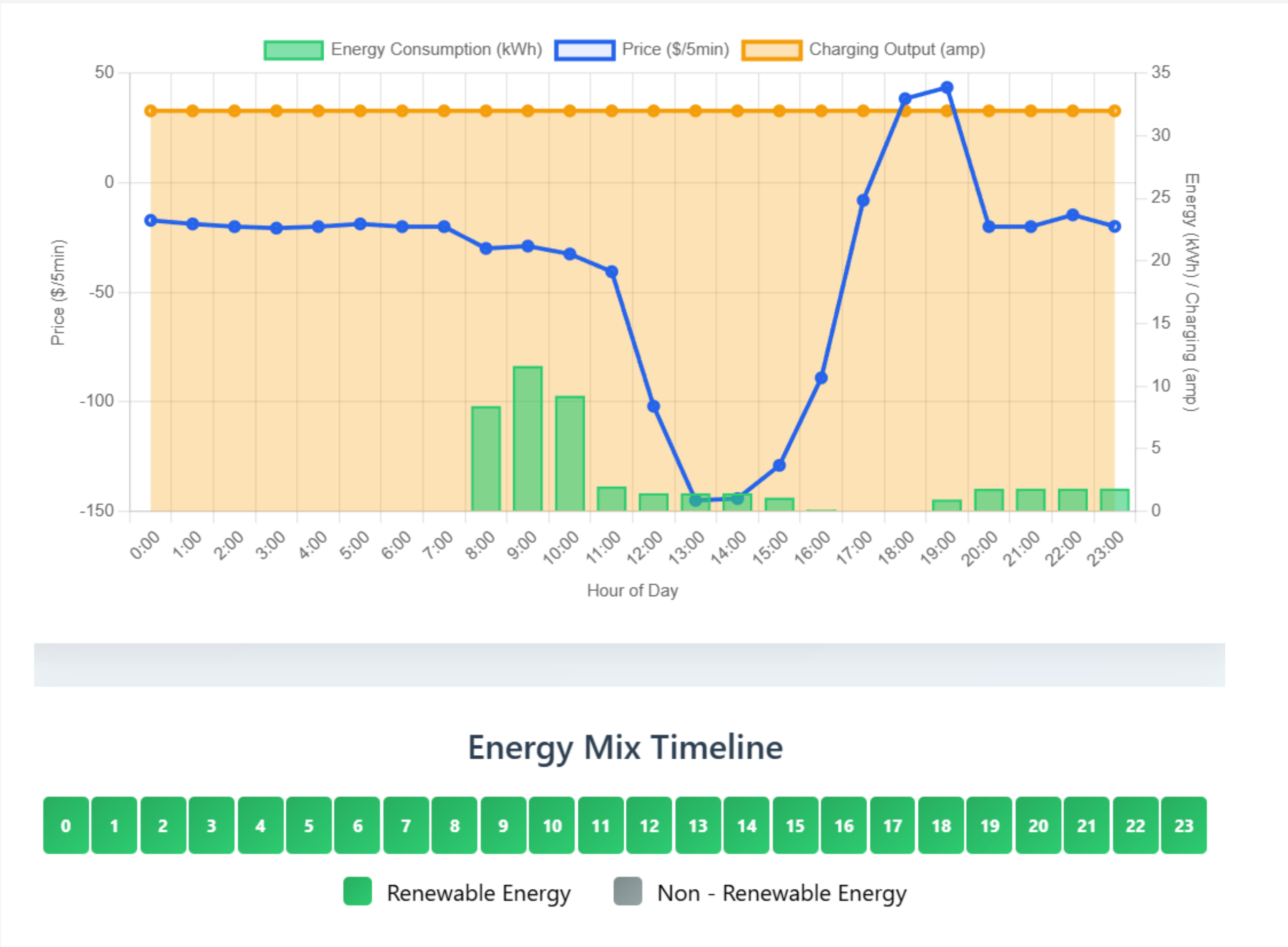


Figure 4.6.9 (a): s Smart Charging performance for 5 May 2025.

Smart Charging on 13 May 2025

10:30 AM to 6:30 PM

Renewable electricity sources mix was higher than non-renewable electricity sources, in response to this favorable generation mix and drop in spot price, the smart charging system automatically configured charging output to operate at maximum capacity (32 amps).

This operational pattern demonstrates the effectiveness of our dynamic charging management system responding to real time changes in generation mix, supporting grid stability while maximising the utilisation of renewable electricity resources.

