UPARK EV FLEET SMART CHARGING TRIAL

Final Report

July 2024

CITY OF ADELAIDE

Acknowledgement of Country

The City of Adelaide acknowledges that we are located on the traditional Country of the Kaurna people of the Adelaide Plains and pays respect to Elders past, present and emerging.

We recognise and respect their cultural heritage, beliefs and relationship with the land. We also extend that respect to visitors of other Aboriginal Language Groups and other First Nations.

Acknowledgement of grant funding

The City of Adelaide acknowledges the Department for Energy and Mining's contribution to the UPark EV Fleet Smart Charging Trial through a Funding Agreement

Document properties

Contact for enquiries and proposed changes

If you have any questions regarding this document or if you have a suggestion for improvements, please contact:

Contact Officer: Naomi Doolette

Title: Senior Sustainability Advisor

Program: Park Lands & Sustainability

Phone: (08) 8203 7448

Email: n.doolette@cityofadelaide.com.au

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2	27 March 2024	Flow Power	Data and analytics
3	28 March 2024	City of Adelaide	Ready to submit to DEM
4	26 April 2024	DEM	Verbal feedback on submission
5	30 July 2024	City of Adelaide	Final submission

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1. EXECUTIVE SUMMARY

The UPark Electric Vehicle Smart Charging Trial was a Department of Energy and Mining and City of Adelaide (CoA) funded project that sought to model the uptake of electric vehicle (EV) charging while reducing user electricity costs and stress on the South Australian electricity grid network. The City of Adelaide's electricity provider, Flow Power, has a unique approach to delivering demand management solutions, and the study utilised this approach to provide commercial fleet and corporate customers charging within UParks.

After sixteen (16) months of research, procurement and implementation work, the data collection phase commenced in February 2023. At each of the Wyatt (18/34 Wyatt Street, Adelaide) and Topham (52/54 Waymouth Street, Adelaide) UPark facilities, six EV chargers were connected to a kWatch device, controlled by Flow Power's demand management system. The intent was to demonstrate viable business models for car parks with fleet vehicles introducing EV charging, linking trial objectives to practical outcomes.

During the trial, the CoA, in partnership with UPark and Flow Power, collected valuable insight into user uptake, the effectiveness of charge strategies and the importance of integrating technologies. The link between carbon intensity, price and renewables was made clear and digestible, reframing the 'costs' and 'price' comprehensibly.

The UPark Electric Vehicle Smart Charging Trial had two parts: development of charge strategies and technology integration. Retrospective analysis demonstrated that smart strategies were successful in managing the charging of EVs for commercial car parks. However, technology integration was unsuccessful due to ongoing communication issues between EV chargers and the 'smart' demand management system.

The trial was unable to deliver on its objective to "reduced electricity costs for City of Adelaide and UPark by controlling load during high-price events". However, retrospective analysis enabled Council to implement the project objective of "reduced complexity of managing EV fleet by providing fixed-price products inclusive of parking and charge requirements for commercial customers".

The reason for not meeting an objective was the failure of communication between technologies. For the latter part of the trial, the demand management system and Chargefox's billing software could not simultaneously communicate with the selected model of Schnieder EV charging units, causing the failure of the technology integration component of the trial.

Although the 'smart' technology could not operate as the trial had intended, Flow Power undertook a retrospective analysis using actual charging data collected. This provided an understanding of the effectiveness of the charge strategies, the costs to the City of Adelaide / UPark, and the benefits of future fixed-priced products for commercial fleet and corporate customers.

The trial did deliver "100% renewable electricity through its PPA and on-site solar" for EV charging at the infrastructure.

Key findings against project objectives

Project Objectives	Key Findings
Support the increase in uptake of EV vehicles by commercial fleets	Though many customers, both existing and new, indicated they would be moving their fleets to EV, the actual uptake since 2021 has been slow. The City of Adelaide cannot directly influence the uptake of EVs and aims to indirectly influence uptake by providing an attractive EV charging product to fleet and corporate customers. Customers were satisfied with the pricing model and expressed a preference to pay an all-inclusive fee for charging and parking.
Demonstrate the effectiveness of using wholesale electricity price triggers for load shifting and cost reduction in the provision of EV charging service	The EV charging units did not adequately support the 'smart' energy demand system. Only a limited period of real data was therefore available, which was supplemented by retrospective analysis. The retrospective analysis demonstrated the potential for cost and emissions savings.
Demonstrate integration of EV fleet charging within existing commercial car park operations.	Integration of chargers with energy demand systems faced hurdles but showed promise for future fixed-price products. Council continues to use these chargers to charge its own EV fleet and those of its fleet and corporate customers vehicles. In line with Council's recently developed Electric Vehicle Charging Infrastructure Transition Roadmap, UPark will continue to explore options for EV charging provisions as demand increases.

Timeline

September 2021
City of Adelaide Electricity Demand Modelling for UPark Topham and UPark Wyatt

November 2021
DEM Grant Approval; Development of Completion of Management Plans and Request for Quote (supply and install) of EV chargers.

February 2022
Installation of six (6) charging units at Wyatt UPark including integration of charging units with Flow Power kWatch device.

March 2022
Installation of six (6) charging units at Topham UPark including integration of charging units with Flow Power kWatch device.

April – June 2022
Finalise set up, programming and commissioning of KWatch controllers.

July 2022 – August 2022
Charge Strategy & Estimated Outcomes including preliminary modelling.

September 2022
Staff Changes - City of Adelaide Project Lead vacant

December 2022
Staff Changes - City of Adelaide New Project Lead

February 2023
Completed design and set up of operating protocols with Flow Power (including automated price mechanism)

Trial began with four (4) CoA EV fleet utilising parking spaces / chargers

March 2023
Designed UPark Smart EV 'product' and marketing / sales campaign to attract commercial fleet EV customers.

April 2023
Marketing and sales commenced.

April 2023
Schneider firmware update issue arose. Conflict between third-party communication and Chargefox software.

May – October 2023
EV chargers offline, unusable due to communication issue. Nilsen and Jet Charge investigating issues and City of Adelaide awaiting diagnosis of the issue.

October 2023
Jet Charge removed Flow Power communication link to allow restoration of EV chargers with Chargefox collecting data.

Staff Changes – City of Adelaide Project Lead vacant

October 2023 – January 2024
EV Chargers are operational but not 'smart' with data being collected by Chargefox and Flow Power accessing through a third party.

January 2024
Staff Changes - City of Adelaide New Project Lead

February 2024
Trial concluded.

2. SMART CHARGING TRIAL DESIGN

What is smart charging and why does it matter?

Smart charging refers to the capability of an electric vehicle (EV) charger to receive directions from a user or system. These directions may include:

- scheduling EV charging to capitalise on cheaper charging rates based on tariffs
- implementing intelligent EV charging strategies to optimise the use of local or market-available renewable energy source
- facilitating load sharing and allocation among chargers to ensure compliance with maximum capacity limits at specific locations
- mitigating peak loads on any given day to adhere to network constraints

There are several ways to implement smart charging, including through a smart meter, smart charger, and/or direct electric vehicle use.

Trial description

The UPark EV Fleet Smart Charging Trial aimed to provide UPark commercial fleet and corporate customers with EV charging linked to real-time electricity demand management based on wholesale electricity prices. The trial anticipated influencing consumer behaviour by demonstrating the economic benefits of smart charging. By potentially offering cheaper rates than home charging, it incentivised fleet and corporate customers to charge their vehicles at UPark facilities. Additionally, consolidating "fuel" management and costs into one system through UParks could provide a streamlined solution for fleet operators, enhancing the appeal of utilising these commercial car parking facilities.

The trial's design allowed the potential to expand this model to other commercial car parking facilities open for exploration, aiming to create a broader impact on the market and encourage widespread adoption of EV charging infrastructure.

The partnership between City of Adelaide (CoA), UPark and Flow Power utilised Flow Power's demand management system and charge strategies (based on wholesale electricity prices) to provide a real-time reflection of network demand conditions aiming to reduce peak demand and electricity costs in the provision of EV fleet and corporate customer EV charging.

The trial saw six (6) EV Link 'smart' enabled chargers and one (1) kWatch demand system, installed at both UPark sites.

Stakeholders

The City of Adelaide served as the project lead, managing delivery efforts and providing coordination among partners. The City of Adelaide City Operators and Sustainability Team have been working closely on the trial. The stakeholders involved in the trial were a collaborative network of organisations seeking to drive innovation with emerging technology to benefit both industry and end consumers. The stakeholders and their roles are listed below.

- **UPark** played a pivotal role in providing the location and customer base for the trial, as well as managing commercial operations and leading marketing and sales efforts for the UPark Smart EV Fleet 'product', as well as contributing to project design and delivery.
- **Flow Power** led on the integration of the kWatch 'smart' controller and charge strategies, with a dedicated engineering team overseeing this aspect. Flow Power performed all the modelling and data analytics for the project, including both predictive and retrospective analyses. Flow Power handled the supply, installation, and operation of the kWatch demand management system integral to the project's success.

- **Department for Energy and Mining (DEM)** provides essential funding to trial emerging technology.
- Additionally, subcontractors and suppliers **Nilsen** and **Jet Charge** provided supply, installation and troubleshooting support to ensure the infrastructure was functional.
- **Chargefox** played a critical role in RFID payment software.

This collaborative team of stakeholders worked to implement the trial vision of smart EV charging technology integration.

Equipment details

The project used various equipment, including twelve (12) 7kW Schneider EV Link Smart Wallbox charging stations at Wyatt UPark and Topham UPark supplied by Jet Charge and installed by Nilsen, along with two (2) kWatch smart controllers, one at each site, provided by Flow Power and installed by Nilsen.

Metering was installed on existing EV distribution boards to monitor EV consumption at each site.

Smart charging charge strategies included scheduling EV charging based on cheaper tariffs and optimising the use of renewable energy. This was managed by Flow Power and included the integration of Topham's 260kWp on-site solar PV into the demand management system.

Functional description

The two (2) Flow Power kWatch devices facilitated the measurement and control of electricity usage via hardwired communications links to the EV chargers. In turn, the kWatch devices were linked to Flow Power's demand management system via 4G.

In every 5-minute electricity market interval:

- Flow Power's central demand management system monitored market electricity price and carbon intensity, determined whether to ramp EV charging power up or down when certain conditions were detected and signalled the on-site kWatch devices.
- The kWatch devices then signalled the EV charging units, which modified charging power accordingly.

Integration

The six EV chargers in each UPark facility were networked together. A Chargefox modem was installed in this network to facilitate data collection for billing and maintenance access for Jet Charge.

Control signals generated by Flow Power's demand management system were routed through the kWatch device to the EV Link charger network over *Modbus TCP*.

The kWatch controller polled charging data from the EV Link chargers to provide information to Flow Power's demand management system, which monitors and verifies the project objectives.

After several months of successful integration between the kWatch controllers, the Chargefox 4G modems and the EV Link chargers, a communication issue arose in the chargers. This persistent error manifested when the kWatch device and Chargefox modem were connected in parallel to the EV Link charger networks.

3. SELECTION OF CHARGE STRATEGY

Pre-trial modelling & evaluation of charging strategies

Several different possible charge strategies could have been employed for the UPark Smart EV Charging Trial. Given the innovation of the project, Flow Power provided the City of Adelaide (CoA) a preliminary assessment and estimation for the outcomes of various charging strategies through extensive modelling and analysis.

UPark provided Flow Power with parking data (entry and exit times) from three fleet parking groups using the Topham Mall and Wyatt Street facilities to conduct this modelling.

The detailed methodology used to develop possible charging strategies and the estimated outcomes of their implementation are outlined below:

1. Conduct a preliminary exploration of the different charging strategies for the collected parking data.
2. Derive a set of metrics for quantitative evaluation.
3. Identify opportunities, challenges, risks, and compromises for each strategy to assist in deciding which strategy to implement.

Methodology

Collect Data

Actual parking data was retrieved from both UPark locations to provide entry, exit, and dwell times at each facility (Appendix 1 – confidential). It should be noted that actual parking data collected was for three vehicle fleets, which included Internal Combustion Engine Vehicles and EVs, using the two facilities (Topham and Wyatt), and did not reflect the parking behaviour of EVs using the dedicated smart EV charging spaces, nor provide any statical estimates for their specific charge requirements.

Quantitative Evaluation Metrics

1. Cost ($/MWh)
2. Carbon intensity – load weighted average carbon intensity.
3. Effective charge ratio – actual charged volume divided by required capacity.
4. Under-charged ratio – the ratio of charging events where the effective charge ratio is below 25 per cent at the end of the event.
5. Idle time ratio – total time not charging divided by total parking time.

Charge Strategies

The charge strategies were devised after considerable analysis and modelling. This involved:

- Extraction of the parking data (as determined by the entry and exit gates) for each UPark to derive statistical distribution of entry, exit, and dwell times.
- Determination of 'typical' and 'reasonable' charge requirements expected of UPark customers, using Australian Bureau of Statistics data for South Australian EV drivers.
- Modelling of different charge strategies using this data to approximate each strategy's cost and carbon outcomes.
- Presentation and discussion of results to determine the most appropriate strategy to employ for the trial.

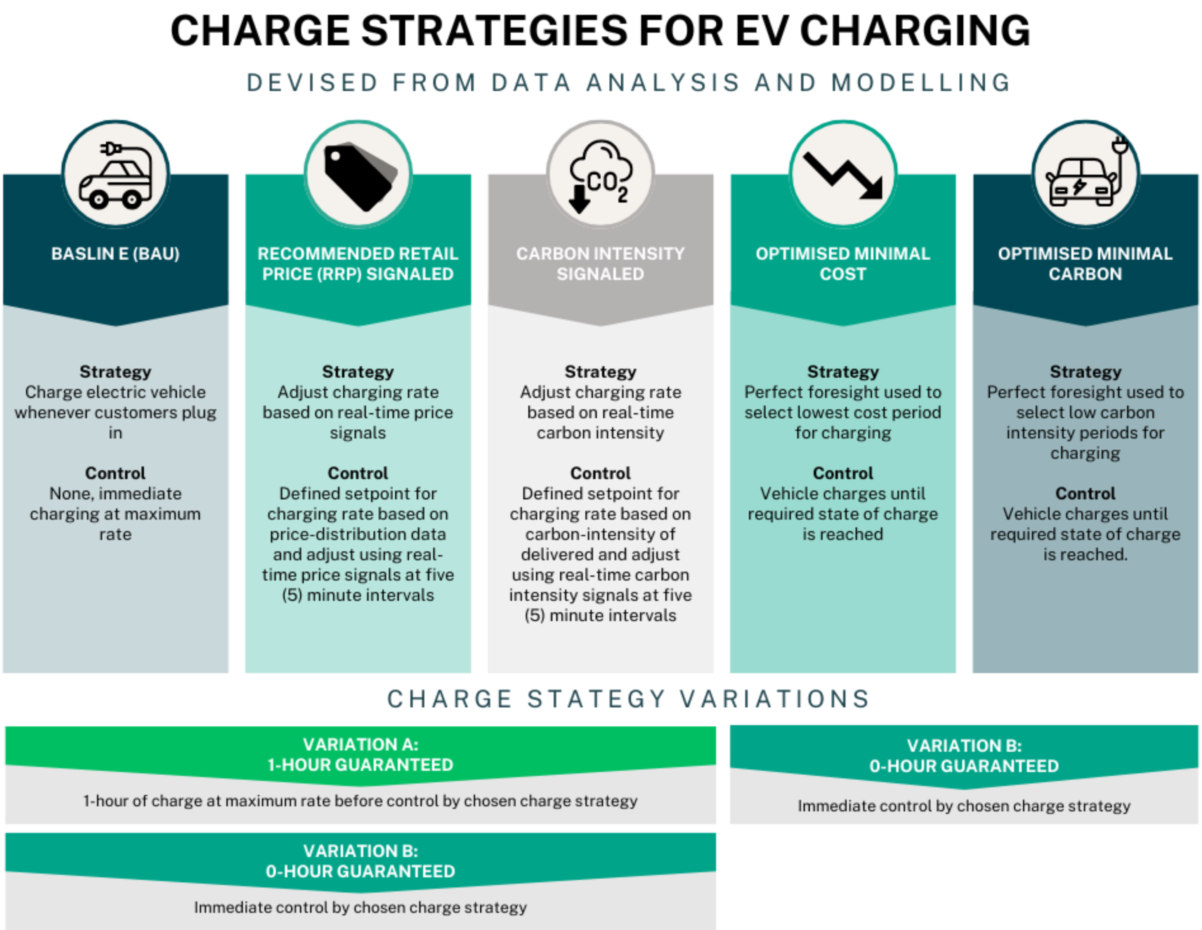


Figure 1: Summary of Charge Strategy Developed

Three (3) primary control strategies were considered, summarised in Figure 1 above. The three (3) primary control strategies were:

1. **Baseline (BAU)** – charge vehicle whenever customers plugin.
2. **Recommended retail price (RRP) signalled** — Use the percentiles (refer to Table 1) of price distribution over the past three (3) months to define several setpoints for the charging rate and adjust it using real-time price signals from each five (5) minute interval.
3. **Carbon intensity signalled** — Use the percentiles (refer to Table 1) of the distribution of the carbon intensity of electricity delivered to the charging stations over the last three (3) months to define setpoints for charging rates and adjust the charging rate based on real-time carbon intensity from each five (5) minute interval.

Table 1: Example of percentile bands and respective charge rate

Percentile	<25%	25-50%	50-75%	75-90%	>90%
Charge rate	100%	75%	50%	25%	0%

For each primary charging strategy, two (2) variations were devised:

A. **One (1) hour guaranteed** – when the user plugs in to charge their EV, they are guaranteed one (1) hour of charge at the maximum kW throughput of the charger before being controlled by the chosen strategy.

B. **Zero (0) hour guarantee** – when the user plugs in to charge their EV, the kW throughput of the charger is immediately controlled by the chosen strategy.

Two further charge strategies were modelled to show the theoretical best outcome for each charging strategy (using variation B), summarised in Figure 1 above. These charge strategies were considered the best outcome because they assume the system has *perfect foresight*, meaning it has all the information required to make an ideal schedule for the charging session. This information includes entry, exit, dwell time, recharge needed for the sessions, future electricity prices and future carbon intensities. These two additional strategies are outlined below:

4. **Optimised minimal cost** – when the user plugs in to charge and, using perfect foresight over the well time, selects the periods with the lowest cost that will allow the vehicle to charge until the required state of charge is reached.
5. **Optimised minimal carbon** – when the user plugs in to charge and, using perfect foresight over the dwell time, selects the periods with the lowest carbon intensity that will allow the vehicle to charge until the required state of charge is reached.

All charge strategies included a logic statement that would stop the chargers if the RRP value exceeded $500/MWh.

Observations and statistical analysis of pre-trial UPark user behaviour

Timing of parking sessions

- Vehicle arrivals peak between 7:30 and 9:30 am (Appendix 1D), and vehicle departures peak between 5:00 and 6:00pm (Appendix 1E).

Parking duration distribution

- Short dwell times (less than 2 hours) were relatively uncommon (Appendix 1F).
- Approximately 95 per cent of dwell times are shorter than 12 hours, suggesting a predominantly daily usage pattern (Appendix 1F).
- The median dwell time was around 8 hours, indicating typical workday parking behaviour (Appendix 1F).

Day-to-day variation:

- There is a distinct difference between parking behaviours on workdays and non-workdays (Appendices 1H, 1I and 1J).

Statistic of parking sessions:

- Daytime parking constitutes the majority of events, encompassing approximately 95 per cent of all parking sessions (Appendices 1H, 1I and 1J)
- Night parking represents a small fraction at around 1 per cent indicating limited overnight parking activities (Appendices 1H, 1I and 1J)
- Overnight parking comprises 2.5 per cent of sessions, indicating occasional longer stays but not a predominant pattern (Appendices 1H, 1I and 1J)
- Parking sessions exceeding 24 hours accounted for 1.5 per cent of sessions (Appendix 1G).
- More than one parking session per user within the same day was observed (Appendix 1G), with:
  - Two return trips occurred in approximately 11.4 per cent of cases.
  - Three return trips occurred in 0.94 per cent of cases.
  - Four return trips occurred in less than 0.1 per cent of cases, indicating rare instances of multiple same-day return parking.

These observations provided a comprehensive understanding of the typical usage patterns at UPark locations, essential for developing and optimising effective charging strategies tailored to user behaviours and parking dynamics.

Observations from charge strategy simulation results:

The simulations conducted to evaluate different charge strategies revealed the following:

1. **Trade-offs between metrics**
   - The simulations highlighted a notable trade-off between reducing cost/carbon intensity and maintaining a high effective charge ratio and a low under-charge ratio.
   - Instigating a one (1) hour minimum charge led to a reduction in under-charge and effective charge ratios but resulted in increased cost and carbon intensity.
2. **Potential for significant cost and carbon reductions**
   - Despite the trade-offs, the simulations demonstrated the potential for achieving substantial reductions in both cost and carbon intensity, exceeding 20 per cent across various parking groups.
   - These reductions were achieved without significantly impacting the delivered charge to the user, indicating efficient optimisation possibilities.

The following conclusions were drawn from the charge strategy simulation.

1. **Balanced strategy selection**
   - The strategy combining RRP signals with a 1-hour minimum charge struck an optimal balance between cost and carbon reduction while ensuring user satisfaction.
   - This balanced approach leverages real-time price signals to adjust charging rates effectively, mitigating carbon emissions without compromising user experience.
2. **Collaborative decision-making**
   - The determination of the chosen strategy was made through collaborative decision-making processes, considering both technical feasibility and user outcomes.
   - This collaborative approach underscores the importance of stakeholder engagement and cross-functional cooperation in implementing effective charging strategies.

The charging strategy combining RRP signals with a 1-hour minimum charge represents a strategic and sustainable approach to UPark Smart EV Charging, aligning emissions reduction goals with user needs and operational efficiency. Results are displayed in Appendix 2.

Figure 5: City of Adelaide fleet vehicle charging during the trial

4. PROCUREMENT

The CoA undertook a Request for Quote process for the supply, installation, and commissioning of smart EV chargers for this trial. Three (3) proponents were chosen to quote, with Nilsen Pty Ltd (Nilsen) being the preferred proponent through the procurement process.

Nilsen supplied (12) EV Link Smart Wallbox Chargers (7.4kW – T2 – RFID) from Jet Charge. The twelve chargers were installed and commissioned at both locations by March 2022.

Chargefox is CoA's existing provider, facilitating data collection for two purposes: billing and maintenance configuration access. This arrangement was extended to the trial smart EV chargers to enable corporate car parkers to access the chargers via an RFID swipe card.

Nilsen set up the Chargefox system via a 4G modem on the JetCarge-supplied EV Link Smart Wallbox Chargers. Jet Charge believes that the communication issues arose from this approach undertaken by CoA through procurement with Nilsen. Previous installations and configurations for other EV chargers in CoA's network have required Jet Charge to set up the Chargefox system via a 4G Modem, not the installer (in this case, Nilsen).

The trial's main component was the integration of a demand management system. Demand management was to be delivered by CoA's electricity retailer (Flow Power) using its kWatch Controller. However, this component of the trial was out of the scope of this Request for Quote as Flow Power was to install the demand management system (in-kind) after Nilsen commissioned the EV chargers and ChargeFox system.

Flow Power and installed and integrated (in-kind) the 'smart' demand management system, through its kWatch Controller. The kWatch Controller was the 'smart' technology chosen as part of the funding agreement due to Flow Power being the electricity retailer through a Power Purchase Agreement (PPA) for CoA and UPark. Leveraging Flow Power's demand management capabilities was the basis of the trial.

The CoA staff was to maintain the smart EV chargers and resolve any issues within the fifty-two-week defect liability period after commissioning. Jet Charge was bought on board (in-kind) with the project after Nilsen could not identify the issue.

The EV chargers were advertised to have the capability to support dual communications for both Modbus TCP and OCCP. Following an update of the Schnieder EV-Link chargers firmware, this capability was no longer demonstrable in the units. Although the chargers could communicate with both the ChargeFox billings and monitoring system and the Flow Power demand management system for the initial months of the trial, once the firmware update was applied, the chargers "locked up" and would drop the ChargeFox system off, leaving the chargers inoperable. This error persisted anytime both devices, kWatch and Chargefox Moden, were connected in parallel to the EV Link EV Charger network.

After reviewing the trial, it became evident that the procurement process with Jet Charge did not clearly articulate the trial's intent. This meant that once the firmware update was applied midway through the trial, the installed EV chargers could not simultaneously support Flow Power's demand management system (kWatch) and the Chargefox billing and maintenance system.

It has been identified that if Jet Charge (the supplier to Nilsen) were aware of the requirement of a smart demand system to be installed with the Chargefox-enabled charges, an alternative charger may have been supplied, or the CoA may have been advised of a firmware update to the system that prevented the dual communication.

Figure 2: EVlink Smart Wallbox Chargers (7.4kW – T2 – RFID) at Wyatt UPark

Figure 3: EVlink Smart Wallbox Chargers (7.4kW – T2 – RFID) installed at Wyatt UPark

5. TECHNICAL

Site identification and design

The project was undertaken at the Wyatt and Topham UParks. Both UParks are centrally located in the Adelaide Central Business District (CBD). Both sites are owned by the City of Adelaide and fall under the City of Adelaide's retail electricity agreement with Flow Power, which provides 100 per cent renewable electricity.

Topham UPark features a 260kW solar PV system on site. Demand dips between 10:00 a.m. and 3:00 p.m., presenting an opportunity to optimise energy usage to benefit users. Topham UPark offers 1,041 car parks, while Parks UPark provides 755 car parks.

Both UParks had existing electrical infrastructure installed, which allowed for the straightforward installation of new charging equipment. This included a dedicated EV electrical distribution board with available capacity.

Site and technical design

Topham and Wyatt UParks were selected for the trial due to their high demand for long-term parking and available capacity, with six (6) car parks identified at both sites. By targeting commercial fleets and corporate customers, the trial aimed to demonstrate the benefits of smart EV charging technology to enable replication at other commercial parking facilities.

For the trial, six (6) EV chargers installed at each facility resulted in 0.57 per cent of car parks at Topham being reserved for electric vehicles and 1.33 per cent at Wyatt being designated as EV charging spaces (six reserved spaces in addition to the existing four causal parking spaces).

The trial was designed to provide UPark commercial fleet and corporate customers with variable minimum charge capacity and volume availability for different periods of the day based on the combined parameters of:

- network demand periods
- site demand
- wholesale / CoA electricity pricing
- CoA renewable electricity supply – PPA supplied and on-site solar

The CoA's retail electricity contract with Flow Power is based on the 30-minute wholesale electricity market and renewable electricity generation. A pre-trial review of existing EV charging trends across CoA sites was overlaid with wholesale electricity pricing, demonstrating that most charging demand aligned with low network demand, high renewable generation periods, and low wholesale electricity prices. Therefore, the UPark EV Fleet Smart Charging Trial aimed to target maximising EV fleet charging between 10:00 am and 3:00 pm.

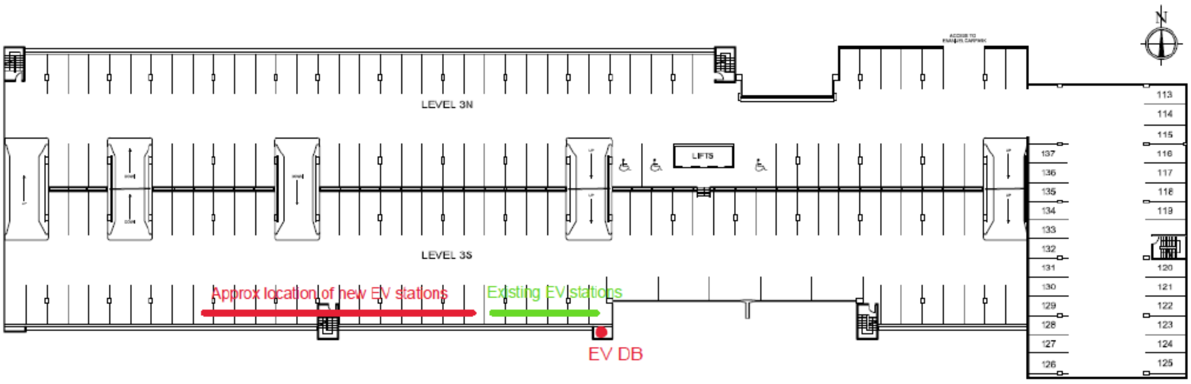


Figure 3: Topham Mall UPark Level 3 trial (and existing) EV charging parking bay locations (confidential)

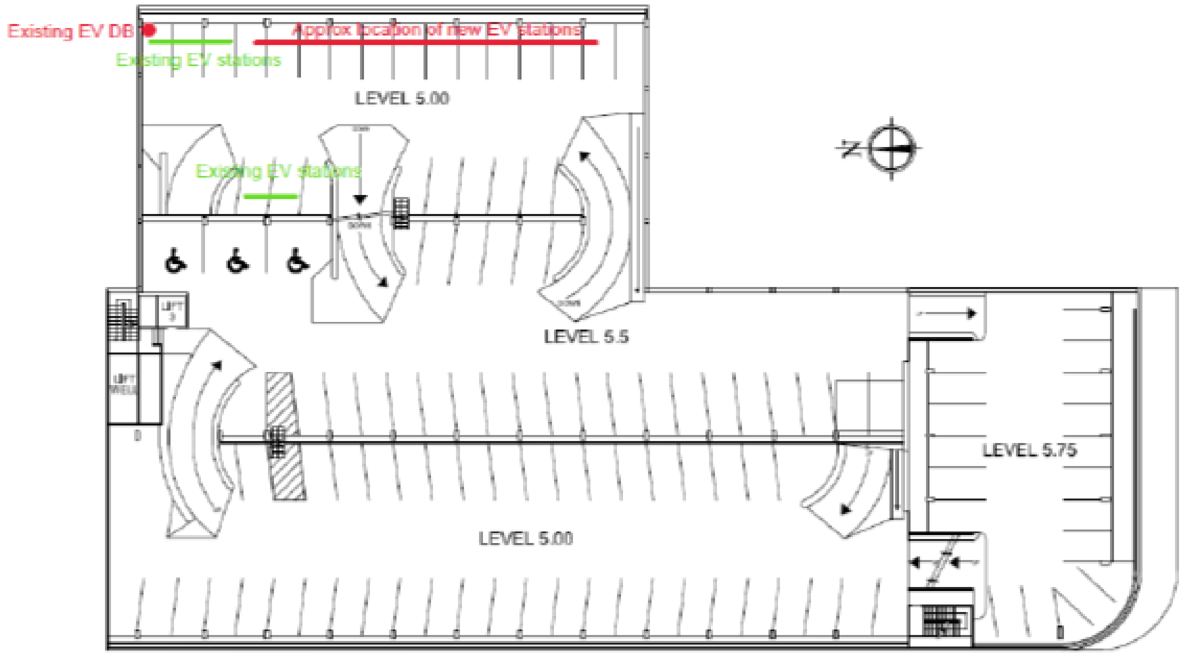


Figure 4: Wyatt UPark Level 5 trial (and existing) EV charging parking bay locations (confidential)

6. PERFORMANCE OF HARDWARE AND SOFTWARE

The combination of Schneider hardware (EV Link Smart Wallbox Chargers or EV Link charger), supplied by Nilsen (via Jet Charge), Flow Power's demand management system (kWatch Controller) and Chargefox RFID payment system did not perform in line with expectations. The hardware and firmware systems were not performing as expected, resulting in the inability to trial the charge strategies. The communication issue that arose between the hardware and firmware used summarised below:

- EV Link chargers were specifically chosen because they were advertised as having Modbus and OCCP communications that could be used simultaneously. When initially installed and commissioned by Nilsen, the simultaneous communication was operational (February 2023 to April 2023).
- Three months into the trial data collection period (April 2023), Jet Charge undertook a firmware update of the Chargefox network for the wider EV chargers across the City of Adelaide's network, including the trial of the EV Link chargers, which seemed to result in the communication issue with the trial chargers and kWatch Controller.
- Following this communication issue, Nilsen (through Jet Charge) was able to restore the chargers to ensure they were online, but simultaneous data collection was not possible. Connection issues with the smart charging platform continued to occur anytime simultaneous data collection was triggered.
- Workflow requests were raised by UPark staff directly with Nislen under warranty periods, but they could not identify the issue. As such, Jet Charge (the supplier of the EV chargers and provider of Chargefox) was requested to investigate the issue.
- The communication issue through the simultaneous data collection for kWatch and Chargefox was identified once Jet Charge provided troubleshooting support.
- As such, Flow Power and Jet Charge worked together between May and October 2023 to identify the exact communication issue and rectify it.
- During this period, several UPark customers, including CoA vehicles, experienced difficulties charging their cars, resulting in low customer satisfaction.
- The continuous attempt to collect simultaneous data during this period resulted in the EV chargers switching offline, and UPark raised maintenance tickets through CoA staff before they were escalated to Nilsen / Jet Charge.
- Jet Charge directly engaged Schnieder, the manufacturer of the EV Link charger, to seek a recommended solution but unsuccessfully received a response from the manufacturer.
- A workaround was discussed between CoA and Jet Charge, which resulted in the kWatch Controller being disconnected and all data being sent to Chargefox.
- In October 2023, when the workaround was implemented, the EV Link chargers have only been offline intermittently and required a hard reset to bring the EV chargers back online.
- At the end of the 12-month data collection period, no resolution was identified. As such, the EV Link chargers were not a 'smart' charging system from April 2023 until February 2024.
- Flow Power was then required to use third-party data to undertake modelling and data analysis retrospectively to ensure the trial's objectives could be considered.
- Although the EV chargers did not enable the smart technology for the duration of the trial. The Council, with assistance from Flow Power and Chargefox, have been able to achieve the objective of demonstrating the effectiveness of using wholesale electricity price triggers for load shifting and cost reduction in the provision of EV charging service through retrospective analysis of charging data.

7. PARTICIPANTS

Customer preferences

Pre-trial UParks customers indicated their preference for a set fee to cover car parking and electricity for charging. They were prepared to pay a monthly fee for the exclusive use of an EV charger in an allocated parking bay. They were comfortable being part of the smart charging trial, particularly at a reduced rate. Customers also showed a preference for having a single point of contact for both parking and charging requirements.

Recruitment process & marketing strategy

The UPark Smart EV Fleet product aimed to simplify the management of EV fleets and corporate customers by providing fixed-price products that include parking and charge requirements.

Rather than trying to change customer charging behaviour through direct electricity consumption-based pricing mechanisms (e.g. time-of-use tariffs), the UPark Smart EV charging system would control the availability of electricity to customers throughout the day and night to align with network demand conditions.

During the trial, corporate customers were offered charging at no cost, paying only a small monthly fee in addition to their parking fee to cover Chargefox's administration fee. Providing free electricity to corporate customers aimed to understand how to optimise the charge strategies, associated pricing and use of renewable energy.

The trial data collection is intended to inform UPark's charge strategy pricing to offer customers an attractive product that also simplifies the energy management of EV fleets. The added advantage of the trial was that corporate customers could promote their fleet vehicles fuelled by 100 per cent renewable electricity.

The UPark Business Development Team developed a marketing and promotion strategy that included direct and indirect marketing packages.

The direct marketing package, included:

- Electronic direct mail (eDM) distributed in October 2022 to a specific database of monthly reserved parkers. A total of 73 recipients were on the mailing list, and the eDM had a 31.5% open rate (Appendix 5C).
- decals installed in UParks (Topham and Wyatt) in June 2023 (Appendix 5B).

Indirect marketing package included:

- social media via Facebook paid ad running from 24 May 2023 to 16 June 2023. The Facebook ad reached 55,000 people. This advertising method was not the most effective as it resulted in $3.61 cost per click compared to City of Adelaide's average of $1 and below (Appendix 5A).
- the trial website, which during the 12-month trial period had 327 sessions, 307 users, an average time of age 29 seconds. The top source was Google, followed by direct search.

Participant Description and Engagement

City of Adelaide's EV fleet comprised a significant proportion of the trial participants, ensuring a rapid uptake to test charge strategies. The fleet was new to the organisation, consisting of pool vehicles with multiple drivers, requiring clear instructions for successful charging.

Corporate customers included individuals and fleet accounts from government departments, private organisations and personal vehicles.

There were various vehicle make/models within the trial, including MG ZS, Hyundai Ioniq, Telsa Model 3 and Kia.

These customers primarily used single reserved EV charging bays and rotated their vehicles between reserved and unreserved EV charging bays. These customers were generally more knowledgeable about EVs and their energy consumption. Some trial participants were existing causal UPark EV charging customers who transitioned to reserved smart EV chargers when available.

Previous charging methods by participants varied from home charging, supercharges, project site chargers or new vehicle with no previous charging history.

Four months into the trial data collection period, the peak participation included nine fleet customers (five of which were CoA fleet vehicles) across the twelve chargers at both locations. Recruitment of customers took longer than expected due to low demand in the UPark corporate customer based for EV charging. The low demand for reserved EV charging bays resulted in low usage of charging bays in the early stages. Despite corporate customers expressing interest in transitioning to EVs, several factors outside City of Adelaide's control contributed to the low demand during the trial period, including:

- high upfront costs of electric vehicles
- limited model availability and supply
- economic uncertainty, particularly due to COVID-19 pandemic, leading to cautious spending and investment strategies by businesses

City of Adelaide aimed to alleviate infrastructure concerns regarding the availability of reliability of EV charging through the trial.

Learnings from participants

During the data collection period, feedback was received regarding chargers' failure to operate, e.g., appearing offline. This is consistent with the timing of the communication issues that arose. Participants also reported initial problems with chargers, faulty systems, and the need for quicker fixes. There was no feedback on the provision of electricity throughout the trial i.e., no complaints regarding lack of charging during periods when electricity was unavailable due to reaching preset costs. During the part of the trial when the 'smart' demand system was not working, this is unsurprising.

Most participants reported no change in charging behaviour during the trial. Regarding noticeable differences in charge speed, there were mixed responses: some participants noticed issues like being capped at 16 Amps, while others did not notice any difference. Feelings about charging speed limitations ranged from frustration to neutrality, with several indicating satisfaction.

Feedback regarding the trial varied, while some participants were very satisfied due to reasons like reliability, cost, convenience, and general system performance, others were neutral or very dissatisfied, citing issues such as faulty chargers and the need for more reliable charging stations.

Additionally, UPark fleet customers expressed the preference to have one RFID card that would allow them access to the UPark facility and to operate the EV chargers. This was explored, but UPark was unable to find a solution that would operate both car park entry systems and the EV charger. Despite these challenges, many participants found the system worked well overall, appreciating the convenience and impact of the trial.

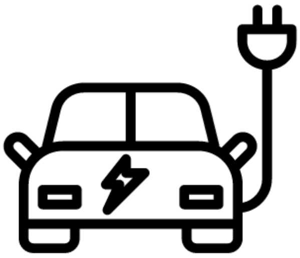
8. RESULTS

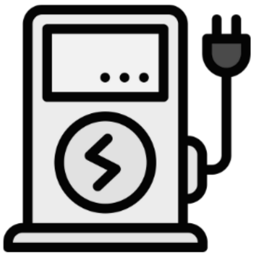
Key Insights and Outcomes

CUSTOMER EV UPTAKE

Corporate customers uptake of EV was slower than expected, despite initial indications that the transition was planned or underway due to high upfront costs of EVs, limited model availability and economic uncertainty, particularly due to COVID-19 pandemic.

Results: importance of indirectly influencing uptake by providing innovative EV charging solution to corporate reserve parking customers, offering commercial incentives.





HARDWARE INTEGRATION

Integration process involved chargers networked in UPark facilities, controlled by Flow Power's demand management system via kWatch. However, challenges arose with communication issues from a third-party firmware update.

Learning: It is vital to ensure hardware and software integration, as well as resources and capacity within the organisation to work through issues.

CHARGE STRATEGY OUTCOMES

Data from the trial indicated that the selected charge strategy, a 1-hour minimum charge and carbon intensity signalling, achieved cost and carbon reduction goals while maintaining high user charge satisfaction levels.

This charge strategy can reduce the period of strain on the grid by lowering charging demand during peak electricity load times, contributing to a more secure, stable energy system for all users.

SCALABILITY

Retrospective analysis demonstrated the scalability and replicability of the similar fleet and commercial parking facilities to reduce electricity costs by controlling load during high-price events.

Despite integration challenges, the retrospective analysis demonstrated the effectiveness of using wholesale electricity price triggers for load shifting. Potential adapts to different user types and real-time pricing signals, promising for broader adoption and long-term sustainability.

Baseline charging behaviour

Some months into the trial, challenges arose from device communication issues and the removal of Flow Power's kWatch Controller at Wyatt Street UPark and Topham Mall UPark. This meant that only business as usual (BAU) behaviour occurred during the trial period instead of the selected charging strategy.

Data for this BAU charging behaviour was recorded by the Chargefox billing system for much of the trial. Using this data, Flow Power was able to undertake a retrospective analysis of how each of the various charge strategies would have performed were the demand management system still active. The following section presents the BAU behaviour observed and Flow Power's simulated outcomes for each of the various charge strategies between 1 February 2023 and 1 March 2024.

Comparison of Topham Mall and Wyatt Street UPark outcomes

The following compares Topham Mall and Wyatt Street UPark's BAU parking behaviour and charging requirements, as well as the simulated outcomes for all the considered charging strategies (Section 3).

Parking and charging requirements

- Wyatt Street UPark exhibited more daytime charging events, while Topham Mall UPark had more evening and overnight charging.
- Charging events at Wyatt Street typically began in the morning and ended in the evening, whereas Topham Mall charging events typically started at night and ended in the morning.
- Wyatt Street had a longer dwell time as compared to Topham Mall. Wyatt Street had a median of 10.6 hours, whereas Topham Mall had a median of 7.6 hours.
- Wyatt Street had a greater average charge requirement than Topham Mall. Wyatt Street had a median charge per session of 15.4kWh, as compared with 11.7kWh for Topham Mall.
- As a result of this, Wyatt Street UPark had a charging versus parking ratio of 24 per cent, while Topham Mall UPark had a ratio of 39 per cent.
- Topham Mall UPark delivered approximately 19MWh worth of charge for EVs over this period, compared to Wyatt Street UPark's 12.5MWh.

Chosen charging strategy:

- Due to the higher proportion of daytime charging events at Wyatt Street, more significant cost and carbon reduction potential existed compared to Topham Mall.
- Wyatt Street's characteristics allow for greater cost and carbon reduction by shifting morning charging events closer to midday when electricity is cheaper, and the energy mixture has a greater percentage of renewables.

All considered charge strategies:

- Strategies with 0-hour minimum charge achieved greater cost and carbon reduction than those with a 1-hour minimum charge.
- Carbon intensity signalled strategies outperformed RRP signalled strategies in carbon reduction, while RRP strategies showed greater cost reduction.
- Optimised charge strategies for RRP and carbon intensity demonstrated the greatest theoretical reduction in cost and carbon emissions based on existing infrastructure and user behaviour.

Overall, the baseline data suggested that implementing simple charge strategies can result in significant cost and carbon reductions without compromising user satisfaction. Factors such as the proportion of daytime charging events and the duration of dwell times influence the effectiveness of these strategies, highlighting specific scenarios with greater potential for cost and carbon reduction.

Post-trial charging strategy simulation

Key Insights:

- Smart charging strategies can significantly enhance both financial and environmental performance.
- Producing detailed parking schedules and charging requirements can lead to even greater cost and carbon reduction without compromising user satisfaction

Conducting a retrospective analysis using the collected data provided the following insights into the performance of the different charging charge strategies. The following section discusses the different outcomes for each of these.

The trial considered several charge strategies, each aiming at optimising cost, carbon reduction and user satisfaction. The charge strategies included:

1-hour versus 0-hour minimum charge: strategies with a 0-hour minimum charge achieved much greater cost and carbon reduction than those with a 1-hour minimum charge. This highlights the importance of demand flexibility for reducing cost and environmental impact.

Carbon intensity versus RRP signalled: carbon intensity signalled charging strategies resulted in marginally higher carbon reduction than RRP signalled strategies. Conversely, RRP strategies showed an equivalent cost reduction. This effectively demonstrates the correlation between carbon intensity and the cost of electricity.

User satisfaction and operational efficiency: carbon intensity and RRP signalled strategies showed approximately 90 per cent effective charge ratio and 5 per cent under charge ratio. This demonstrates that significant cost and carbon reductions can be achieved using simple charge strategies while maintaining user satisfaction.

User satisfaction was defined based on the effective charge ratio and under charge ratio, indicating the percentage of successful charges and instances of undercharging. The analysis intertwines quantitative metrics such as cost reduction and carbon intensity reduction with qualitative assessments of assumed user satisfaction to provide a holistic view of the trial's outcomes

Optimised charge strategies: the optimised charge strategies for RRP and carbon intensity showed the maximum theoretical reduction in cost and carbon emissions achievable using the selected EV chargers and assuming perfect foresight for user parking behaviour and charging requirements.

Under the optimised RRP charging strategy, Wyatt Street UPark could theoretically reduce its retail electricity cost by 124.7 per cent and its carbon intensity by 28.8 per cent while still delivering a 98.1 per cent effective charge ratio and a 0 per cent under charge ratio. Similarly, Topham Mall UPark could achieve a reduction of 58.9 per cent in electricity costs and 14.5 per cent in carbon intensity under the same strategy while still delivering a 96.2 per cent effective charge ratio and a 0 per cent under charge ratio.

These strategies have the potential to significantly improve the financial and environmental aspects of EV charging for long-term parking. This also demonstrates that if fleets can provide more information about their parking schedules and charging requirements, they can achieve even more significant reductions to coins and carbon intensity without sacrificing user satisfaction.