6:30 PM to 10:30 AM

During this period, the grid was powered by non-renewable electricity sources, and the spot price was higher than the baseline price expectations. The smart charging system automatically configured charging output to 16 amps (50% of maximum capacity).

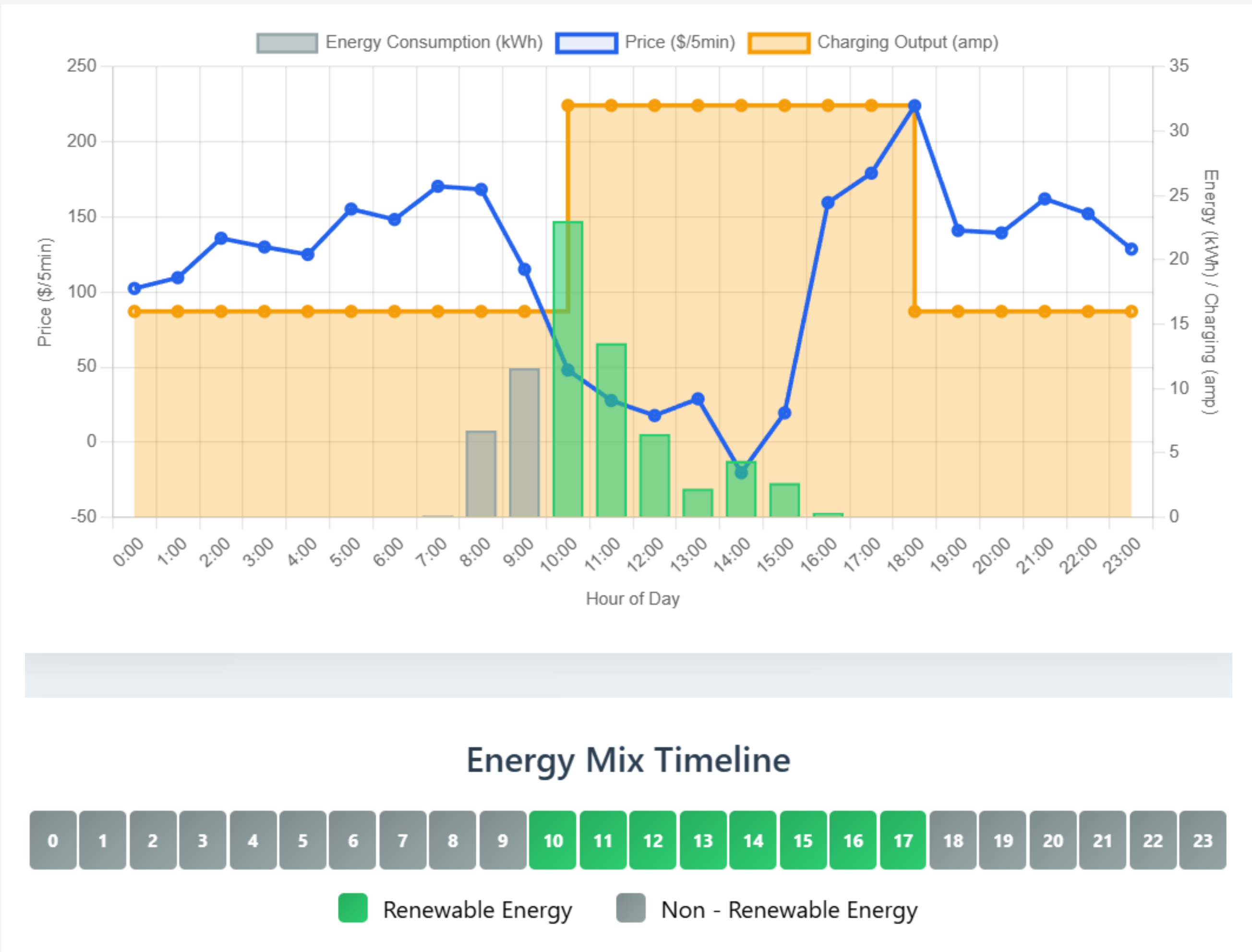


Figure 4.6.9 (b): Smart Charging performance for 13 May 2025.

Key Takeaways

Smart charging can deliver substantial advantages for network operators and electricity generators through improved grid stability, optimised electricity consumption, and cost reduction. However, charging providers face a complex challenge: while renewable electricity may be abundant during peak periods, time-of-use (TOU) pricing structures can result in higher electricity costs during these same windows.