Comparative Analysis:

- Wyatt Street UPark: more potential for cost and carbon reduction due to a higher proportion of daytime charging
- Topham Mall UPark: lower but still substantial potential for improvements

Tables 2 to 7 below provide further details of the percentage reductions in cost and carbon intensity under different charge strategies, effective charge ratios, and under-charge ratios for both sites. These results demonstrate the effectiveness of smart charging charge strategies in achieving sustainable and cost-efficient EV charging operations.

The comparison between Topham Mall and Wyatt Street UPark revealed distinct parking and charging characteristics, influencing the effectiveness of different charge strategies. Wyatt Street UPark, with its higher proportion of daytime charging events, showed greater potential for cost and carbon reduction compared to Topham Mall. The analysis demonstrated that simple charge strategies could significantly reduce costs and carbon emissions without compromising user satisfaction. The optimised charge strategies, based on RRP and carbon intensity, showed the maximum theoretical reduction in cost and carbon emissions achievable with the existing infrastructure and user behaviour assumptions.

The trial results underscore the potential of smart charging strategies to achieve cost-efficient EV charging operators for fleets and commercial customers. Tables 2 – 7, provided in this section, outline the percentage reduction in cost and carbon intensity under different charge strategies, effective charge ratios, and undercharge ratios for both sites, highlighting the effectiveness of smart charging in meeting operational efficiency goals.

Cost Reduction: Wyatt Street UPark showed higher cost reduction across all strategies compared to Topham Mall UPark

Table 2: Charge strategy simulation results for cost reduction

Site and charging strategy	Carbon intensity signalled		RRP signalled	
	0 hour minimum charge	1 hour minimum charge	0 hour minimum charge	1 hour minimum charge
Topham Mall UPark	37.1%	14.5%	41.7%	18.0%
Wyatt Street UPark	66.7%	31.3%	76.4%	38.4%

Carbon Intensity Reduction: Significant reductions in carbon intensity were observed, with Wyatt Street UPark again outperforming Topham Mall UPark.

Table 3: Charging strategy simulation results for carbon intensity reduction

Carbon intensity reduction (%)				
Site and Charging Strategy	Carbon intensity signalled		RRP signalled	
	0 hour minimum charge	1 hour minimum charge	0 hour minimum charge	1 hour minimum charge
Topham Mall UPark	29.8%	14.8%	14.6%	6.9%
Wyatt Street UPark	39.1%	18.8%	28.3%	12.7%

Effective Charge Ratio: Both sites achieved high effective charge ratios, indicating efficient use of charging infrastructure.

Table 4: Charging strategy simulation results for effective charge ratio

Effective charge ratio				
Site and Charging Strategy	Carbon intensity signalled		RRP signalled	
	0 hour minimum charge	1 hour minimum charge	0 hour minimum charge	1 hour minimum charge
Topham Mall UPark	77.2%	88%	82.7%	93.1%
Wyatt Street UPark	86.4%	93.1%	88.2%	94.2%

Undercharge Ratio: Both sites kept the undercharge ratio low, ensuring users' charging needs were met.

Table 5: Charging strategy simulation results for undercharge ratio

Undercharge ratio				
Site and Charging Strategy	Carbon intensity signalled		RRP signalled	
	0 hour minimum charge	1 hour minimum charge	0 hour minimum charge	1 hour minimum charge
Topham Mall UPark	11.9%	1.1%	6.3%	0.3%
Wyatt Street UPark	6.8%	0.9%	4.6%	0.4%

Optimised Strategies: Optimised Cost & Carbon Reduction: Wyatt Street UPark achieved higher optimisations in cost and carbon reductions.

Table 6: Charging strategy optimised cost & carbon reduction (%)

Optimised cost & carbon reduction (%)				
Site and Charging Strategy	Optimised carbon Intensity		Optimised RRP	
	Cost reduction	Carbon reduction	Cost reduction	Carbon reduction
Topham Mall UPark	36.5%	23.8%	58.9%	14.5%
Wyatt Street UPark	89.6%	47.8%	124.1%	38.8%

User Satisfaction: Both sites maintained high user satisfaction, with nearly perfect effective charge and minimal undercharge ratios.

Table 7: Charging strategy simulation results for optimised user satisfaction

Optimised user satisfaction				
Site and Charging Strategy	Optimised carbon intensity		Optimised RRP	
	Effective charge ratio	Under charge ratio	Effective charge ratio	Under charge ratio
Topham Mall UPark	96.1%	0.0%	96.2%	0.0%
Wyatt Street UPark	97.9%	0.0%	98.1%	0.0%

9. BUSINESS MODEL

Revenue generation

The UPark EV Fleet Smart Charging 'product' fee structure was formed using an analysis of the City of Adelaide's five (5) minute pricing relative and the estimates for the expected charging demand.

The Council's dynamic wholesale energy price arrangement, through its PPA with Flow Power, offers significantly more opportunities to realise the benefits of smart charging technology than a standard peak, shoulder, or off-peak tariff arrangement. Using price and charging signals directly from the wholesale market provides a connection to the energy system in real-time. Prices are low and even negative in times of excess generation supply and high in times of peak demand.

This trial aimed to control and shift EV charging to periods of high renewable generation and low demand. While standard peak and off-peak network tariffs remained, these were relatively static and were considered alongside wholesale pricing. In doing this, a full cost stack for electricity could be considered, and the associated benefits could be realised for EV charger consumers and operators. In turn, it allowed a fixed-price product to be offered to electric vehicle fleet and cooperate customers instead of the typical volumetric charging cost models. Additionally, removing complicated billing and invoicing arrangements managed to reduce administrative requirements and the overall cost for customers and operators.

Another advantage of the fixed-price product was that it provided businesses with a fixed operating cost for their fleet, which included all usage costs associated with EV charging. Pre-trial feedback from businesses indicated that fixed and predetermined pricing was of significant benefit to them as it allowed them to budget expenses accurately and removed administrative complexity, time, and costs associated with understanding and paying for volumetric-based cost models. The trial has been unable to confirm this last assumption.

Replicability and scalability of business model

This trial aimed to create a business model to reduce emissions, generate revenue and save money for UPark operations. It also aimed to investigate a scalable and replicable solution for future EV fleet management. The following is an assessment of the trial's alignment with the proposed business model and its potential replicability and scalability.

1. **Development of pricing structure**
    - The trial successfully determined the average daily charging requirement per vehicle and analysed load profiles to establish baseline electricity prices.
    - Pricing thresholds were incorporated into Flow Power's signals to control EV charging stations in real-time, aligning with the proposed methodology.
2. **Financial and business benefits**
    - The trial simulation reduced electricity costs for CoA and UParks by controlling load during high-price events, validating the anticipated financial benefits.
    - Administrative costs would be reduced through a simplified pricing structure and product offering, as envisioned in the proposed model.
    - However, the ability to capture the EV market and increase the market share of fleet EVs was not demonstrated.
3. **Modelling and analysis**
    - Additional modelling simulation was conducted to assess the success of charging strategies for all different user types.

- Standardised user profiles were used to simulate charge events, and the results provided insights into the effectiveness of charging strategies across various user segments.

4. Scalability and replicability

- The trial's simulated success in achieving cost savings, reducing administrative complexities, and providing a clear value proposition for customers indicates its scalability and replicability.
- The business model's ability to adapt to different user types and optimise charging based on real-time pricing signals demonstrates its scalability across diverse fleet and consumer scenarios.

Comparative Analysis for Different User Types

Flow Power undertook additional modelling to provide a comparative analysis of the success of these charging strategies for different user types to support the replicability of learnings from this trial. The user profiles assessed were given the following standardised characteristics:

- **Fleets**—park for 1-2 weeks, starting in the morning (8 am –9 am) or afternoon (5 pm–6 pm).
- **Residents**: Park for 16 hours (overnight) and additional days, assume return home in the evening (5 pm—8 pm), and park until morning.
- **Workers** can park for 8 hours on workdays, from 8 am to 10 am.
- **Visitors** – park for 2 hours between 9 am and 9 pm.

The same charging strategies devised for the trial were used to simulate 250,000 charge events for each user profile, and the results were collated. The results of these simulations are detailed in Appendix 4J. However, Figure 4, below, showcases the Optimised Carbon Strategy's effectiveness across the four user types in reducing cost and emissions while delivering effective charge ratios for users.

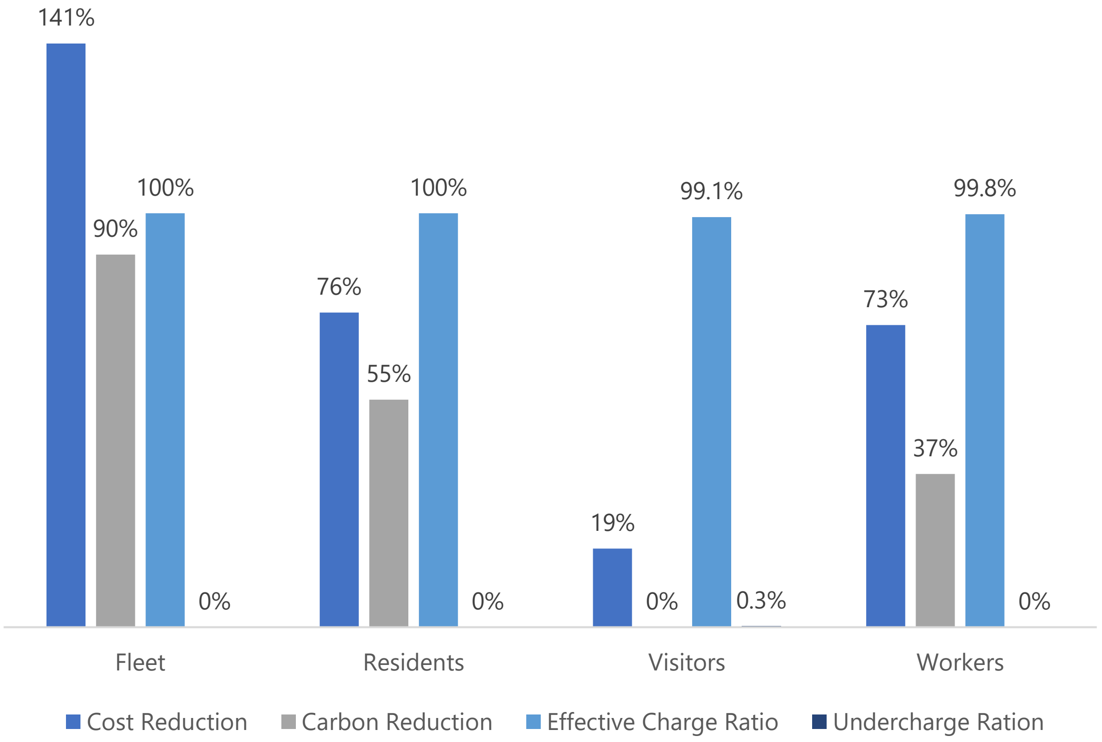


Figure 4: Summary of business case modelling for user types utilising Optimised carbon charge strategy

Key Takeaways from the charge strategy simulations:

- Optimised Carbon Strategy is highly effective across the four user types
- Significant cost and carbon reductions can be achieved without compromising user satisfaction
- Smart charging strategies like these can be expanded and replicated to enhance emissions

Recommendations for going forward

Based on the trial charge strategy simulation outcomes, it is feasible for similar smart charging initiatives to be continued and expanded across City of Adelaide's UPark facilities. Correct integration of technologies is essential for future success.

Further research and development can focus on refining charging strategies, incorporating advanced data analytics, and enhancing customer engagement to drive broader adoption and long-term sustainability.

The UPark Smart EV Fleet Charging Trial validated the proposed business model and showcased its replicability and scalability potential. Building on these successes and lessons, future initiatives can leverage smart charging technologies to achieve greater cost savings, operational efficiencies, and environmental benefits in the EV fleet management sector.

10. KEY LEARNINGS

Performance of hardware and software: the trial encountered significant challenges due to communication issues between hardware and software systems, particularly with the EV Link Smart Wallbox Chargers and Flow Power's kWatch Controller (demand management system). This resulted in the inability to trial charge strategies as planned. It highlights the critical importance of seamless integration and reliable communication in smart charging systems to achieve intended outcomes effectively.

Participants: the recruitment process for trial participants revealed insights into customer preferences and expectations. Customers preferred fixed-price products that simplified billing and administration, indicating the importance of offering attractive and convenient charging solutions to encourage adoption and satisfaction among users.

Data (post-trial charging strategy simulation): the post-trial charging strategy simulation demonstrated the significant impact of different charge strategies on cost reduction, carbon emissions, and user satisfaction. Strategies with 1-hour minimum charge and carbon intensity signalling showed greater effectiveness in achieving cost and carbon reduction goals while maintaining high user satisfaction levels.

Business model (revenue generation and savings): the trial's fixed-price product structure aligned with wholesale energy pricing and aimed to simplify billing for customers, reducing administrative complexity and costs. This approach, retrospectively, proved beneficial for businesses, offering a predictable operating cost for EV fleets and facilitating accurate expense forecasting.

Business model (replicability and scalability): the trial's success in retrospectively demonstrating cost savings, reducing administrative complexities, and providing clear value propositions for customers indicates its scalability and replicability potential. The business model's adaptability to different user types and real-time pricing signals demonstrates its potential for broader adoption and long-term sustainability in EV fleet management.

These learnings underscore the importance of seamless technology integration, customer-centric approaches, data-driven decision-making, and scalable business models in implementing successful smart charging initiatives.

11. CONCLUSION

The UPark EV Fleet Smart Charging Trial conducted in partnership with the Department of Energy and Mining and the City of Adelaide has yielded valuable insights and learnings for the future of smart charging initiatives.

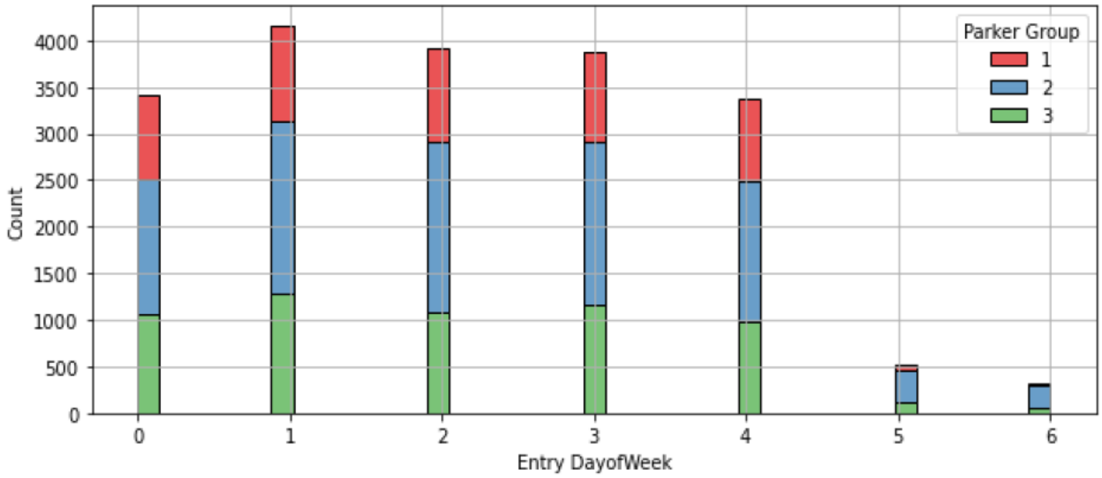
Despite encountering challenges in hardware and software integration, the trial successfully demonstrated the potential for significant cost and carbon reduction through optimised charge strategies. Communications issues arising in the EV Link Smart Wallbox Chargers highlighted the critical importance of seamless technology integration for effective smart charging operations.

The trial's findings underscored the importance of customer-centric approaches, fixed-price products, and real-time pricing signals in driving adoption and satisfaction among users. The business model's scalability and replicability potential were evident through retrospective analysis, showcasing opportunities for broader implementation across City of Adelaide UPark facilities. Moving forward, further research and development efforts can focus on refining charging strategies, enhancing data analytics, and improving customer engagement to maximise the long-term sustainability and benefits of smart charging solutions.

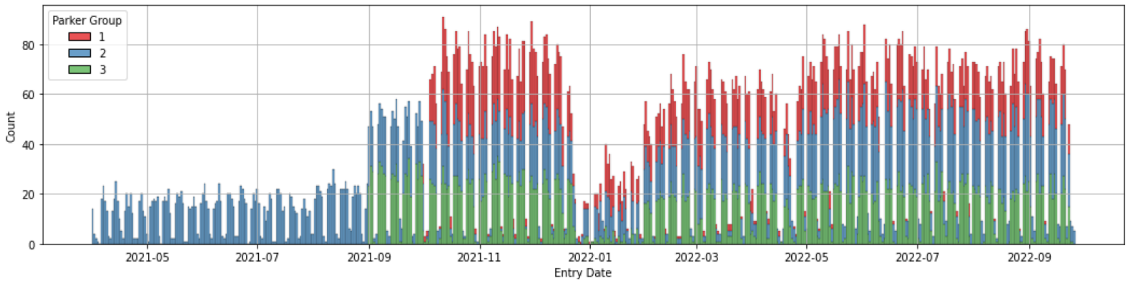
Figure 6: City of Adelaide fleet vehicle charging during the trial period

APPENDICES – (CONFIDENTIAL)

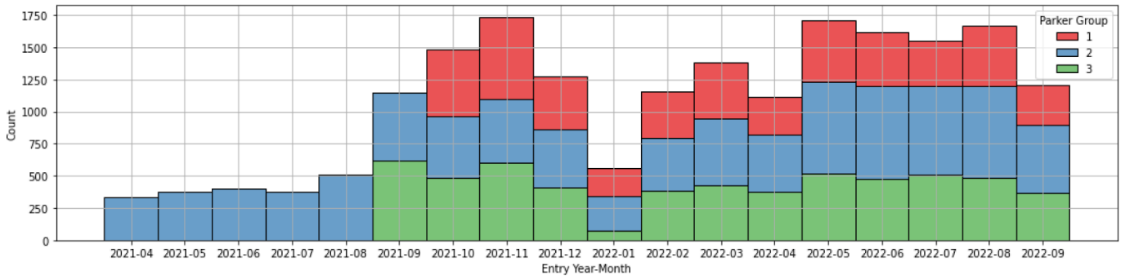
Appendix 1 – Pre-trial parking data from Wyatt and Topham Mall UParks (confidential)



Appendix 1A: UPark customer entry counts by day of week by parker group

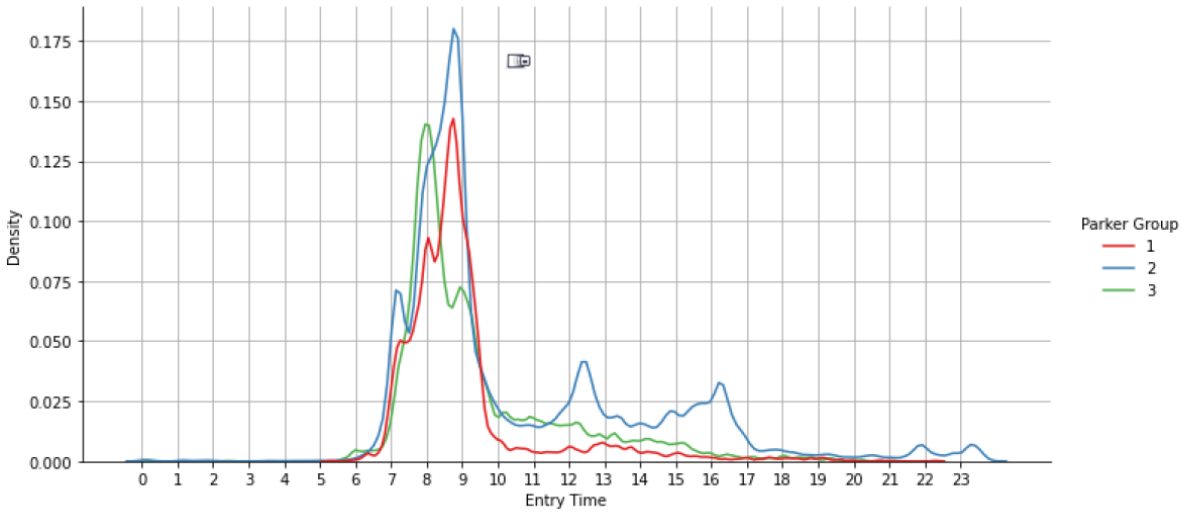


Appendix 1B: UPark customer daily counts of parker entry by parker group

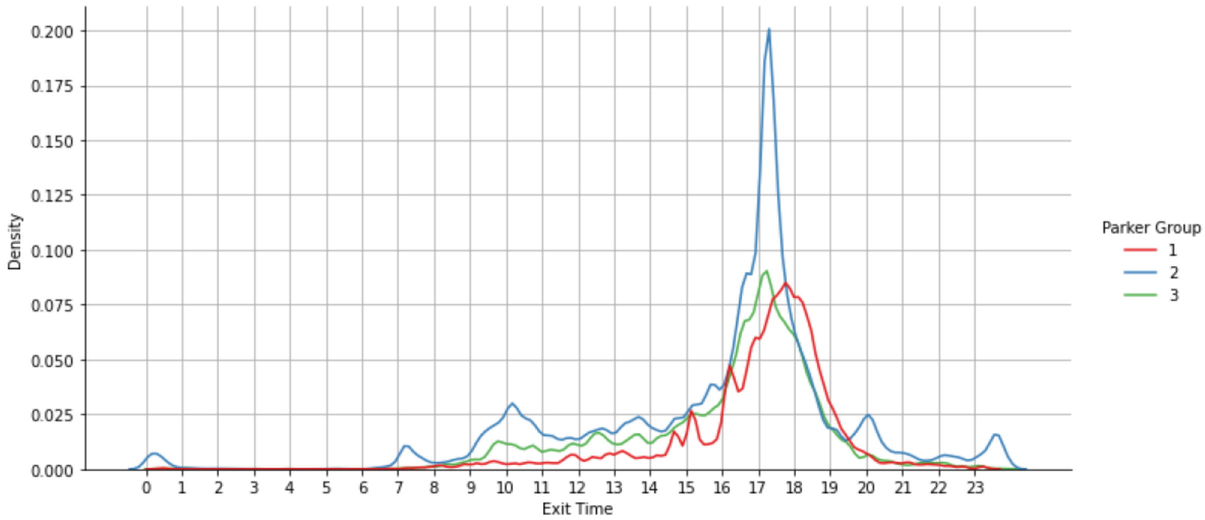


Appendix 1C: UPark customer monthly counts of entry by parker group

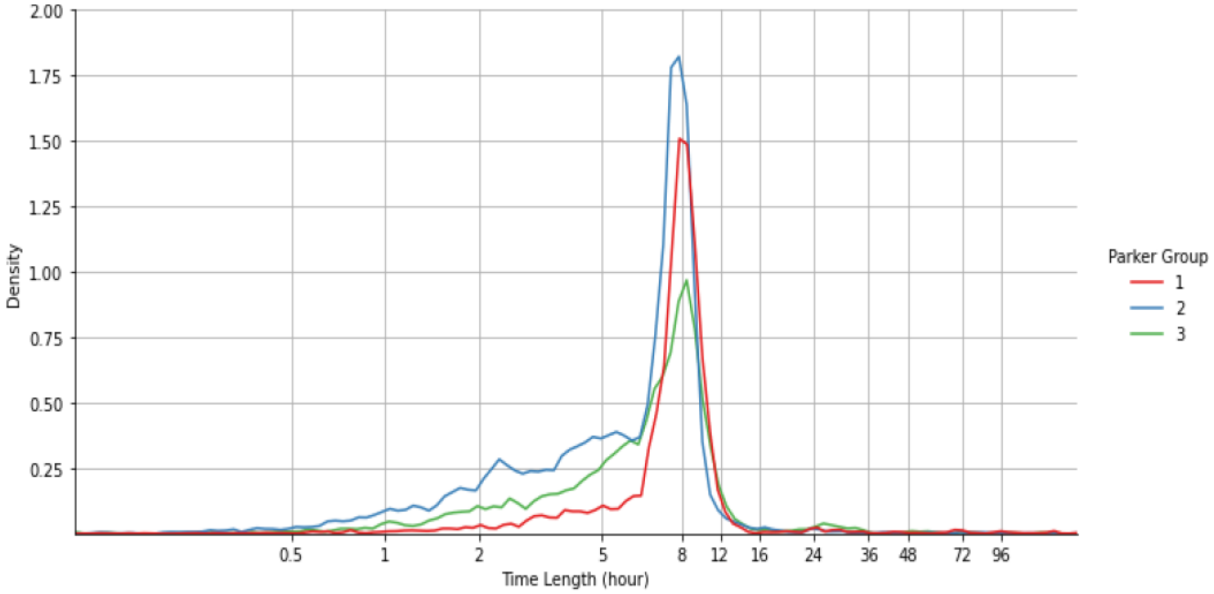
As



Appendix 1D: UPark customer entry time by parker group



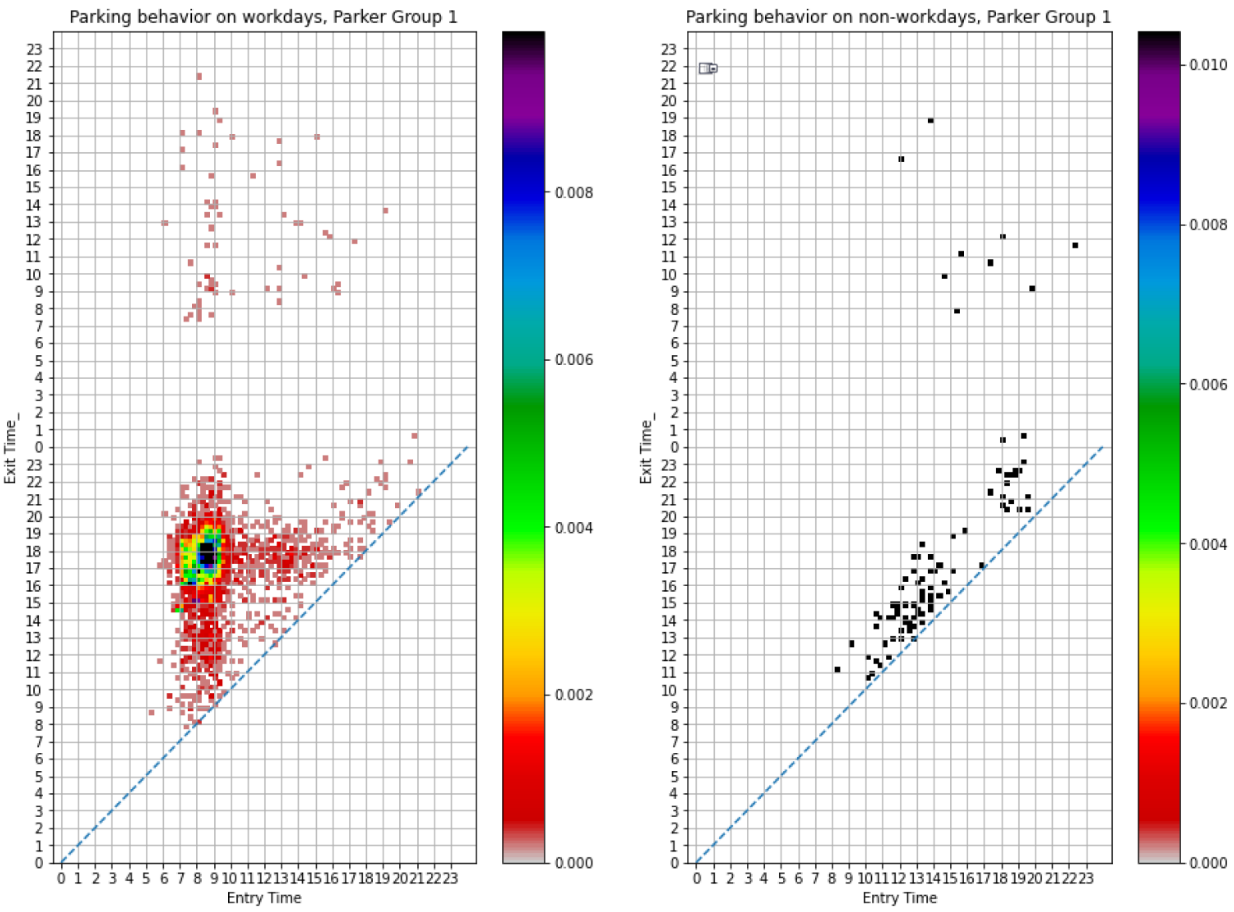
Appendix 1E: UPark customer exit time by parker group



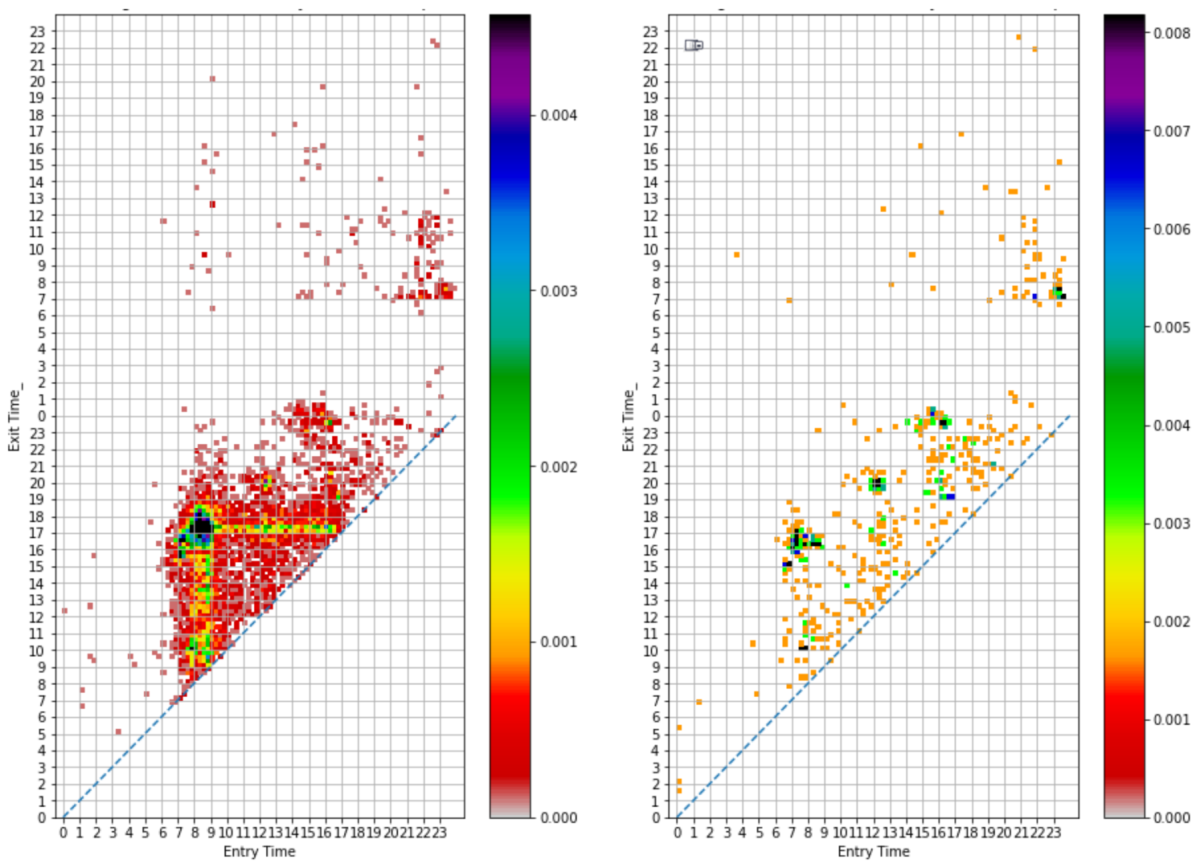
Appendix 1F: UPark customer length of time parked by parker group

Group	count	mean	std	min	2%	5%	10%	15%	25%	50%	75%	90%	95%	99%	max
1	4905	10.42	28.46	0.02	1.60	2.95	4.35	5.95	7.58	8.87	9.73	10.75	11.63	67.40	1336.7
2	8963	7.03	22.74	0.00	0.58	1.03	1.68	2.23	3.40	7.18	8.75	9.58	10.17	17.14	1634.0
3	5735	8.28	46.47	0.03	0.89	1.52	2.22	3.02	4.53	7.47	9.35	10.72	12.12	31.43	3480.6

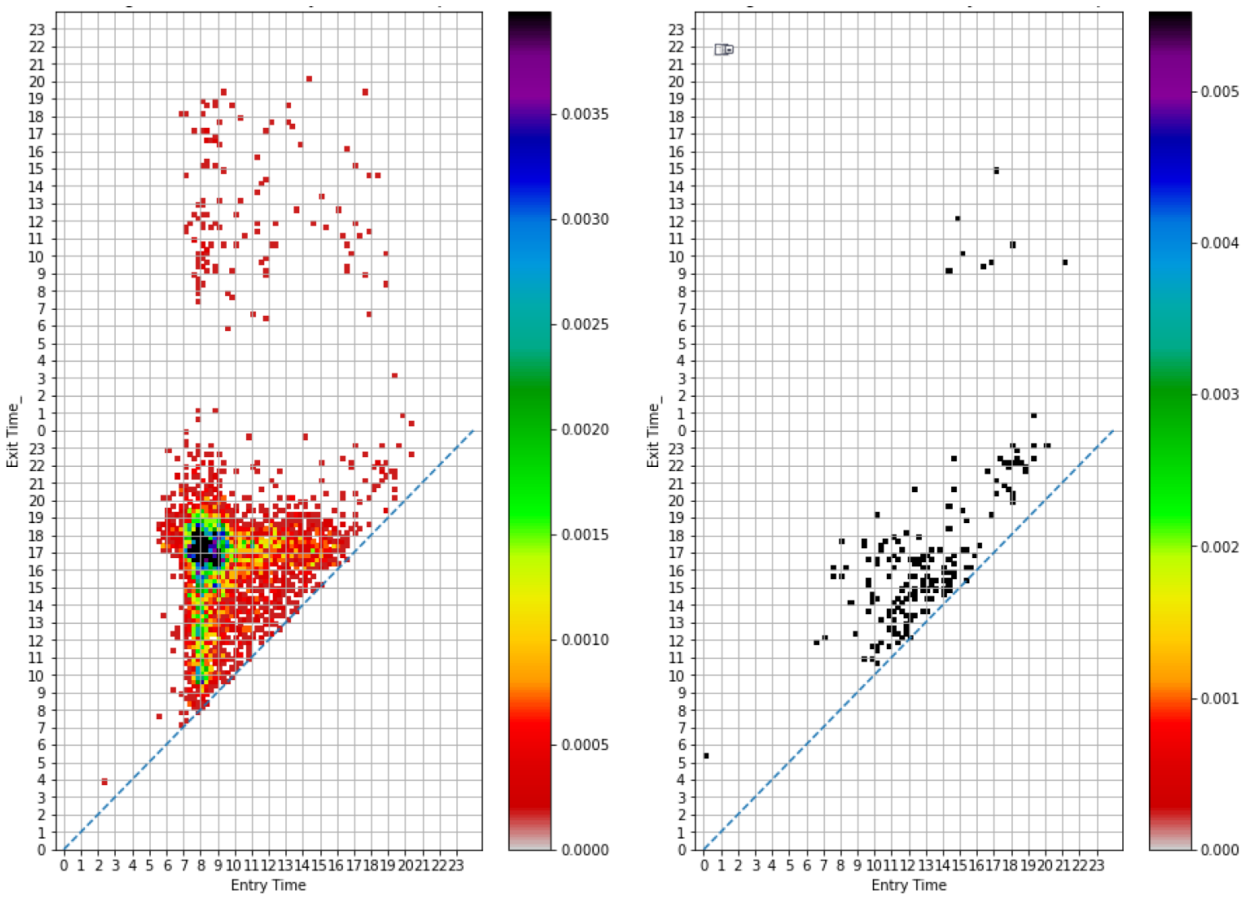
Appendix 1G:UPark customer parking time length (hour) percentiles



Appendix 1H: UPark customer parker Group 1 - parking behaviour on weekdays (left) and weekends (right)



Appendix 1I: UPark customer parker Group 2 - parking behaviour on weekdays (left) and weekends (right)



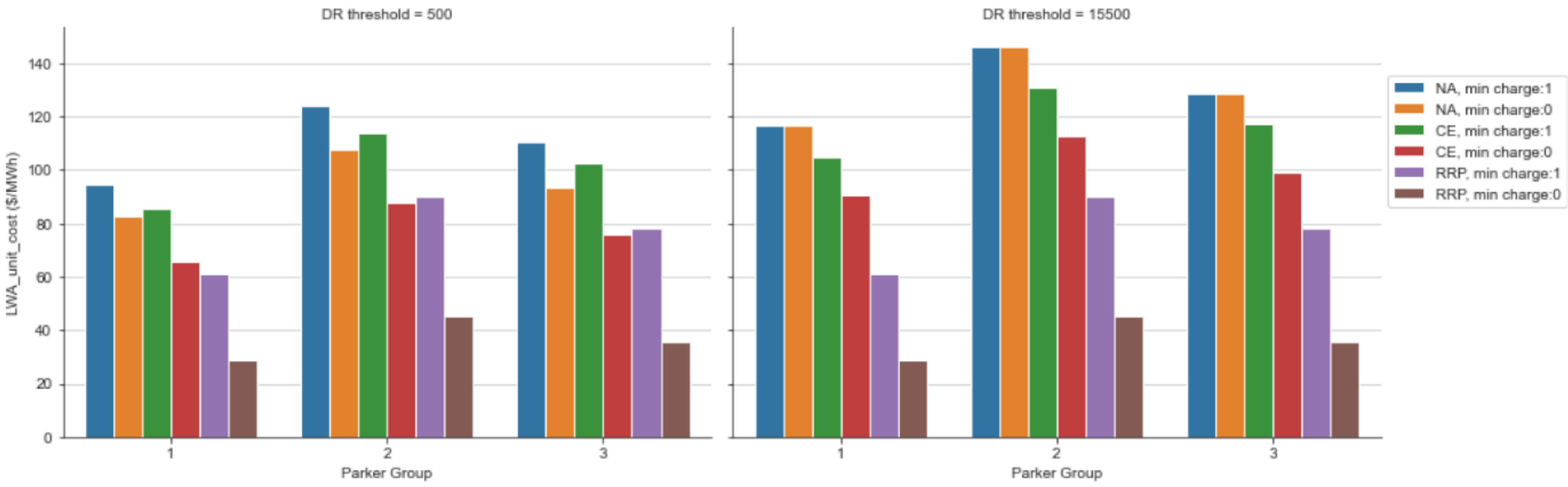
Appendix 1J: UPark customer parker Group 3 - parking behaviour on weekdays (left) and weekends (right)

Appendix 2 – Pre-trial charging strategy simulation results (confidential)

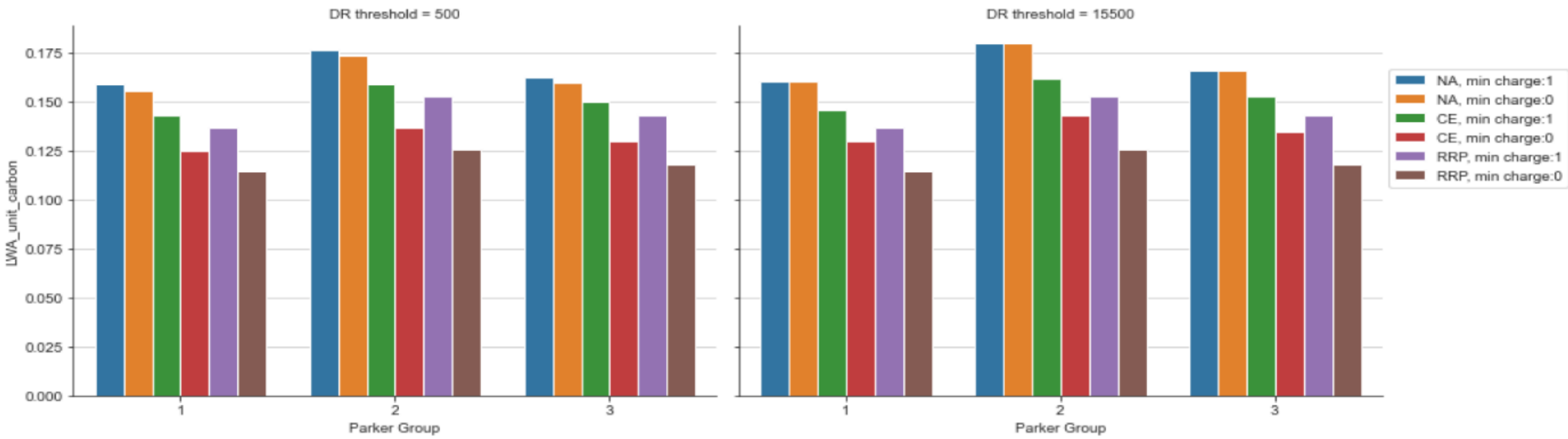
The following terms refer to:

- N/A, min charge:1 is BAU with 1 hour guaranteed
- N/A, min charge: 0 is BAU with 0 hour guaranteed
- CE, min charge: 1 is Carbon Intensity Signalled with 1 hour guaranteed
- CE, min charge: 0 is Carbon Intensity Signalled with 0 hour guaranteed
- RRP, min charge: 1 is RRP Signalled with 1 hour guaranteed
- RRP, min charge: 0 is RRP Signalled with 0 hour guaranteed

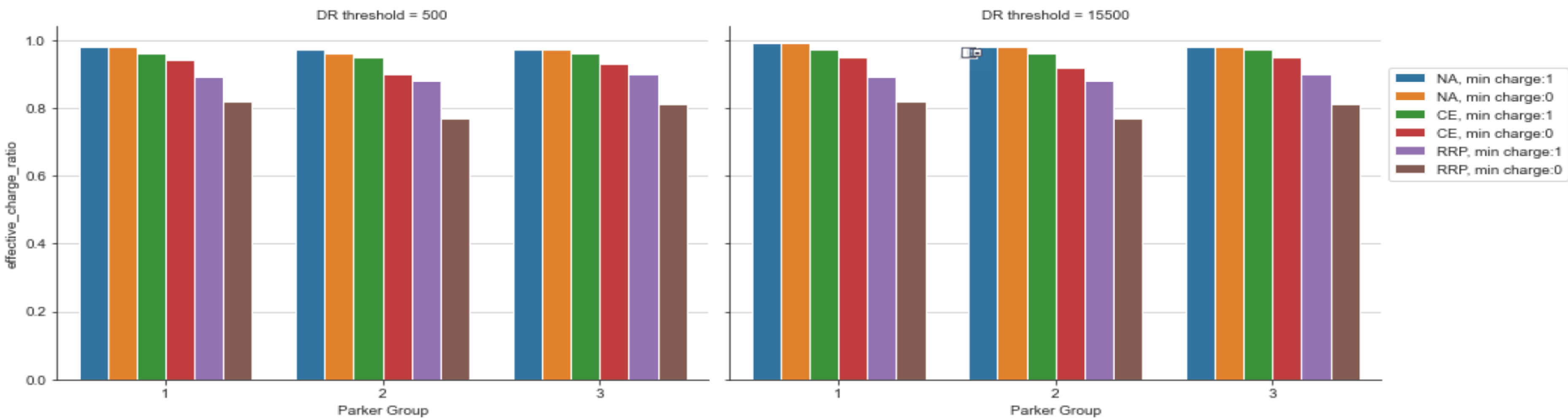
Note that N/A refers to a simple demand response at the specified DR threshold.



Appendix 2A: cost ($/mwh) by charging strategy



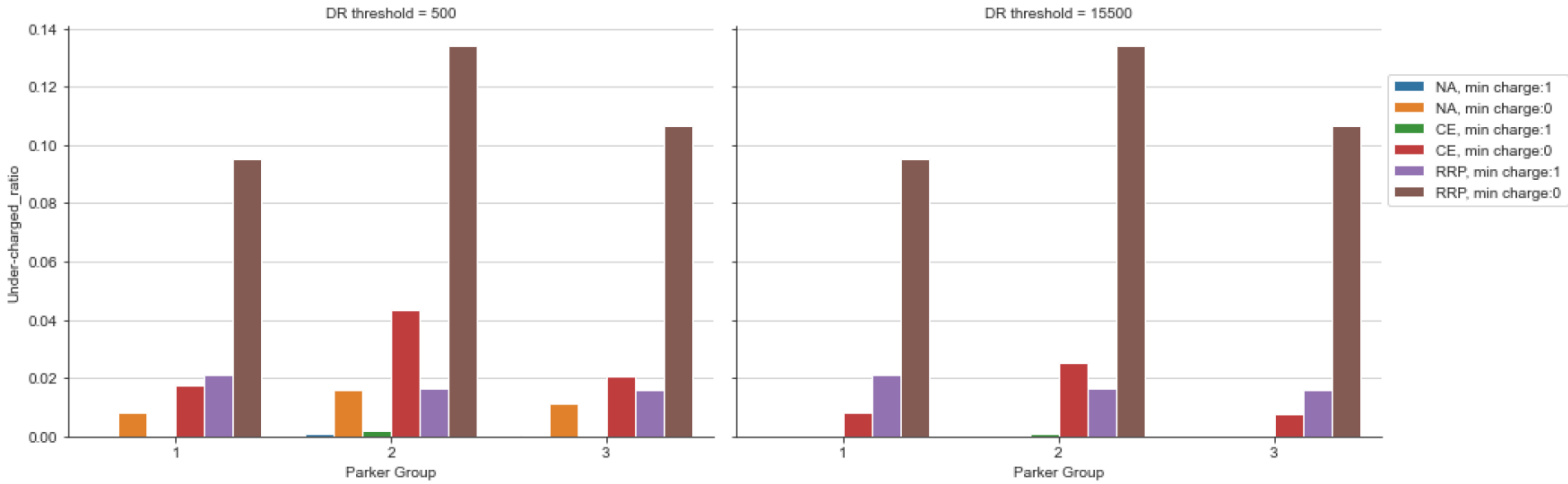
Appendix 2B: carbon intensity (load weighted average) by charging strategy



Appendix 2C: effective charge ratio (actual charge volume / required capacity) by charging strategy

Appendix 2C simulation is based on the required capacity, which refers to a delivered charge of 28kWh per session.