Our analysis of controlled charging versus smart charging implementations revealed that neither approach alone delivers optimal outcomes for end customers. The most effective charging solutions must integrate customer requirements, usage patterns, idle time, electricity production patterns (renewable/fossil fuel electricity and grid demand to achieve truly optimised results. A clear example emerged from our smart charging deployment on 5 May 2025, where charging activity between 7:00 PM and 11:00 PM coincided with peak electricity costs. Since Fleet Users (User 6) typically park overnight, their charging could be shifted to the 1:00 AM to 6:00 AM window to leverage lower electricity prices and reduced grid demand.

4.6.10. Smart Charging + TOU Implementation Results

Maximising Value Through Hybrid Smart Charging Solutions

Charging providers can unlock maximum value by partnering with customers to understand their unique charging requirements and deploying hybrid solutions that integrate Time-of-Use (TOU) pricing with intelligent charging strategies. This collaborative approach delivers multiple benefits: significant electricity cost reductions, enhanced customer value propositions through lower leasing costs, and accelerated EV adoption rates.

Rather than viewing energy management as a cost burden, this integrated methodology transforms it into a competitive differentiator that creates win-win outcomes for all stakeholders while advancing broader sustainability objectives. The following implementation demonstrates how this approach was implemented to capture actionable insights and validate the strategy's effectiveness.

17 & 18 June 2025

Smart Charging combined with Time-of-Use (TOU) pricing was implemented on User 6 parking bays during specified periods (10:00 AM – 3:00 PM & 1:00 AM – 6:00 AM). By analysing User 6's charging patterns and vehicle idle times—particularly overnight parking behaviour—we successfully deployed this strategy and captured valuable insights.

17 May Implementation

On 17 May the smart charging system demonstrated adaptive behaviour based on grid conditions:

Morning to Afternoon (Until 5:00 PM):

- System maintained 32-amp charging due to high renewable electricity availability on the grid

Evening Transition (5:00 PM onwards):

- As renewable electricity mix decreased and spot prices rose, the system automatically reduced charging to 16 amps

Overnight Optimisation (18 June, 1:00 AM):

- Leveraging knowledge of User 6's charging patterns, the system resumed charging at 1:00 AM
- Due to lower renewable electricity mix compared to higher carbon intensity sources, charging remained at reduced 16-amp rate
- Charging completed by 6:00 AM, maximising off-peak period utilisation

Key Results:

The hybrid Smart Charging + TOU implementation delivered substantial improvements across multiple metrics. In terms of operational performance, the system achieved a significant increase in off-peak charging compared to the Smart Charging from May 5th, 2025. The financial impact was equally impressive, with Smart Charging alone costing $20.35 compared to the Smart Charging + TOU combination at $14.60, resulting in total savings of $5.75 or a 28% reduction. This demonstrated the system's effectiveness in simultaneously optimising electricity costs, reducing grid strain during peak periods, and maximising utilisation of renewable electricity resources.

Charging Type	Period	Electricity Consumption (kWh)	Solar Sponge Period (10:00 AM – 3:00 PM) (kWh)	Peak- Period (6:00 AM – 10:00 AM and 3:00 PM – 1:00 AM) (kWh)	Off-Peak Period (1:00 AM – 6:00 AM) (kWh)
Smart Charging	5 May 2025	45.25	15.63	29.62	0
Smart Charging + TOU	18 June 2025	43	24	0 (↓ 66pp*)	19 (↑ 44pp*)

* Percentage point

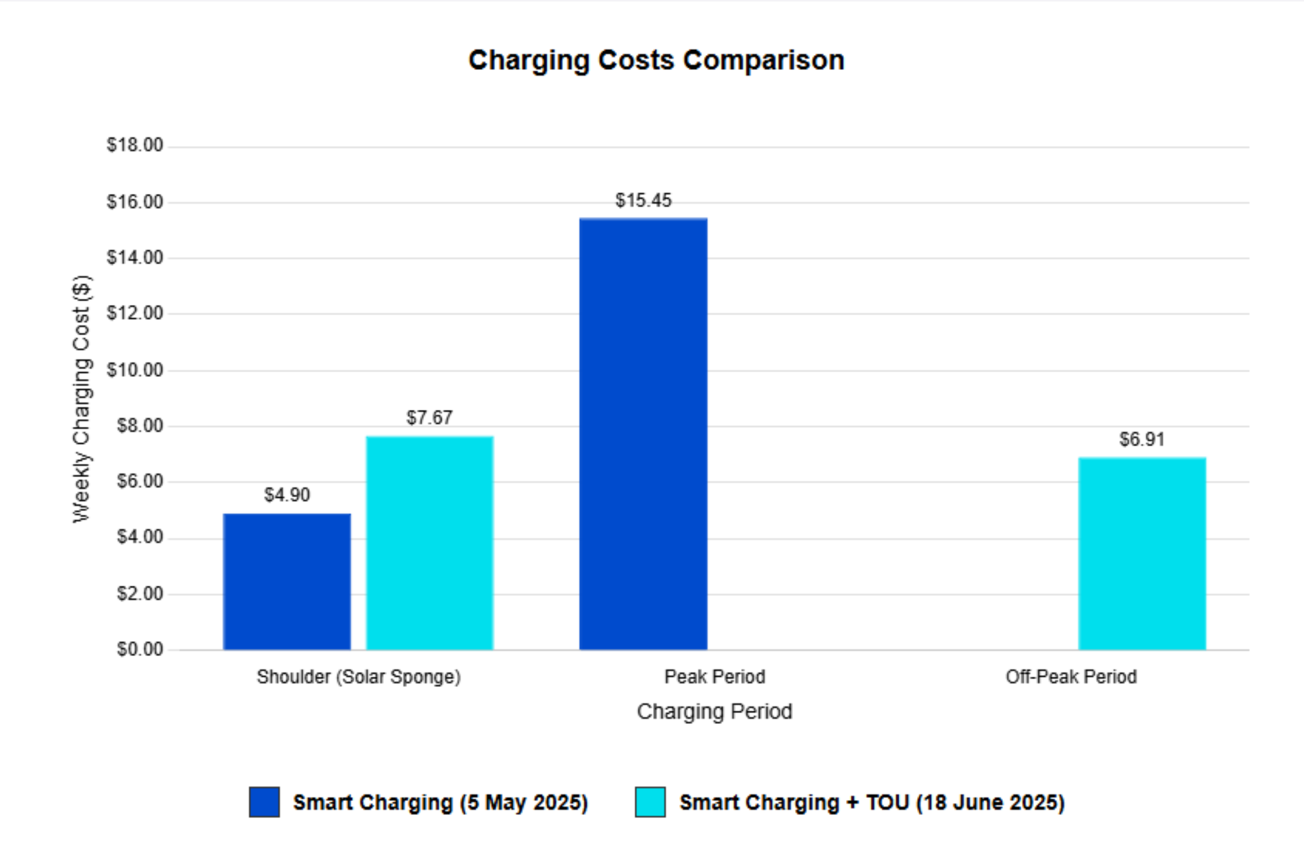
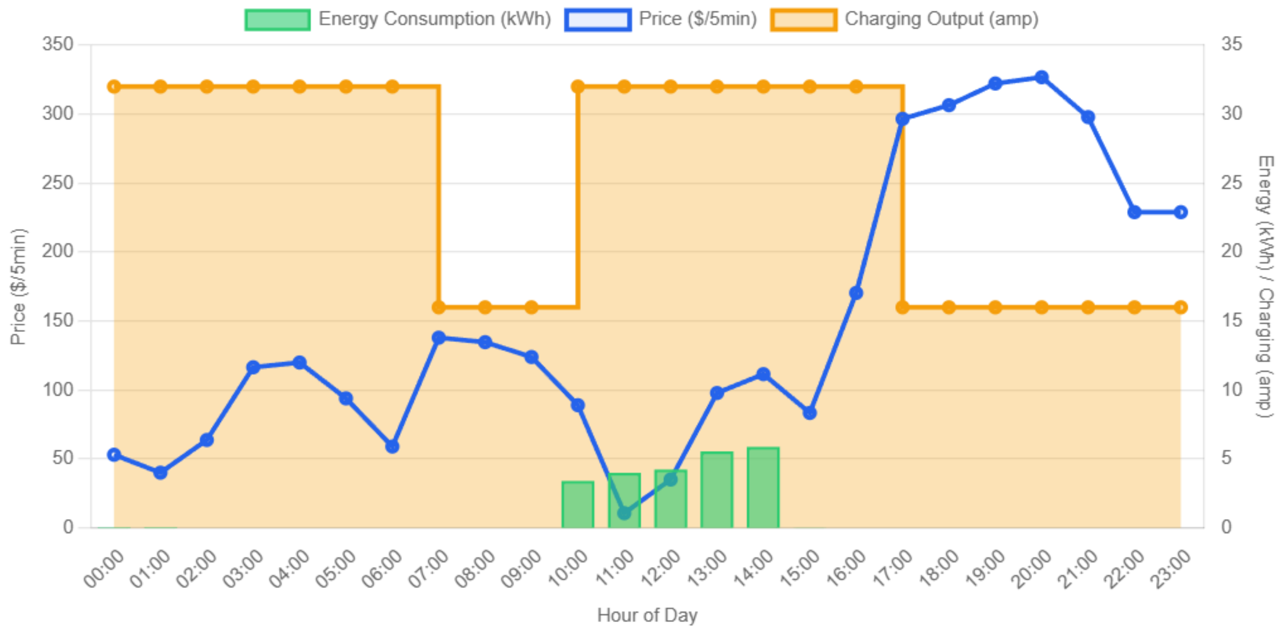