- Effective charge is the ratio of actual charge volume / 28kWh.
- Undercharged is when less than 25% of 28kWh is delivered in a session.

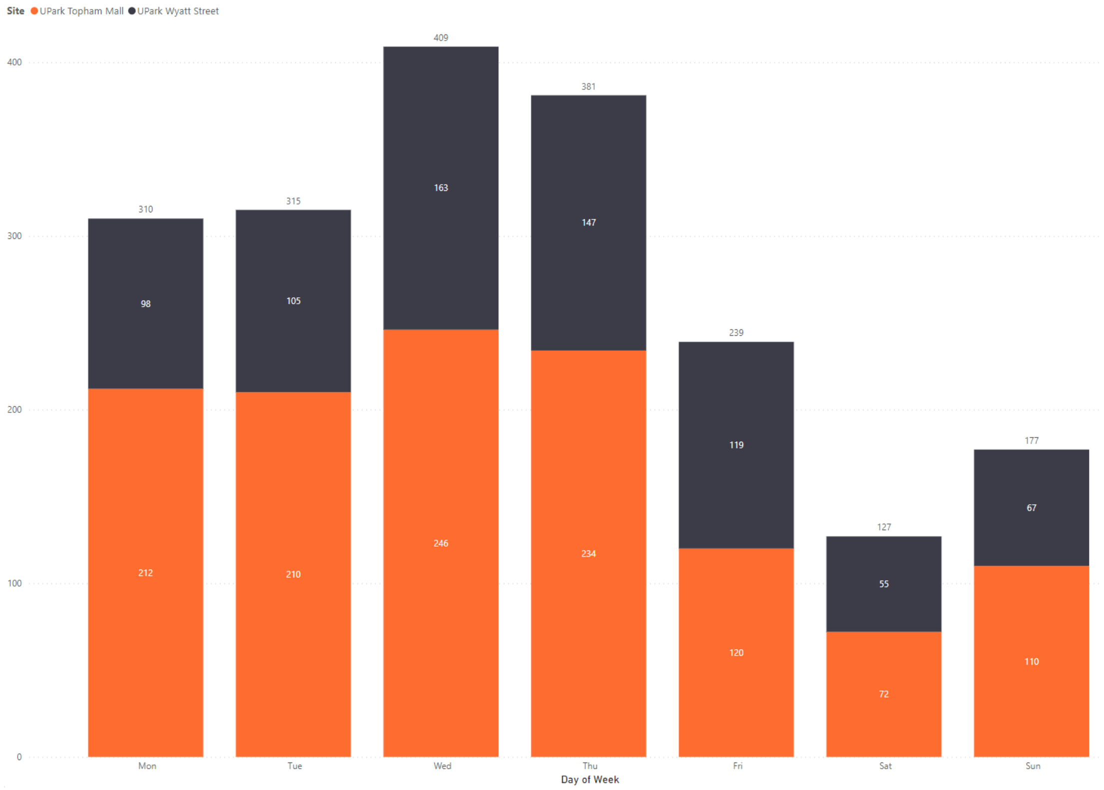


Appendix 2D: under-charge ratio by charging strategy

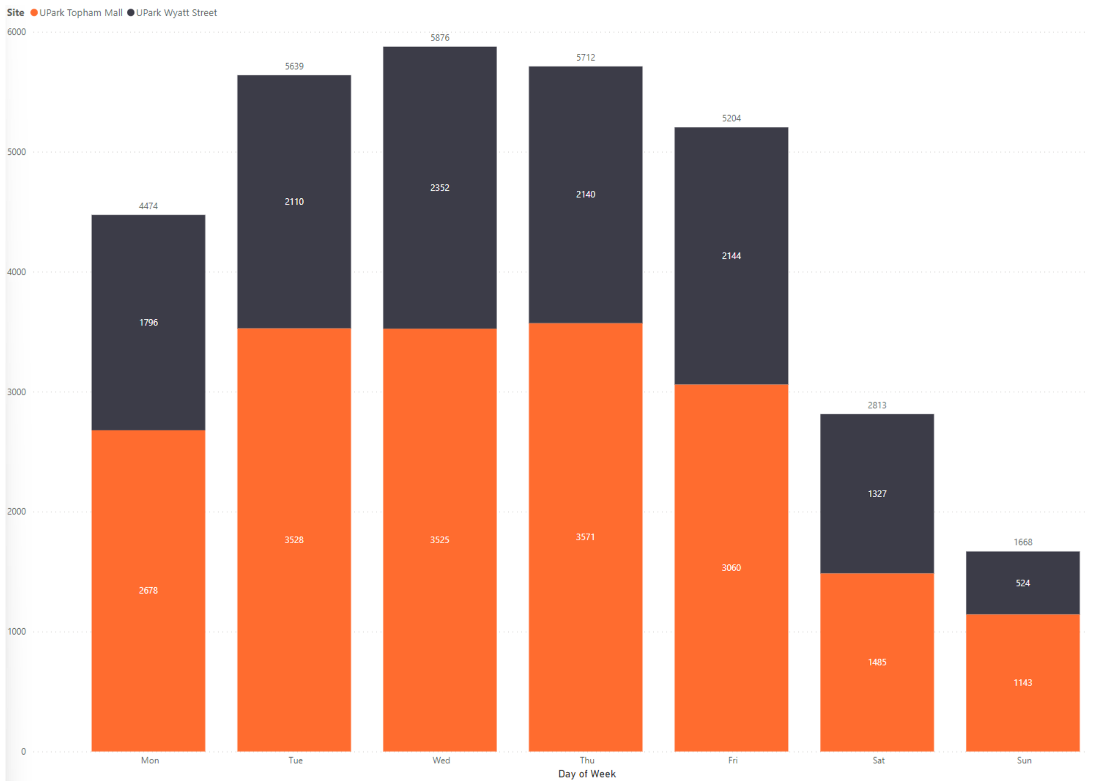
Appendix 2D simulation is based on the required capacity refers to a delivered charge of 28kWh per session.

- Effective charge is the ratio of actual charge volume / 28kWh.
- Undercharged is when less than 25% of 28kWh is delivered in a session.

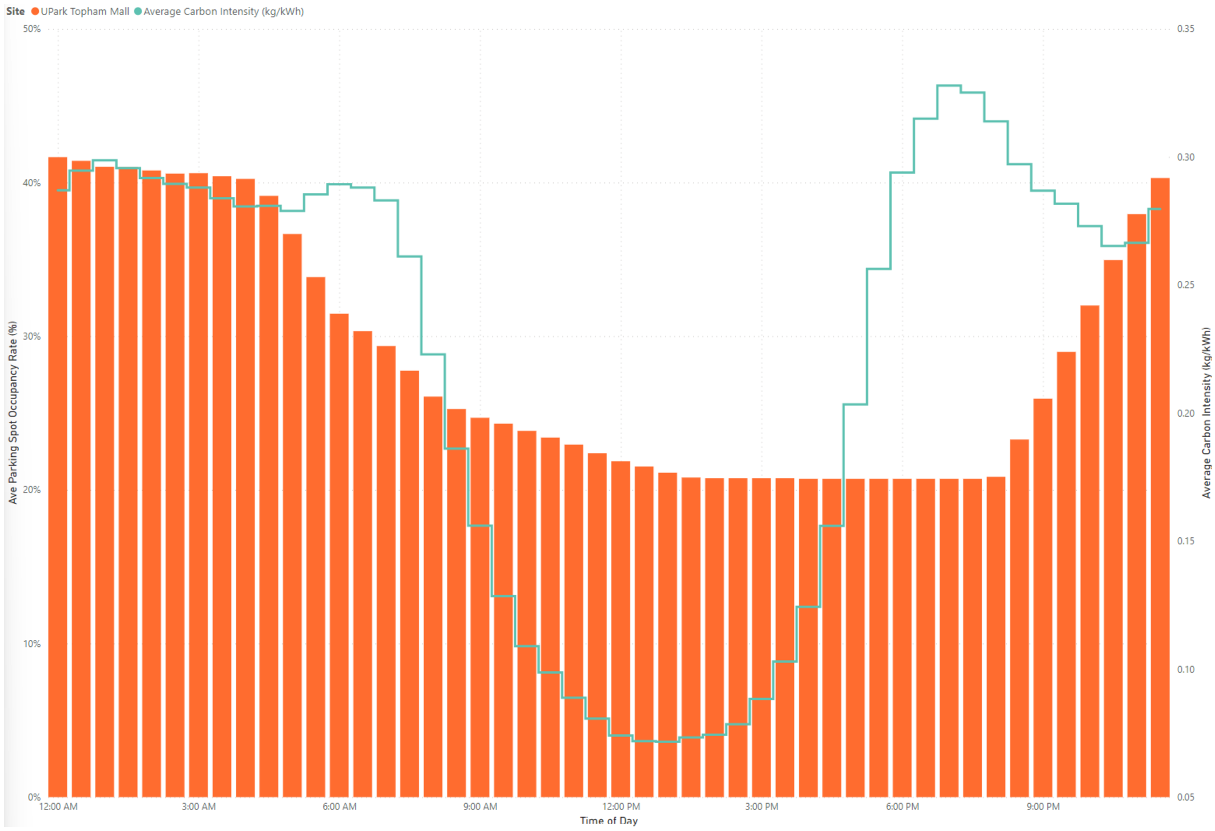
Appendix 3: Post-trial retrospective simulations between 1 February 2023 to 1 March 2024 (confidential)



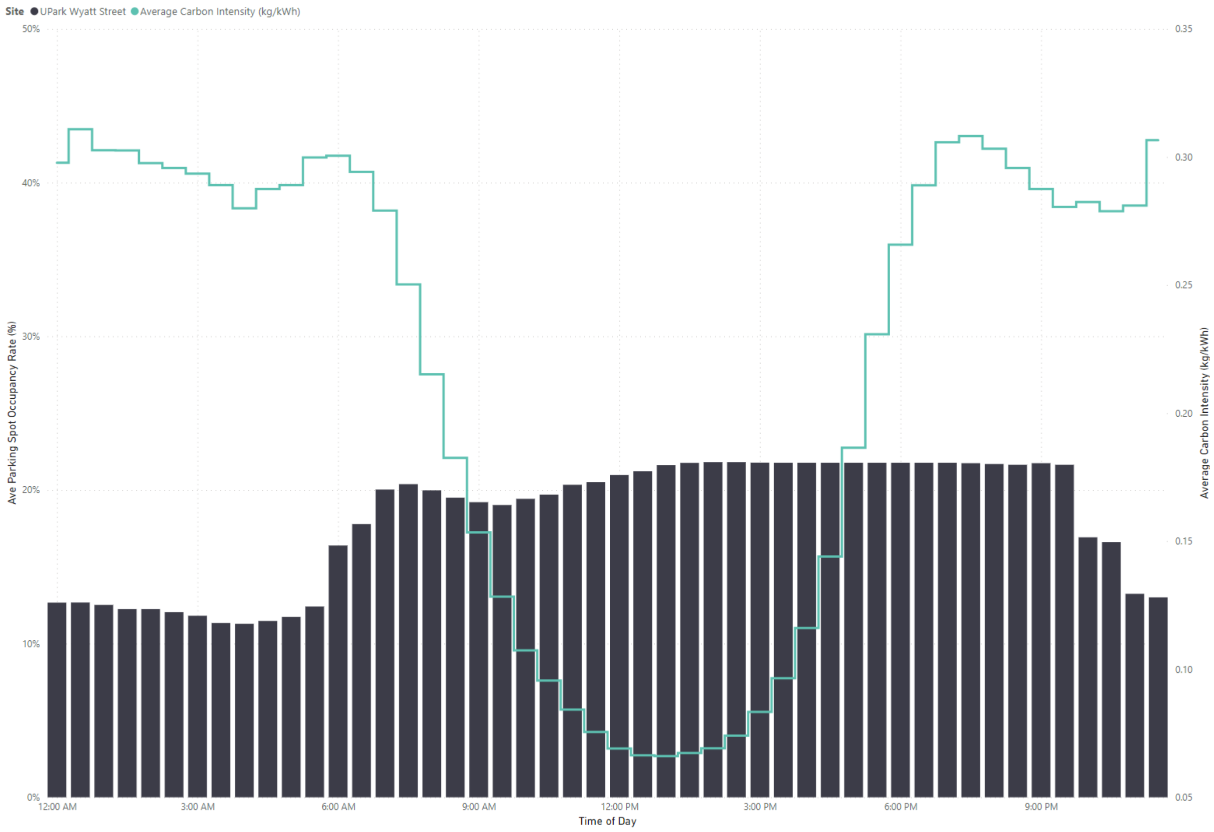
Appendix 3A: UPark customer counts of parking events



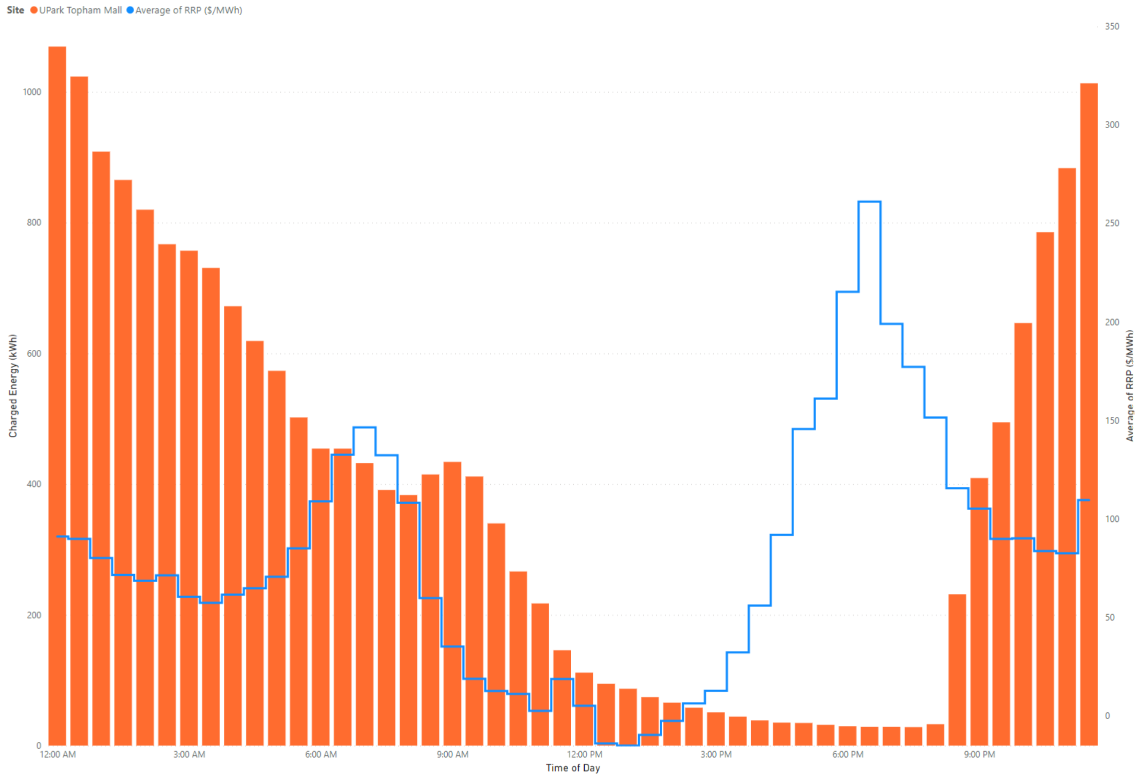
Appendix 3B: UPark customer charged energy (kWh)



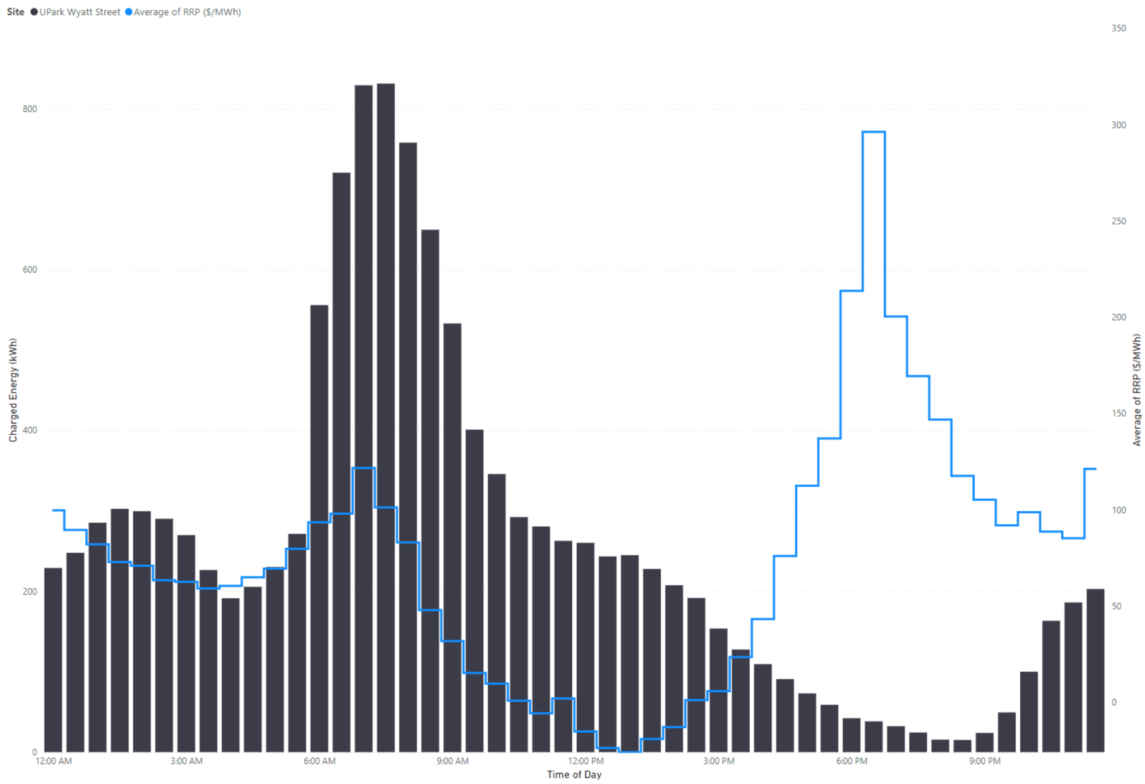
Appendix 3C: Topham Mall UPark customer parking space occupancy and carbon intensity



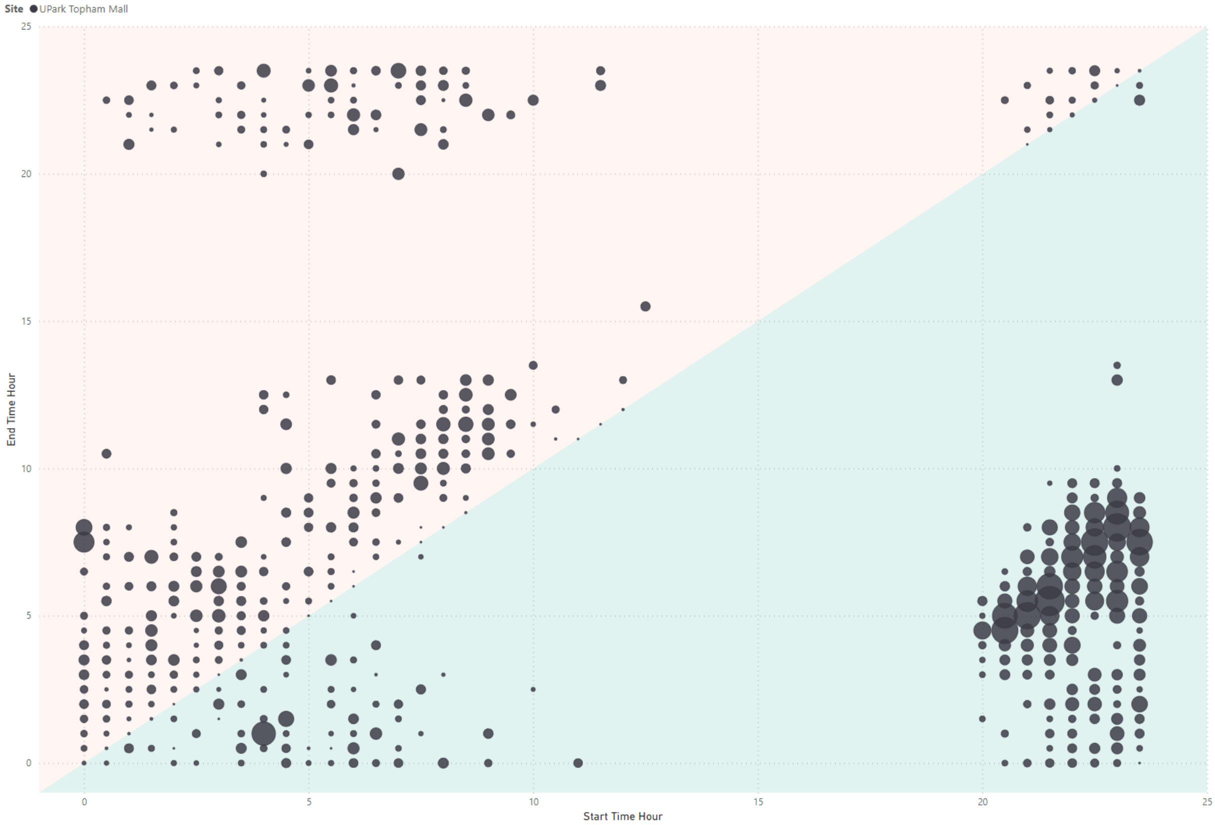
Appendix 3D: Wyatt UPark customer parking space occupancy and carbon intensity