Figure 4.6.10 (a): Cost comparison between Smart Charging and Smart Charging +TOU across two time periods.



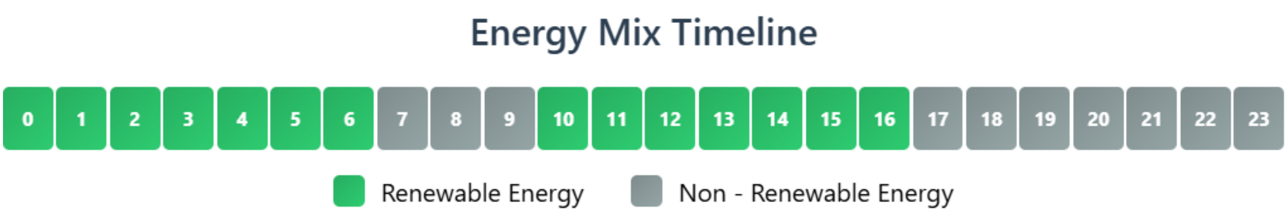


Figure 4.6.10 (b): Smart Charging performance for 17 June 2025.

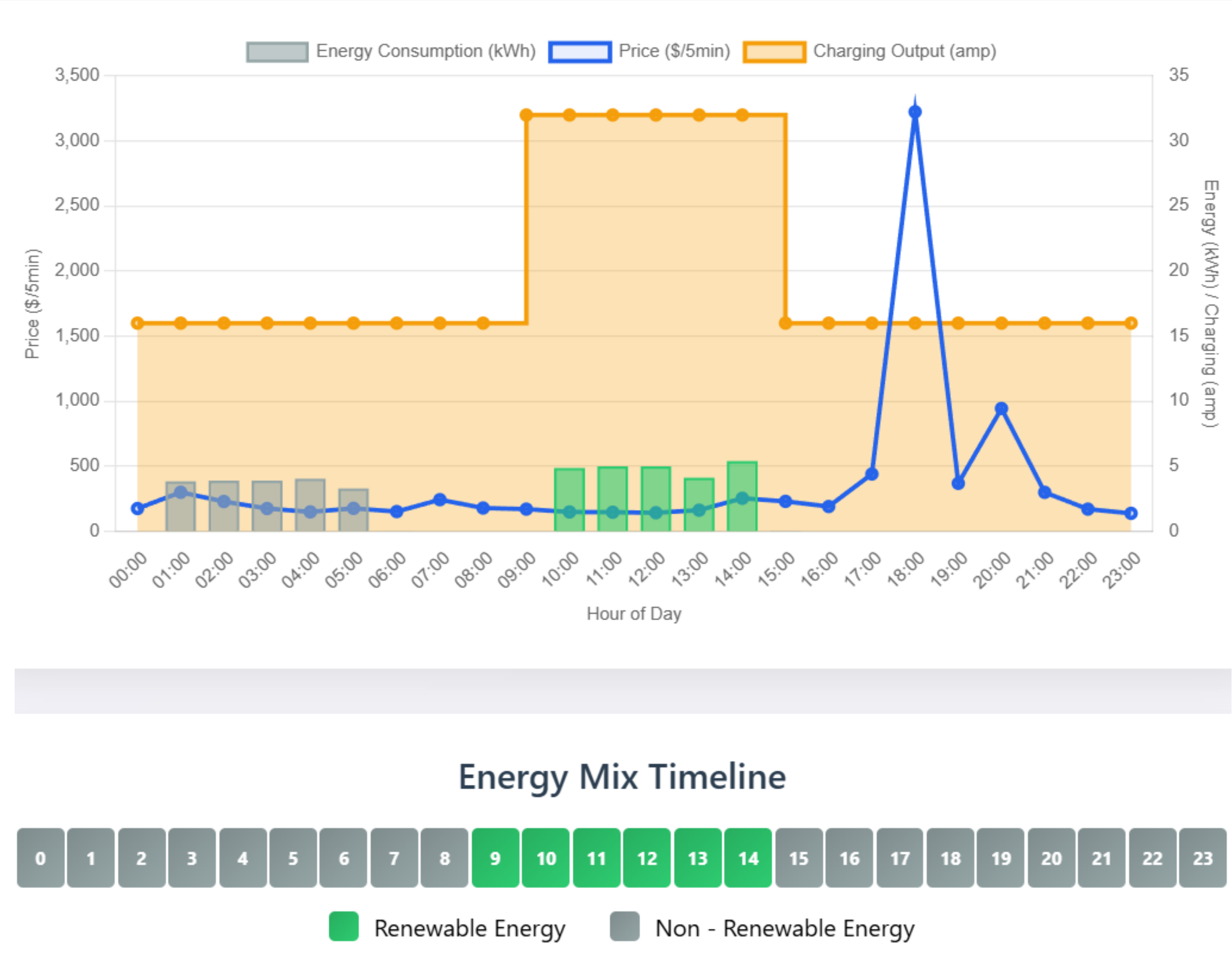


Figure 4.6.10 (c): Smart Charging performance for 18 June 2025.

Smart Charging Feedback

User feedback has been overwhelmingly positive, with user reporting no noticeable differences or inconvenience when their charging schedules were optimised. The key to successful implementation was in transparent communication, ensuring users understand the benefits and feel confident in the system managing their charging needs efficiently.

5. Future Areas of Exploration

The findings from the SA Smart Charging Trial provide a robust foundation for a strategic roadmap. This roadmap moves beyond the initial findings to propose a multi-layered evolution in technology, commercial models, and policy engagement, designed to build a scalable, user-centric, and economically sustainable EV charging ecosystem.

5.1. Technological and Infrastructure Evolution: Building the Foundation

The trial identified core hardware and software limitations that could be addressed to unlock the full potential of smart charging. The following pathways outline a strategy for developing a more robust and intelligent infrastructure.

5.1.1. The Critical Path to OCPP 2.0.1: Unlocking Vehicle-Side Intelligence

The trial was fundamentally constrained by its reliance on the OCPP 1.6 protocol, which prevented access to vehicle State of Charge (SOC) data. Without real time SOC data, the calculation of "'idle capacity" remains a theoretical estimate rather than a measurable, monetisable asset. This limitation was a key reason why implementing a smart charging profile for the high-turnover car-sharing fleet (User 4) was not feasible.

Therefore, the industry-wide upgrade to OCPP 2.0.1 or later versions is not merely a 'technology enhancement' but the foundational enabler for the next generation of value-added services. It is the essential gateway to:

- Precise, Needs-Based Charging: Allowing the system to deliver exactly the amount of electricity a vehicle requires to meet its user's needs, optimising charger turnover and electricity delivery.
- Intelligent Fleet Management: Providing the real time data necessary to solve the core operational pain point for car-sharing and other fleet operators, enabling them to automate charging based on vehicle battery levels and upcoming bookings.
- Accurate Idle Capacity & Vehicle-to-Grid (V2G) Readiness: Transforming theoretical idle time into a quantifiable grid asset. Access to SOC is the non-negotiable technical prerequisite for any future V2G services, which rely on knowing how much electricity can be safely discharged from a vehicle's battery.
- Enhanced User Trust: Enabling the creation of companion apps that provide transparent, real time SOC data to users, building confidence that the system is managing their charge effectively.

5.1.2. Beyond the Charger: Integrating with Building Electricity Management Systems

The experience of the Fleet (User 6) serves as a critical case study. Their adoption of off-site charging was not a matter of preference but of necessity, forced by the fact that their primary office building had reached its electrical capacity limit, with the owners mandating a costly distribution board upgrade to install more chargers. This scenario reveals a massive, looming barrier to corporate EV adoption across the nation. The problem is often not the charger itself, but the building to which it is connected. Treating EV charging as an isolated, unmanaged load will inevitably lead to widespread and costly capacity issues in commercial buildings.