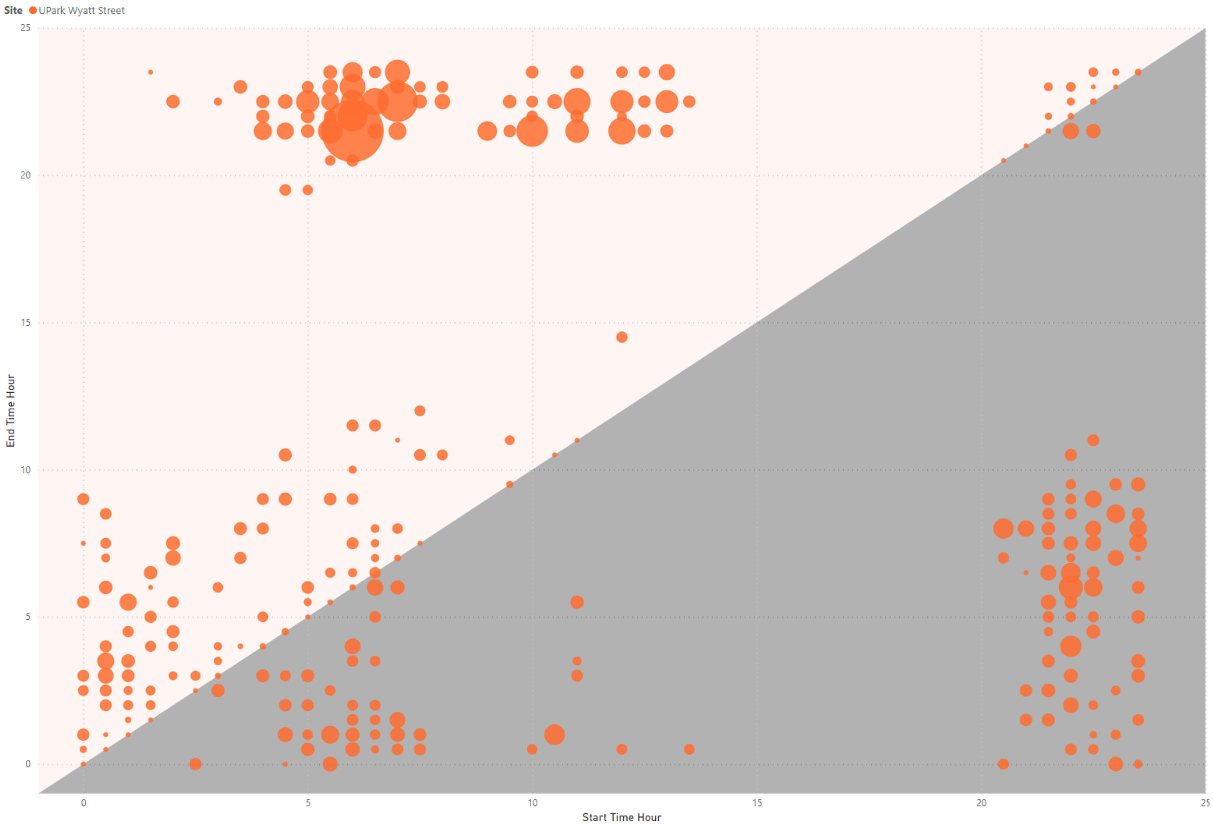
Appendix 3E: Topham Mall UPark customer charged energy (kWh)



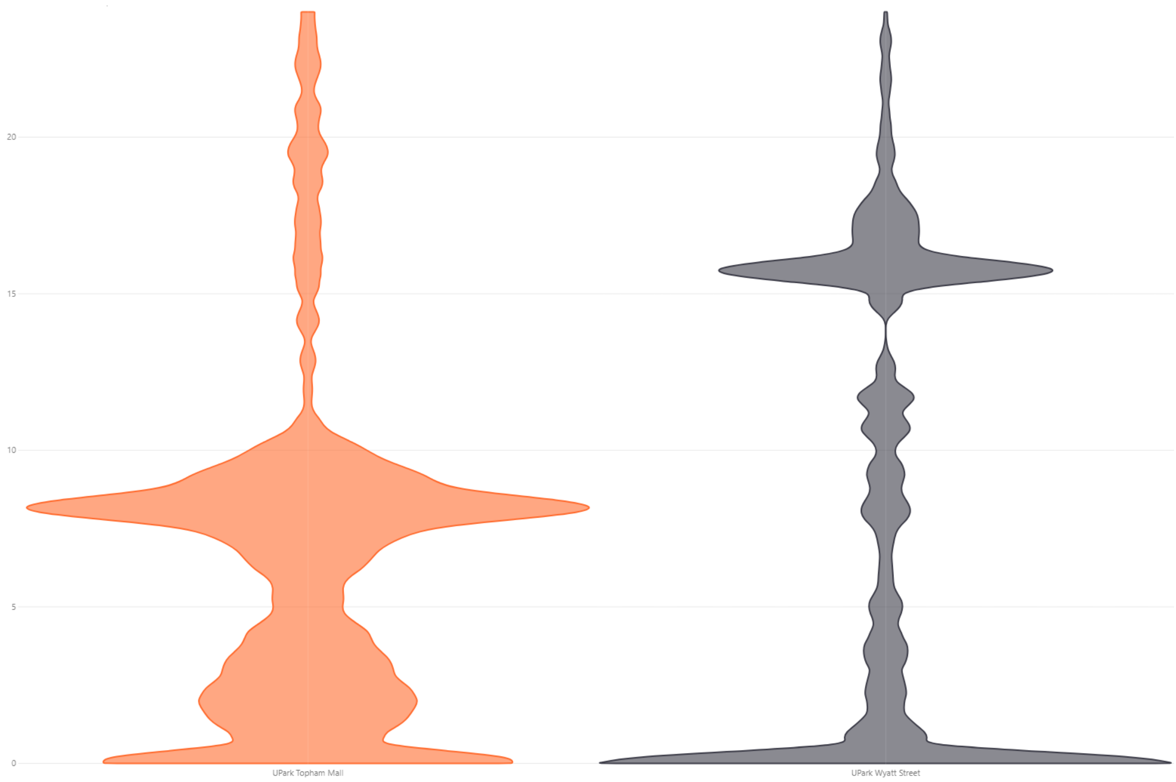
Appendix 3F: Wyatt UPark customer charged energy (kWh)



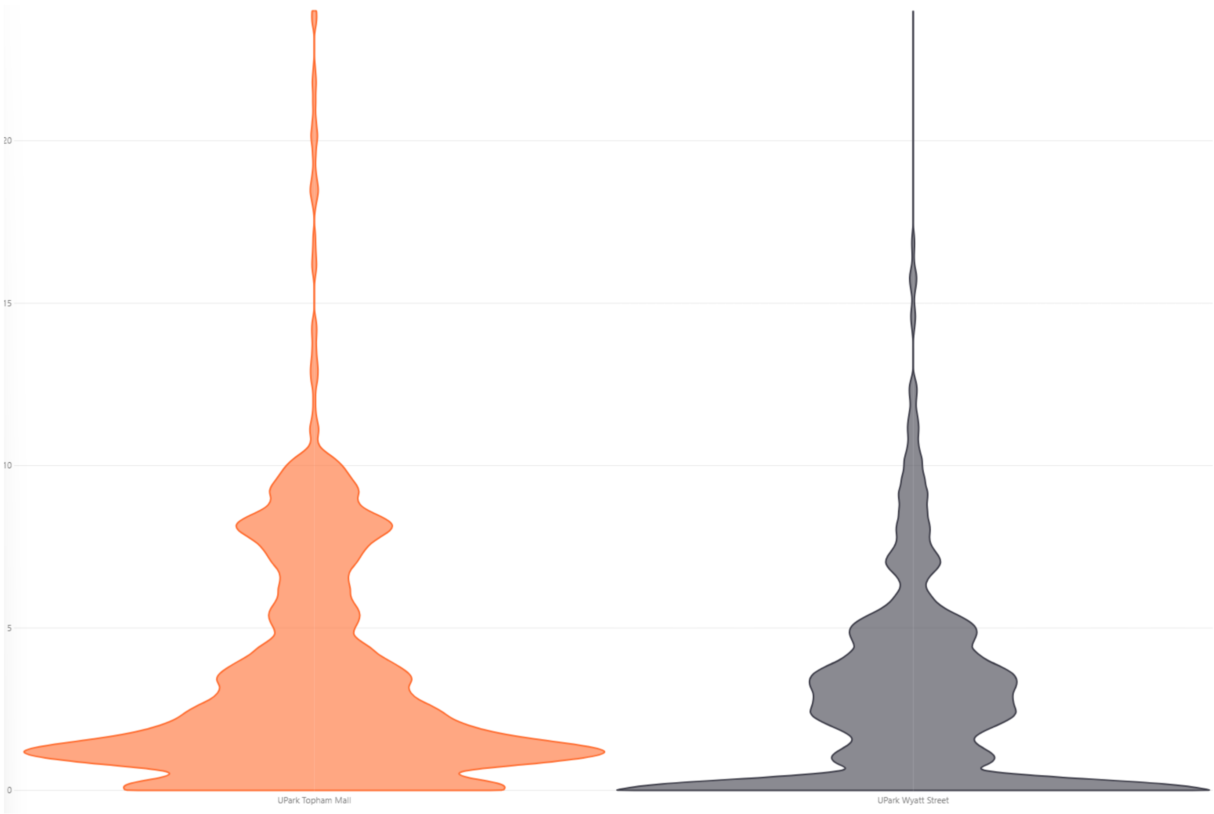
Appendix 3G: Topham Mall UPark customer parking start/end time and charging energy distribution



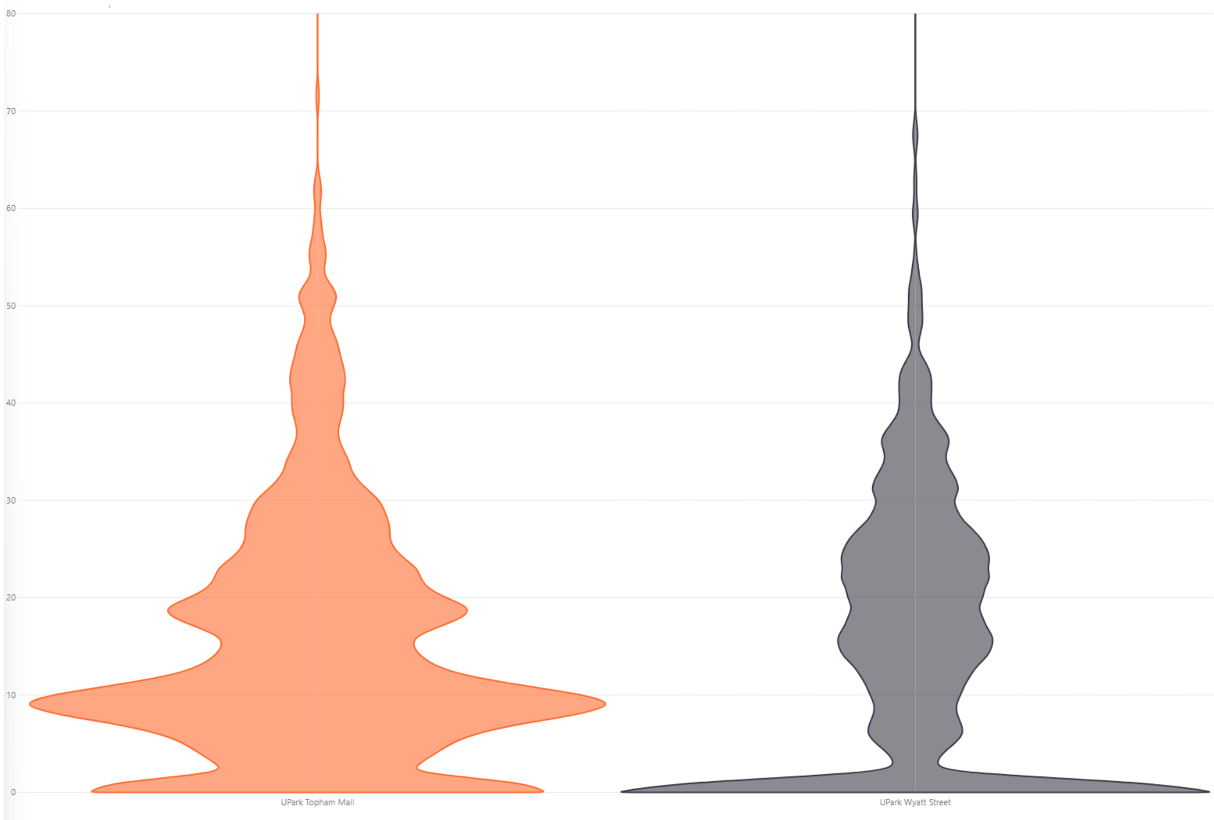
Appendix 3H: Wyatt UPark customer parking start/end time and charging energy distribution



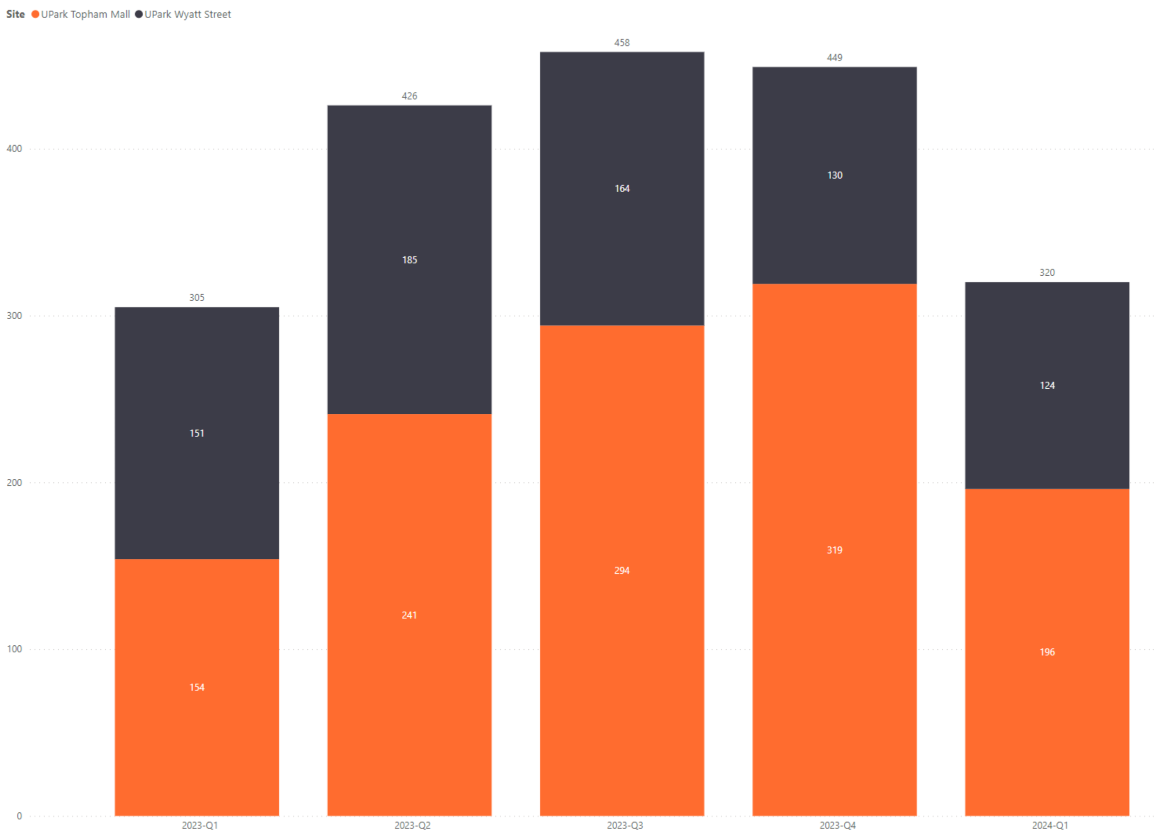
Appendix 3I: Topham Mall (left) and Wyatt (right) UPark customer parking time length distribution (hour)



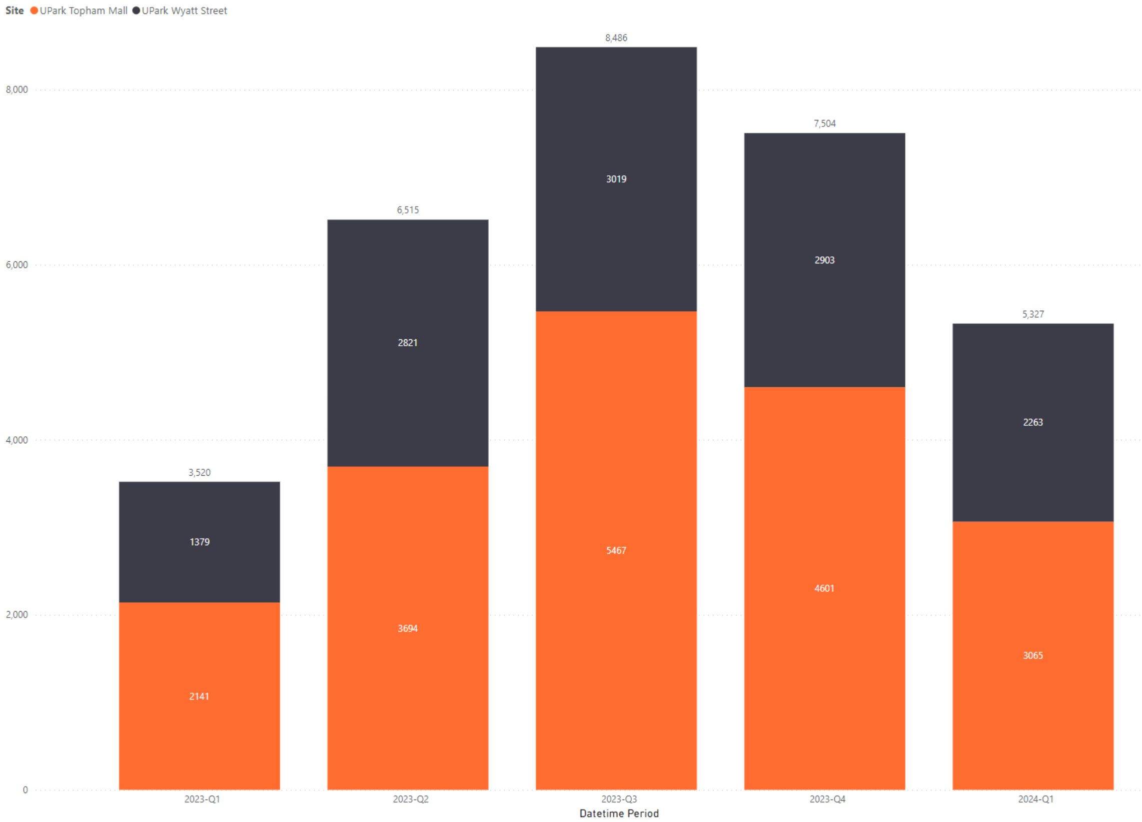
Appendix 3J: Topham Mall (left) and Wyatt (right) UPark customer charging time length distribution (hour)



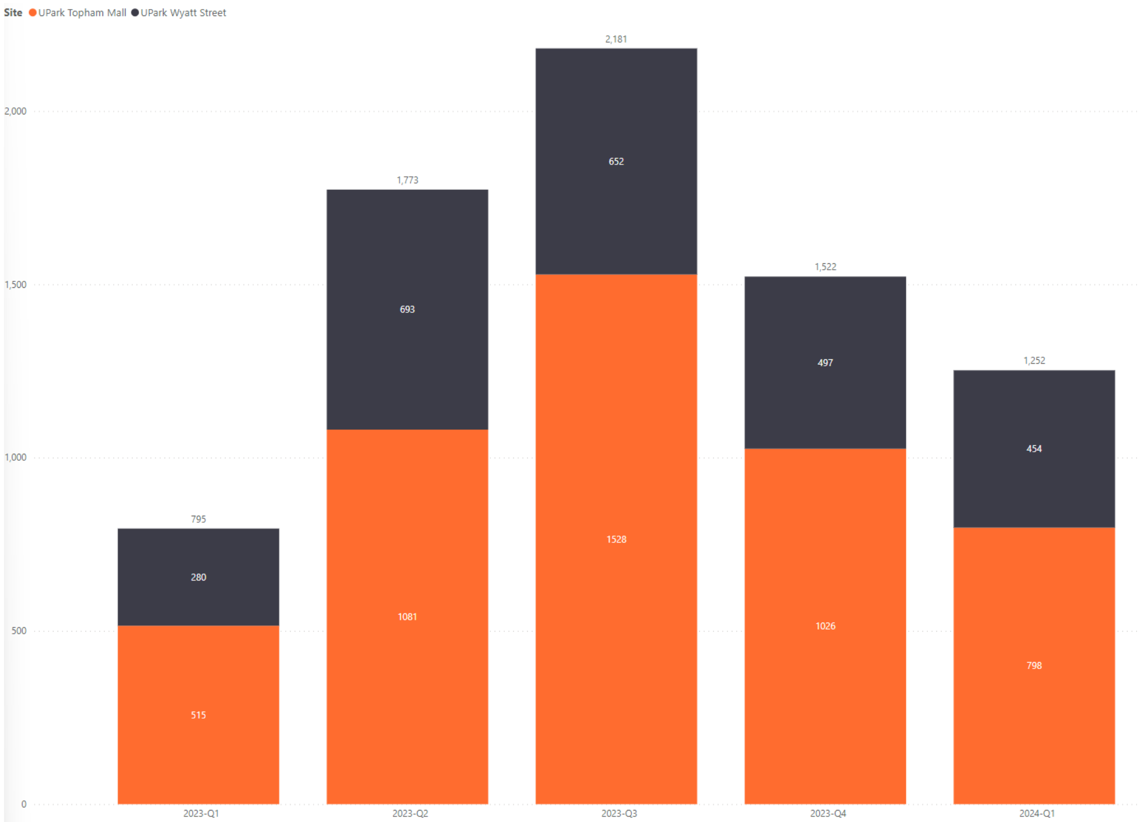
Appendix 3K: Topham Mall (left) and Wyatt (right) UPark customer charging energy distribution (hour)