The recommended path forward involves a pivot from viewing chargers as standalone devices to integrating them into a holistic site electricity management system. This requires exploring and deploying solutions that allow charging management platforms to communicate directly with a building's electricity management system. This integration could enable:

- Dynamic Site Load Balancing: The building could intelligently throttle EV charging power in real time to ensure the site's total consumption doesn't exceed its main power limit, potentially avoiding the need for expensive electrical infrastructure upgrades altogether.
- Maximising On-site Renewables: Intelligently aligning EV charging demand with the building's own on-site solar production, maximising self-consumption and further reducing electricity costs.

This represents an evolution for operators, transforming them from simple 'charging providers' into 'integrated workplace electricity solution partners'.

5.1.3. Hardware Reliability and UI/UX Standardisation

A recurring theme in users feedback was the comparison with Tesla's seamless and reliable Supercharger network. User 1 noted the initial 'handshake' issue with the trial's chargers was not as smooth, while User 3 praised the charger's reliability, but lamented the frequent failures and confusing fragmentation of other public networks, which often require multiple apps and RFID cards. This fragmentation erodes user trust and is a significant barrier to mainstream adoption.

The industry could prioritise a move towards radical simplification and unwavering reliability. This requires a multi-pronged effort:

- Deep Hardware/Software Co-design: Fostering deeper collaboration between charger manufacturers and platform providers to eliminate integration bugs, streamline the connection process, and ensure robust, reliable communication.
- Advocating for 'Plug and Charge' (ISO 15118): This international standard is the key to replicating the seamless Tesla experience on public networks. It allows for the secure, automated exchange of authentication and billing information directly through the charging cable, eliminating the friction of cards and apps.

AGL recently launch its innovative Vehicle-to-Grid trial which aims to help customers maximise the potential of their electric vehicles by using them not only as a form of transport but also as a source of energy to power their homes.

5.2. Advanced Commercial and Service Models: From Cost Center to Value Engine

The trial's findings provide a clear blueprint for moving beyond a one-size-fits-all subscription model. The future lies in developing a sophisticated suite of products and services that cater to the diverse needs of identified user segments, transforming charging infrastructure from a potential cost centre into a dynamic value engine.

5.2.1. Designing the Hybrid 'Smart-Controlled' Product: The Best of Both Worlds

Based on the trial data, trial's principal recommendation for charge point operators is that a hybrid approach is superior to either controlled or smart charging alone. This approach resolves the core conflict between the user's desire for predictable, low costs (achieved via controlled charging aligned with TOU rates) and the grid operator's need for dynamic flexibility (achieved via smart charging reacting to real time signals).

The recommendation is to develop and market a default 'Smart Charging' product that is a hybrid by design:

- Core Logic: The system's default behaviour is to follow a 'controlled' profile, scheduling the bulk of the charge for the low-cost solar sponge or off-peak periods. This provides the cost certainty that users value.
- Smart Overlay: The system is empowered to make minor 'smart' adjustments within that pre-defined window. For example, it could ramp up to 32 amps if the spot price turns negative or temporarily ramp down to 16 amps to help the building avoid a demand peak. This provides grid value without violating the user's core expectation of a low-cost charge.
- User Override: Crucially, the user must always have a simple, accessible option to bypass the charging profile for that session, likely for a premium fee. This structure provides the cost certainty users want, the grid flexibility operators need, and the ultimate control users' demand.

5.2.2. Dynamic Pricing and Tiered Service Levels: Monetising Convenience

The trial clearly demonstrated that the value of a charge is situational. User 1, a sophisticated participant, explicitly articulated this when he pondered paying a 'different premium for that convenience' of a guaranteed fast charge versus a slower charge. This, combined with the market need for flexible subscription terms driven by post-COVID hybrid work patterns, points to the inadequacy of a single fixed-price model.

One of the recommendations is to implement a multi-tiered service and pricing structure that allows customers to choose the value they need at a price that reflects it.

This tiered structure could include:

- **Tier 1:** 'Eco-Saver' Subscription: The lowest-cost monthly option, which requires the user to default to the 'Smart Charging' hybrid profile. This is aimed at daily commuters with predictable schedules who are most price sensitive.
- **Tier 2:** 'Flex-Charge' Subscription: A mid-tier price point that includes a set number of 'Priority Overrides' per month, allowing the user to bypass the Smart schedule without a per-use fee. This caters perfectly to users like User 1, whose schedules are mostly predictable but occasionally require flexibility.
- **Tier 3:** Pay-Per-Use/Casual: The highest per-kWh rate for non-subscribers, featuring a clear on-screen or in-app choice to select 'Eco' (managed, cheaper) or 'Priority' (immediate, expensive) charging for that session. This captures revenue from occasional visitors and makes the value proposition for smart charging explicit to all users.

5.2.3. Bespoke Solutions for "Garage Orphans" and Fleets

The trial demonstrated that a single off-street subscription model could fail to meet the unique needs of key growth segments. A more targeted approach is recommended.

- **For "Garage Orphans":** User 2, an apartment dweller without home charging, found the service convenient but expensive, noting that many other EV owners in the car park did not subscribe, suggesting a significant price barrier. The recommendation is to offer a Solar sponge plus off-peak period charging subscription. This product could be priced to be cheaper than public DC fast charging, directly addressing the price sensitivity of this segment and providing them with a reliable, affordable overnight charging solution.
- **For Corporate Fleets:** User 6 case highlights the infrastructure challenges corporations face. The opportunity here is to create a 'Fleet Electrification as a Service' offering. This comprehensive B2B solution could bundle the chargers, integration with the building's BEMS, fleet telematics data, and a unified management platform. This provides a turnkey solution for businesses that want to electrify but are stalled by internal infrastructure constraints or a lack of expertise.

5.3. User-Centric Design and Behavioral Economics: Driving Adoption and Engagement

Technology and commercial models are only effective if users embrace them. The trial provided critical lessons in human factors, highlighting the need to design systems that move from passive user acceptance to active, valuable participation.

5.3.1. Resolving the 'Convenience vs. Control' Dilemma: Designing for Agency

The most powerful lesson in user-centric design came from User 1's rejection of the controlled charging profile. When his schedule changed unexpectedly, the system failed him, leaving him with an uncharged vehicle. This demonstrates that a system designed only for the 'average' day is brittle and will fail in the face of real-world exceptions. This failure mode completely erodes user trust. The user must feel they are in ultimate control, even if they willingly cede that control 99% of the time.

Future systems could be designed with user preferences as a core, non-negotiable principle. This can be achieved through (examples below):

- A 'Smart Skip' or 'Boost' Button: A simple, one-touch function, either physically on the charger or in a companion app, that allows the user to immediately override the charging schedule for the current session.
- User-Defined Constraints: Moving beyond rigid, pre-set schedules to allow users to set their own parameters. For example, a user could specify, 'I need my car to be at least 80% charged by 5:00 PM.' The system is then free to optimise the charging session within those user-defined boundaries.
- Adaptive Learning Algorithms: Developing systems that could learn from user behaviour. If a user consistently overrides the schedule on Friday afternoons, the system could proactively send a notification Example 'We've noticed you often need an immediate charge on Fridays. Would you like to set a different charging rule for this day?'

5.3.2. From 'Black Box' to Transparent Partner: Building Trust Through Communication

User 2's experience of finding his car not charging and having to research error codes to understand that the system was intentionally delaying the charge is a case study in poor communication. From the user's perspective, a lack of feedback is indistinguishable from a system failure. This opacity undermines the entire value proposition of controlled/Smart charging.

To build trust, the system could transform from a 'black box' into a transparent partner. This requires a multi-layered communication strategy:

- On-Charger Interface: Simple, intuitive visual cues are essential. For example, a slowly pulsing blue light could indicate 'Scheduled to charge later,' a solid green light for 'Actively charging,' and a pulsing green light for 'Charging complete, now available for grid support.'
- Companion App Dashboard: The app can provide clear, concise explanations for system actions. Instead of a cryptic status, it could say: 'Charging is paused. It will resume at 10:00 AM to use cheaper, cleaner solar power. You are on track to save an estimated $1.20 on this session.'
- Proactive Notifications: Push alerts for key events can foster a sense of partnership. Notifications such as, 'Your controlled charging session has started,' 'Your vehicle will be fully charged by your 4:30 PM departure time,' or 'A grid event has been detected. Your car is helping to stabilise the grid, and you've earned a $0.50 credit for your participation,' would transform the user experience from one of uncertainty to one of informed engagement.

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