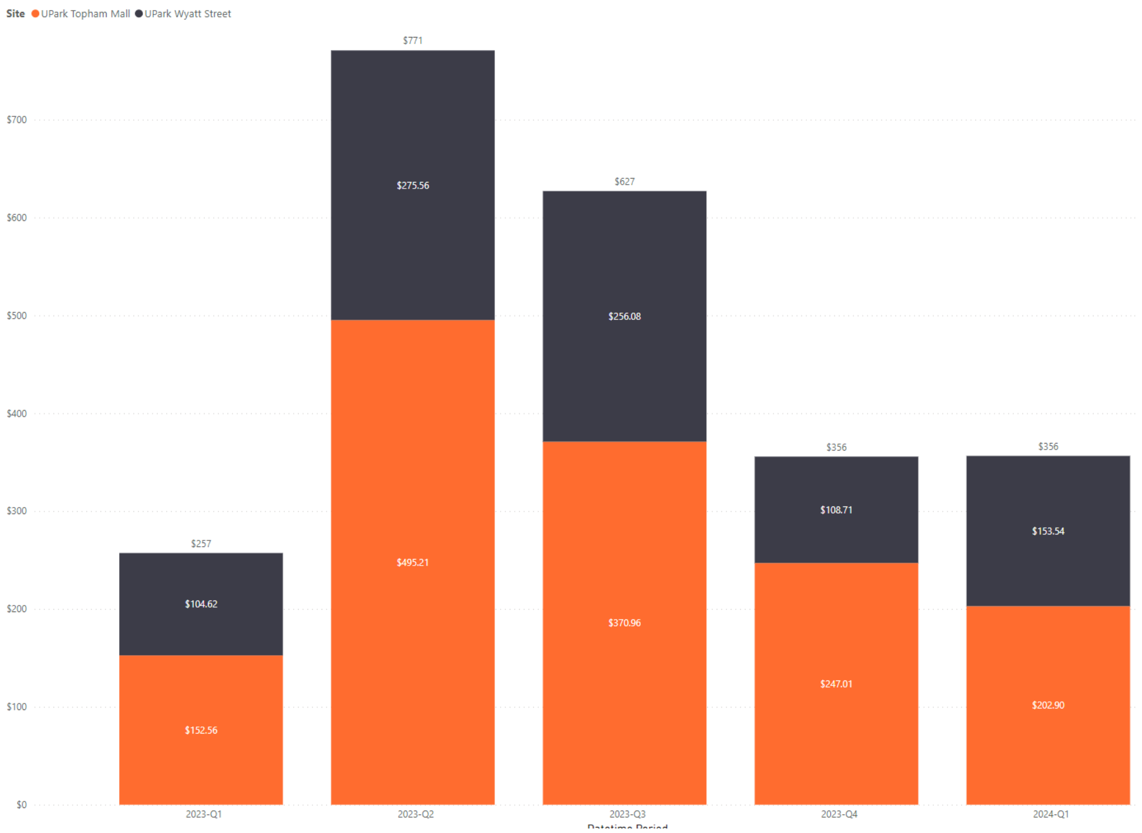
Appendix 3L: UPark customer parking events



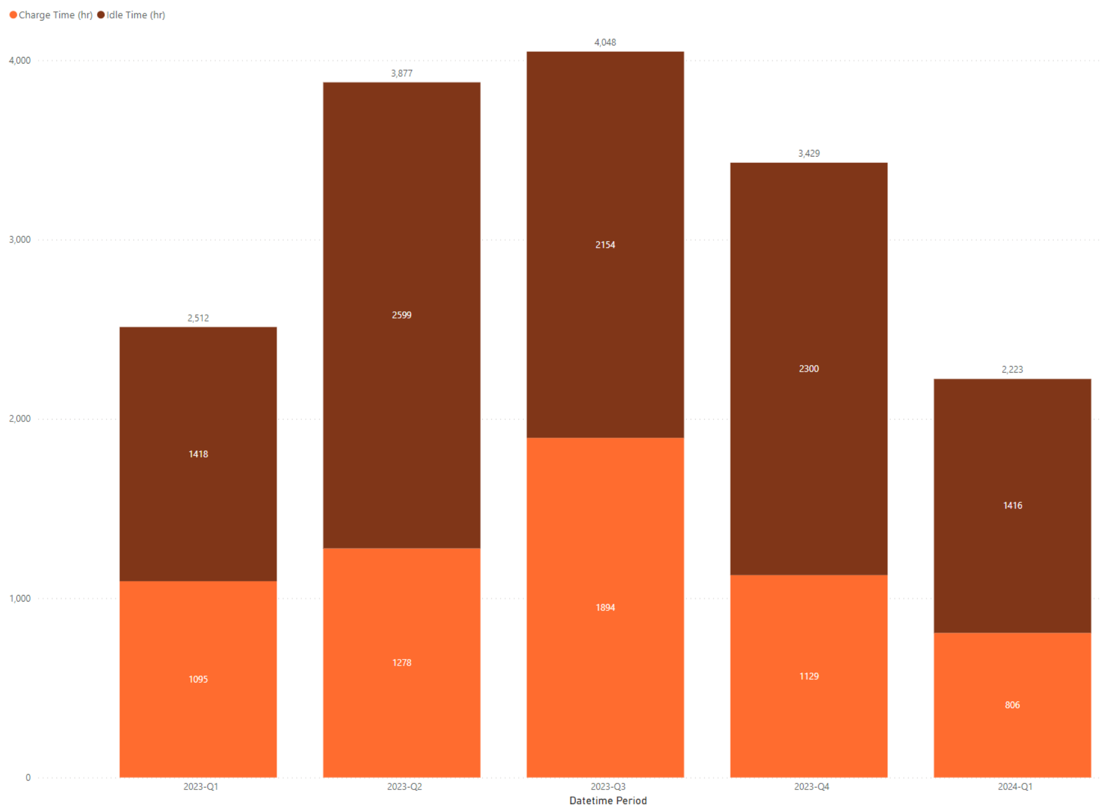
Appendix 3M: UPark customer charge energy (kWh)



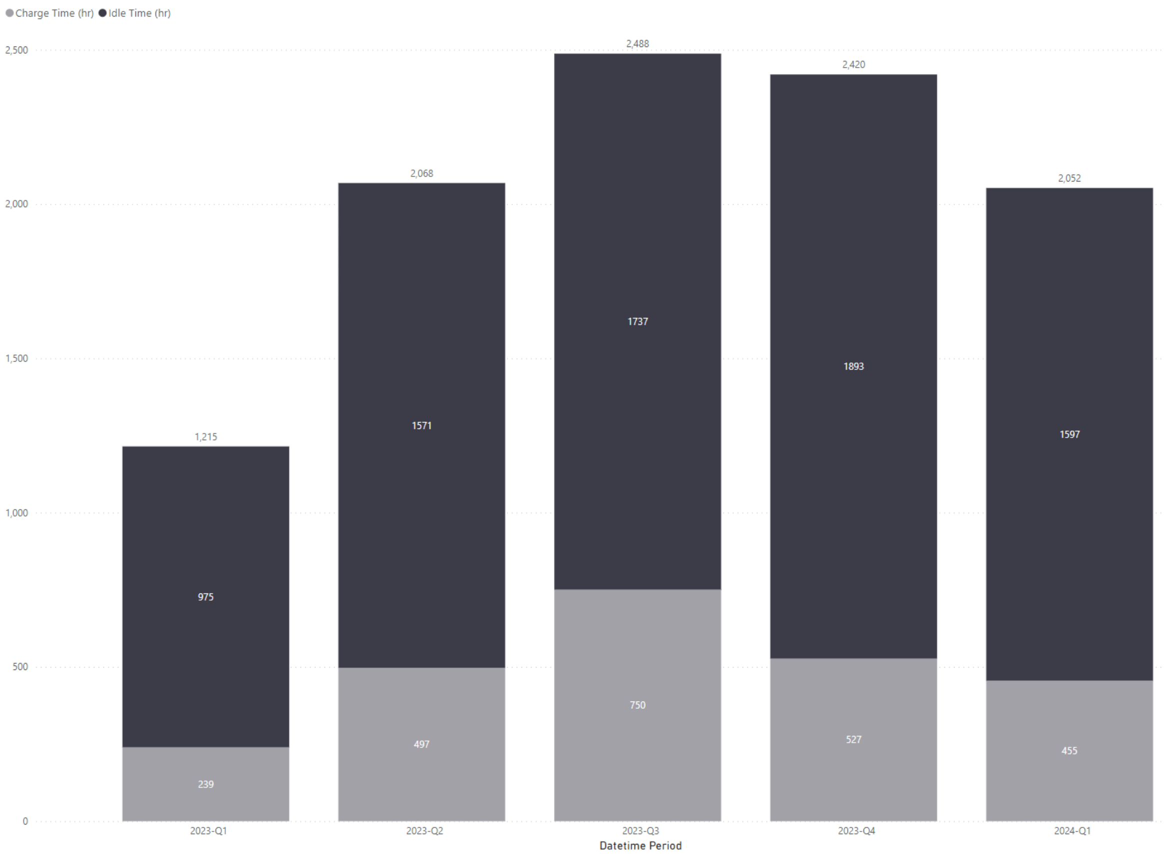
Appendix 3N: UPark customer carbon emissions (kg)



Appendix 3O: UPark customer charging cost ($)



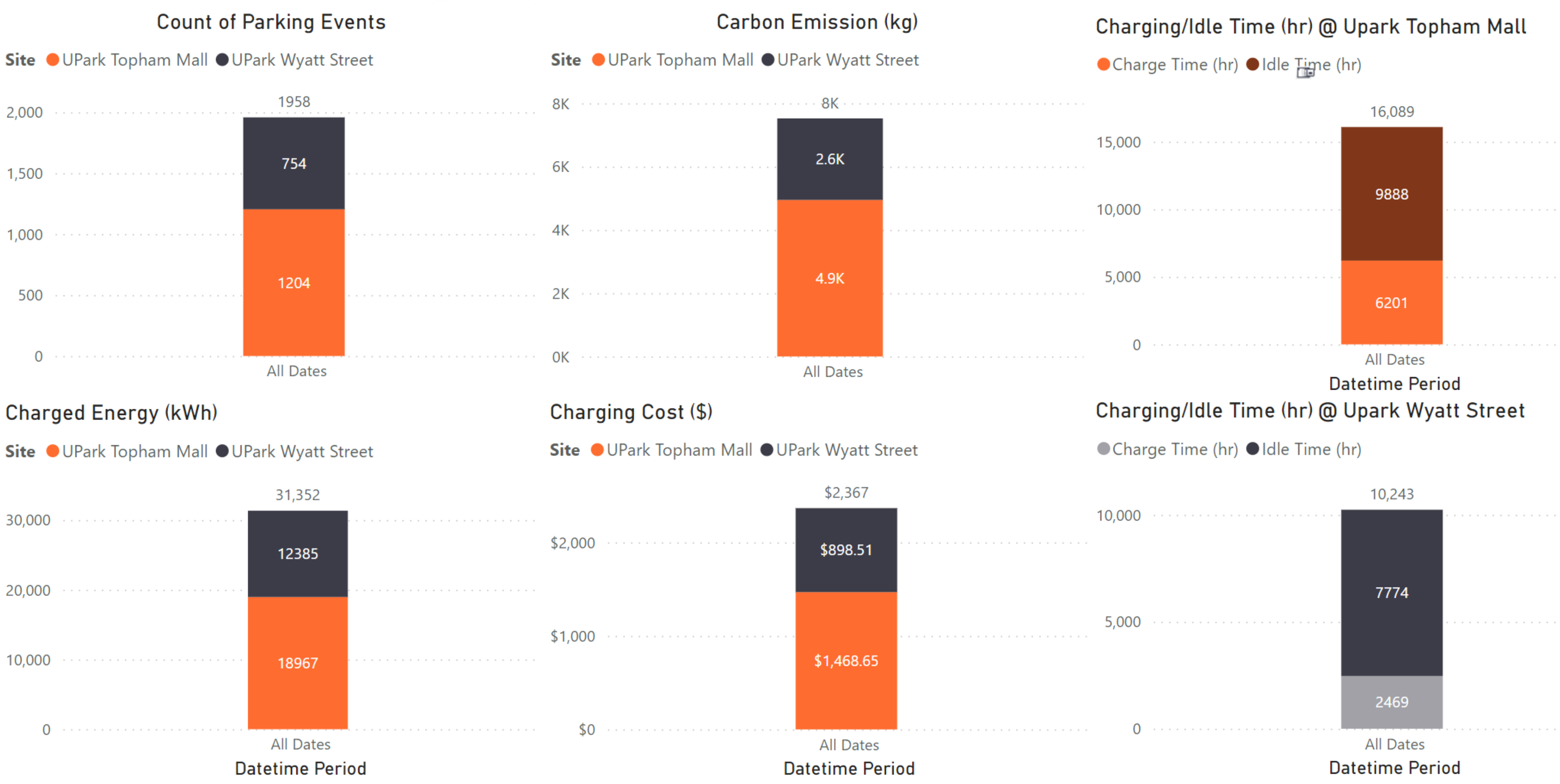
Appendix 3P: Topham Mall UPark customer charging verse ideal time (hours)



Appendix 3Q: Wyatt UPark customer charging verse ideal time (hours)

Site	Counts of Parking Events	Counts of Charging Events	Fully Charged Events (%)	Charged Energy (kWh)	Charge Time (hr)	Idle Time (hr)	Charging Time vs Total Parking Time (%)	Charge Cost ($)	Carbon Emission (kg)	Ave Charged Energy (kWh)	Ave Fully Charged Energy (kWh)	Ave Cost (¢/kWh)	Ave Charging Time (hr)
UPark Topham Mall	**1204**	**1085**	**68.8%**	**18,967.1**	**6,201.4**	**9,887.8**	**39%**	**$1,468.65**	**4,947.6**	**17.5**	**17.9**	**7.74**	**5.7**
2023-02	86	63	66.7%	851.3	709.1	595.2	54%	$63.23	168.9	13.5	15.1	7.43	11.3
2023-03	68	64	75.0%	1,289.2	385.4	822.6	32%	$89.33	345.9	20.1	20.9	6.93	6.0
2023-04	56	54	64.8%	952.7	221.8	1,110.2	17%	$73.17	226.3	17.6	17.6	7.68	4.1
2023-05	94	75	64.0%	1,439.8	734.9	869.2	46%	$315.27	531.2	19.2	17.9	21.90	9.8
2023-06	91	80	68.8%	1,301.1	321.0	620.0	34%	$106.77	323.2	16.3	16.3	8.21	4.0
2023-07	120	112	66.1%	1,946.1	452.7	780.0	37%	$126.76	553.7	17.4	20.1	6.51	4.0
2023-08	92	89	77.5%	1,690.7	523.1	593.7	47%	$143.84	514.8	19.0	18.2	8.51	5.9
2023-09	82	78	76.9%	1,830.5	918.3	780.6	54%	$100.37	459.9	23.5	24.7	5.48	11.8
2023-10	124	102	76.5%	1,506.1	304.4	1,230.4	20%	$50.51	310.0	14.8	14.7	3.35	3.0
2023-11	110	105	64.8%	1,741.6	466.7	694.9	40%	$114.53	378.0	16.6	16.9	6.58	4.4
2023-12	85	80	56.3%	1,353.5	357.5	374.9	49%	$81.97	337.6	16.9	15.9	6.06	4.5
2024-01	94	91	67.0%	1,522.5	398.9	513.6	44%	$105.52	441.8	16.7	17.4	6.93	4.4
2024-02	102	92	69.6%	1,542.0	407.5	902.6	31%	$97.38	356.1	16.8	17.1	6.32	4.4
UPark Wyatt Street	**754**	**562**	**74.2%**	**12,385.2**	**2,468.9**	**7,773.6**	**24%**	**$898.51**	**2,576.5**	**22.0**	**23.8**	**7.25**	**4.4**
2023-02	113	40	75.0%	716.9	149.6	531.5	22%	$61.67	129.3	17.9	20.7	8.60	3.7
2023-03	38	35	91.4%	662.5	89.7	443.8	17%	$42.94	151.1	18.9	19.5	6.48	2.6
2023-04	41	35	68.6%	590.7	90.1	509.6	15%	$45.06	161.1	16.9	18.8	7.63	2.6
2023-05	91	32	78.1%	949.8	149.6	573.9	21%	$102.62	219.7	29.7	29.1	10.80	4.7
2023-06	53	49	61.2%	1,280.5	257.3	487.6	35%	$127.89	311.9	26.1	26.6	9.99	5.3
2023-07	69	55	67.3%	1,179.2	334.4	593.1	36%	$79.99	271.9	21.4	25.4	6.78	6.1
2023-08	46	41	78.0%	1,018.2	228.7	579.5	28%	$150.96	241.3	24.8	24.8	14.83	5.6
2023-09	49	43	69.8%	821.5	187.2	564.7	25%	$25.12	139.2	19.1	22.3	3.06	4.4
2023-10	42	39	69.2%	992.3	179.5	623.8	22%	$11.26	171.4	25.4	28.9	1.13	4.6
2023-11	44	41	80.5%	970.6	187.9	579.3	24%	$32.51	162.1	23.7	24.8	3.35	4.6
2023-12	44	41	78.0%	940.2	159.6	690.0	19%	$64.94	163.4	22.9	25.0	6.91	3.9
2024-01	55	52	76.9%	1,237.0	231.2	841.8	22%	$39.63	292.6	23.8	25.8	3.20	4.4
2024-02	69	59	76.3%	1,025.8	224.2	755.1	23%	$113.92	161.5	17.4	19.8	11.11	3.8
Total	**1958**	**1647**	**70.7%**	**31,352.3**	**8,670.3**	**17,661.4**	**33%**	**$2,367.16**	**7,524.0**	**19.0**	**20.1**	**7.55**	**5.3**

Appendix 3R: UPark customers charging event key metrics (table)

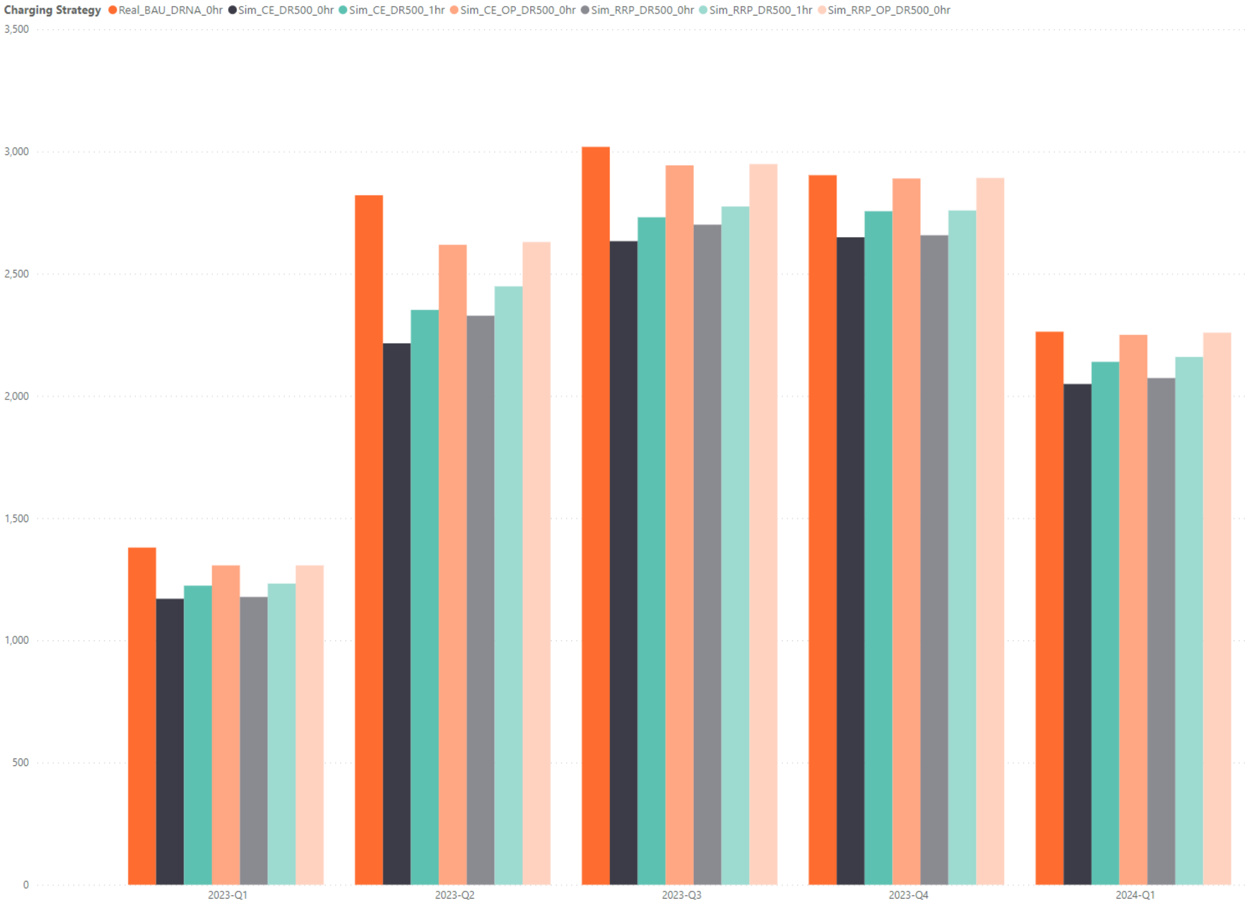


Appendix 3S: UPark customers charging totals for assessed period

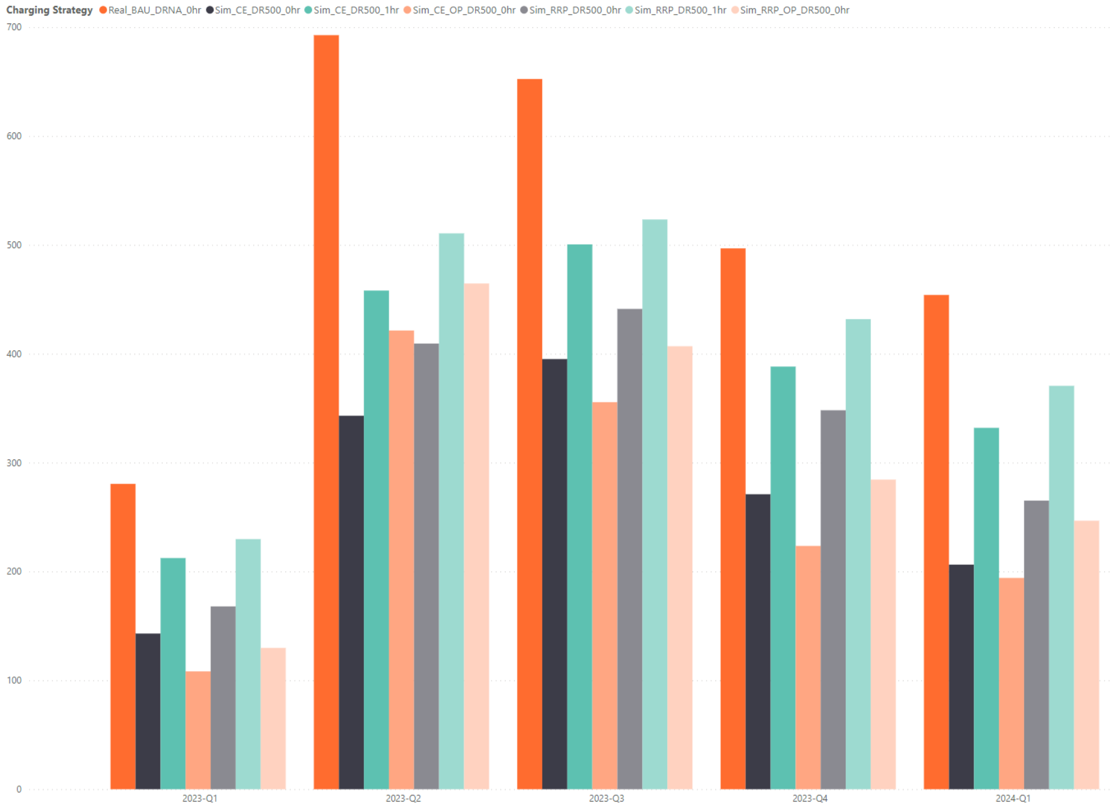
Appendix 4: Comparison of realised performance verse simulated performance (confidential)

The following headings refer to charge strategies:

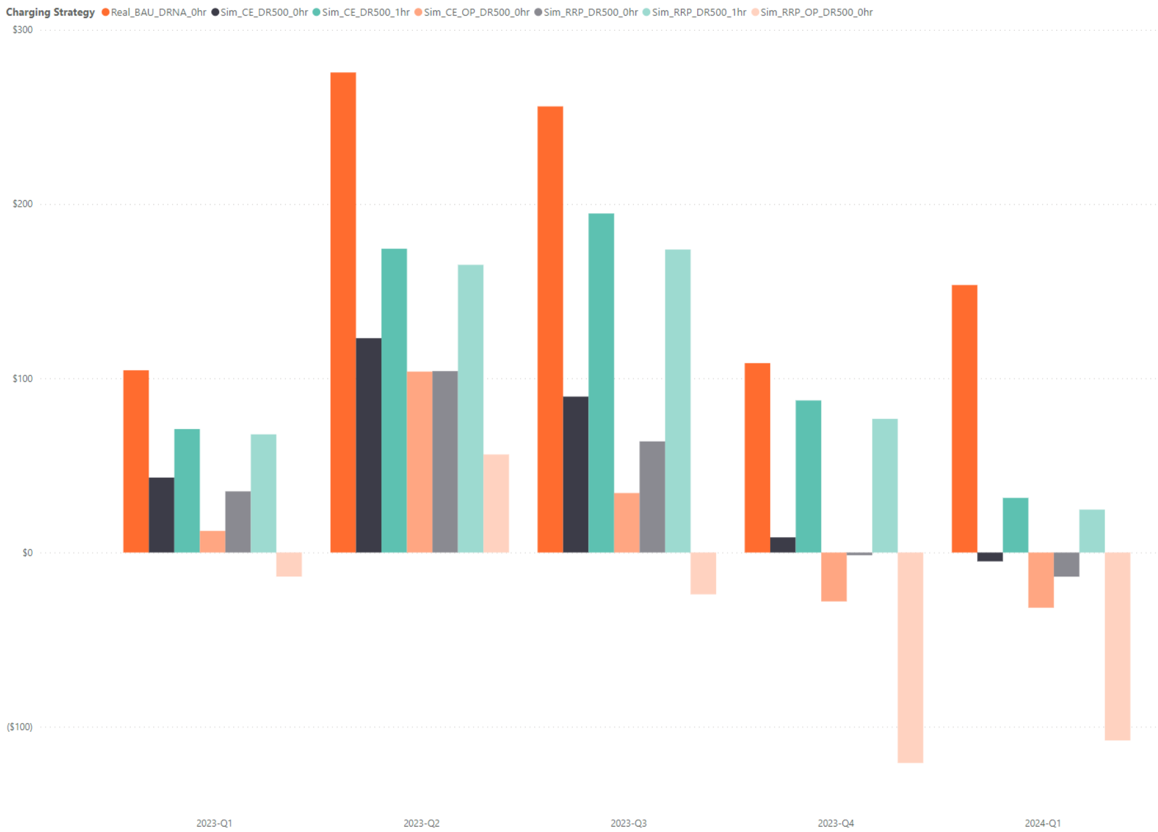
- Real_BAU_DRNA_0hr is Real data from business as usual with 0 hour guaranteed
- Sim_CE_DR500_0hr is Simulated Carbon Intensity Signalled with 0 hour guaranteed
- Sim_CE_DR500_1hr is Simulated Carbon Intensity Signalled with 1 hour guaranteed
- Sim_CE_OP_DR500_0hr is Simulated Carbon Intensity Optimised with 0 hour guaranteed
- Sim_RRP_DR500_0hr is Simulated recommended retail price (RRP) Signalled with 0 hour guaranteed
- Sim_RRP_DR500_1hr is Simulated RRP Signalled with 1 hour guaranteed
- Sim_RRP_OP_DR500_0hr is Simulated RRP Optimised with 0 hour guaranteed



Appendix 4A: UPark customers realise vs simulated performance for charged energy (kWh)

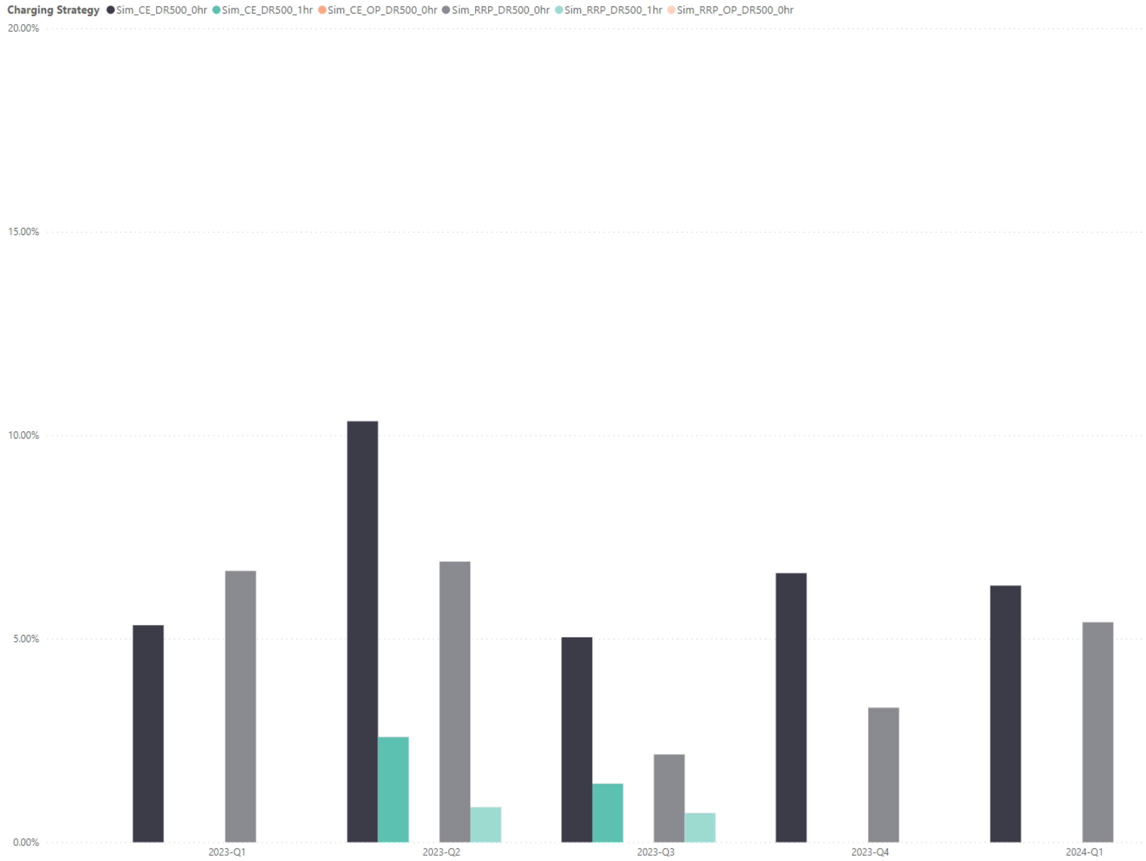


Appendix 4B: UPark customers realise vs simulated performance for carbon energy (kg)

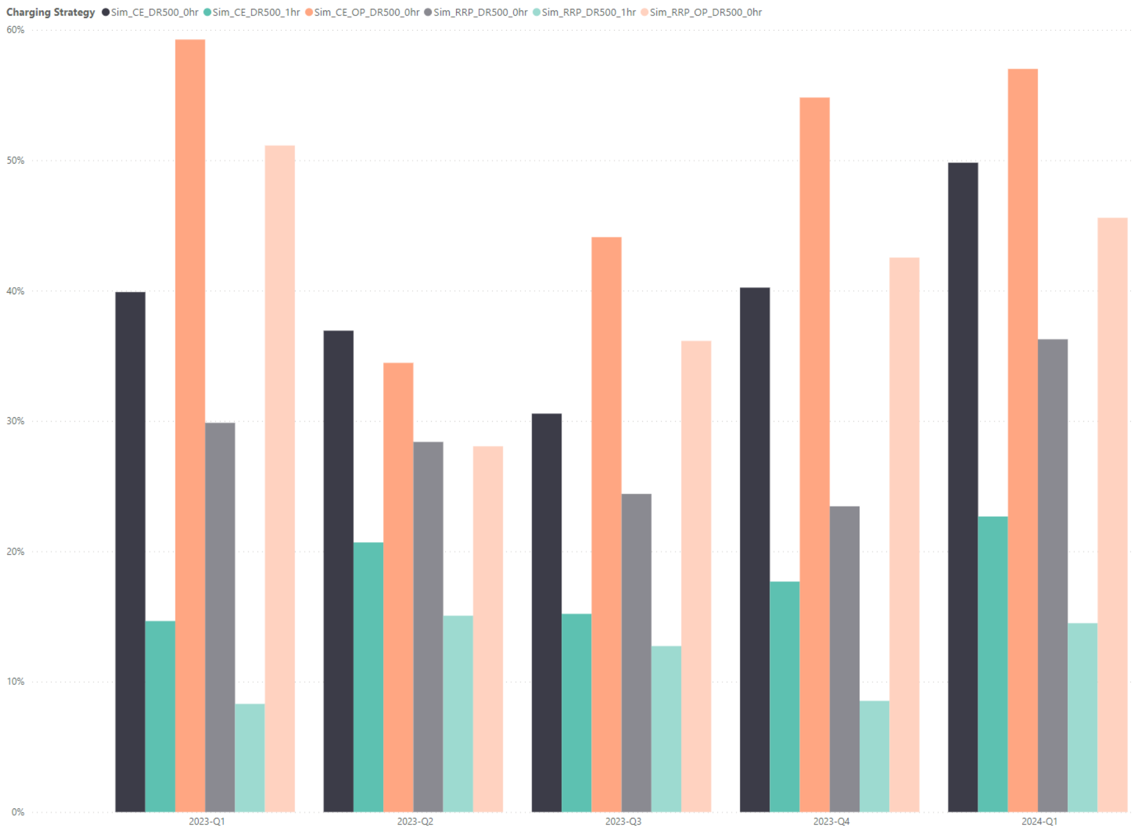


Appendix 4C: UPark customers realise vs simulated performance for charging cost ($)

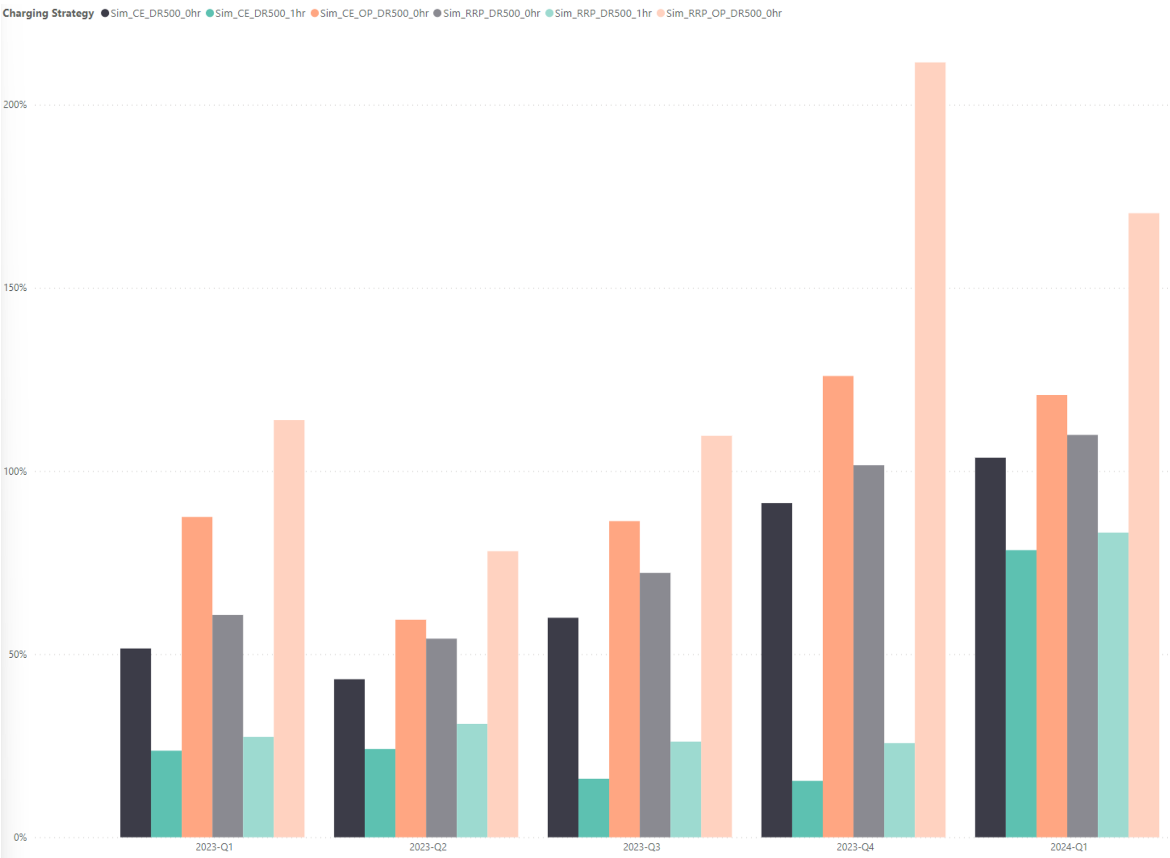
T



Appendix 4D: UPark customers simulated performance for under-charge ratio (%)



Appendix 4E: UPark customers simulated performance for average carbon reduction vs business as usual (%)



Appendix 4F: UPark customers simulated performance for average cost saving vs BAU (%)

Site	Charged Energy (kWh)	Carbon Emission (kg)	Carbon Reduction (kg)	Charge Cost ($)	Cost Saving ($)	Ave Cost (¢/kWh)	Ave Cost Saving (%)	Ave Carbon Emission (kg/kWh)	Ave Carbon reduction (%)	Effective Charge Ratio	Under-charged Ratio
UPark Topham Mall											
2023-Q1											
Real_BAU_DRNA_0hr	2,140.6	514.9	0.0	$152.56	$0.00	7.1	0.0%	0.24	0.0%	100.0%	0.0%
Sim_CE_DR500_0hr	1,552.2	264.6	250.3	$83.38	$69.19	5.4	24.6%	0.17	29.1%	78.4%	7.9%
Sim_CE_DR500_1hr	1,751.2	358.5	156.4	$111.07	$41.49	6.3	11.0%	0.20	14.9%	89.0%	2.4%
Sim_CE_OP_DR500_0hr	2,057.4	373.5	141.3	$99.81	$52.75	4.9	31.9%	0.18	24.5%	96.8%	0.0%
Sim_RRP_DR500_0hr	1,717.7	357.7	157.2	$93.87	$58.69	5.5	23.3%	0.21	13.4%	86.3%	3.9%
Sim_RRP_DR500_1hr	1,855.5	417.7	97.2	$118.36	$34.21	6.4	10.5%	0.23	6.4%	92.3%	0.0%
Sim_RRP_OP_DR500_0hr	2,058.0	410.8	104.1	$71.35	$81.22	3.5	51.4%	0.20	17.0%	96.8%	0.0%
2023-Q2											
Real_BAU_DRNA_0hr	3,693.6	1,080.7	0.0	$495.21	$0.00	13.4	0.0%	0.29	0.0%	100.0%	0.0%
Sim_CE_DR500_0hr	2,572.3	535.7	545.0	$201.65	$293.56	7.8	41.5%	0.21	28.8%	76.4%	12.9%
Sim_CE_DR500_1hr	2,920.4	749.1	331.6	$347.75	$147.46	11.9	11.2%	0.26	12.3%	86.7%	1.0%
Sim_CE_OP_DR500_0hr	3,415.8	819.9	260.8	$291.86	$203.35	8.5	36.3%	0.24	18.0%	94.6%	0.0%
Sim_RRP_DR500_0hr	2,743.0	675.3	405.4	$184.82	$310.39	6.7	49.7%	0.25	15.9%	82.3%	5.7%
Sim_RRP_DR500_1hr	3,023.1	830.1	250.6	$336.12	$159.09	11.1	17.1%	0.27	6.2%	89.3%	1.0%
Sim_RRP_OP_DR500_0hr	3,446.0	907.7	173.0	$225.10	$270.12	6.5	51.3%	0.26	10.0%	95.2%	0.0%
2023-Q3											
Real_BAU_DRNA_0hr	5,467.2	1,528.5	0.0	$370.96	$0.00	6.8	0.0%	0.28	0.0%	100.0%	0.0%
Sim_CE_DR500_0hr	4,201.5	841.0	687.5	$151.05	$219.91	3.6	47.0%	0.20	28.4%	79.8%	10.4%
Sim_CE_DR500_1hr	4,623.8	1,115.5	413.0	$242.80	$128.17	5.3	22.6%	0.24	13.7%	89.0%	1.1%
Sim_CE_OP_DR500_0hr	5,241.8	1,058.1	470.4	$170.82	$200.14	3.3	52.0%	0.20	27.8%	96.6%	0.0%
Sim_RRP_DR500_0hr	4,593.1	1,119.8	408.7	$165.94	$205.03	3.6	46.8%	0.24	12.8%	86.9%	3.2%
Sim_RRP_DR500_1hr	4,859.3	1,287.4	241.1	$248.15	$122.82	5.1	24.7%	0.26	5.2%	92.4%	0.0%
Sim_RRP_OP_DR500_0hr	5,247.8	1,177.7	350.8	$60.13	$310.83	1.1	83.1%	0.22	19.7%	96.7%	0.0%
2023-Q4											
Real_BAU_DRNA_0hr	4,601.3	1,025.6	0.0	$247.01	$0.00	5.4	0.0%	0.22	0.0%	100.0%	0.0%
Sim_CE_DR500_0hr	3,262.2	505.5	520.1	$132.54	$114.47	4.1	24.3%	0.15	30.5%	76.7%	12.9%
Sim_CE_DR500_1hr	3,715.4	705.4	320.2	$182.42	$64.59	4.9	8.5%	0.19	14.8%	87.6%	1.0%
Sim_CE_OP_DR500_0hr	4,335.6	734.5	291.1	$171.11	$75.90	3.9	26.5%	0.17	24.0%	95.4%	0.0%
Sim_RRP_DR500_0hr	3,388.8	645.8	379.8	$118.90	$128.12	3.5	34.6%	0.19	14.5%	78.3%	10.5%
Sim_RRP_DR500_1hr	3,846.1	805.6	219.9	$179.74	$67.28	4.7	12.9%	0.21	6.0%	89.1%	0.0%
Sim_RRP_OP_DR500_0hr	4,336.7	843.1	182.5	$105.94	$141.07	2.4	54.5%	0.19	12.8%	95.5%	0.0%
2024-Q1											
Real_BAU_DRNA_0hr	3,064.5	797.9	0.0	$202.90	$0.00	6.6	0.0%	0.26	0.0%	100.0%	0.0%
Sim_CE_DR500_0hr	2,159.1	371.2	426.8	$100.71	$102.19	4.7	29.6%	0.17	34.0%	74.4%	14.2%
Sim_CE_DR500_1hr	2,500.9	519.0	278.9	$142.93	$59.97	5.7	13.7%	0.21	20.3%	87.9%	0.5%
Sim_CE_OP_DR500_0hr	2,977.6	597.5	200.5	$152.36	$50.54	5.1	22.7%	0.20	22.9%	97.4%	0.0%
Sim_RRP_DR500_0hr	2,345.3	495.2	302.7	$104.42	$98.48	4.5	32.8%	0.21	18.9%	81.3%	6.6%
Sim_RRP_DR500_1hr	2,624.1	594.1	203.9	$146.17	$56.73	5.6	15.9%	0.23	13.1%	90.9%	0.5%
Sim_RRP_OP_DR500_0hr	2,978.6	691.4	106.5	$111.84	$91.06	3.8	43.3%	0.23	10.9%	97.4%	0.0%

Appendix 4G: Topham Mall UPark customers realised and simulated comparison of charging performance (Quarterly 1 February 2023 to 1 March 2024)

Site	Charged Energy (kWh)	Carbon Emission (kg)	Carbon Reduction (kg)	Charge Cost ($)	Cost Saving ($)	Ave Cost (¢/kWh)	Ave Cost Saving (%)	Ave Carbon Emission (kg/kWh)	Ave Carbon reduction (%)	Effective Charge Ratio	Under-charged Ratio
UPark Wyatt Street											
2023-Q1											
Real_BAU_DRNA_0hr	1,379.5	280.5	0.0	$104.62	$0.00	7.6	0.0%	0.20	0.0%	100.0%	0.0%
Sim_CE_DR500_0hr	1,170.1	143.0	137.5	$43.01	$61.61	3.7	51.5%	0.12	39.9%	86.6%	5.3%
Sim_CE_DR500_1hr	1,223.7	212.3	68.1	$70.87	$33.75	5.8	23.6%	0.17	14.7%	92.9%	0.0%
Sim_CE_OP_DR500_0hr	1,306.5	108.2	172.2	$12.43	$92.19	1.0	87.5%	0.08	59.3%	96.6%	0.0%
Sim_RRP_DR500_0hr	1,177.5	167.9	112.5	$35.12	$69.50	3.0	60.7%	0.14	29.9%	86.7%	6.7%
Sim_RRP_DR500_1hr	1,232.1	229.7	50.7	$67.82	$36.80	5.5	27.4%	0.19	8.3%	93.5%	0.0%
Sim_RRP_OP_DR500_0hr	1,306.5	129.8	150.7	($13.78)	$118.40	-1.1	113.9%	0.10	51.1%	96.6%	0.0%
2023-Q2											
Real_BAU_DRNA_0hr	2,821.0	692.7	0.0	$275.56	$0.00	9.8	0.0%	0.25	0.0%	100.0%	0.0%
Sim_CE_DR500_0hr	2,215.2	343.1	349.6	$123.02	$152.55	5.6	43.1%	0.15	36.9%	80.9%	10.3%
Sim_CE_DR500_1hr	2,351.9	458.1	234.6	$174.39	$101.18	7.4	24.1%	0.19	20.7%	89.1%	2.6%
Sim_CE_OP_DR500_0hr	2,618.3	421.4	271.3	$103.87	$171.69	4.0	59.4%	0.16	34.5%	96.3%	0.0%
Sim_RRP_DR500_0hr	2,328.2	409.4	283.3	$104.11	$171.45	4.5	54.2%	0.18	28.4%	83.9%	6.9%
Sim_RRP_DR500_1hr	2,448.2	510.6	182.1	$165.14	$110.43	6.7	30.9%	0.21	15.1%	91.6%	0.9%
Sim_RRP_OP_DR500_0hr	2,629.6	464.6	228.1	$56.28	$219.28	2.1	78.1%	0.18	28.1%	96.8%	0.0%
2023-Q3											
Real_BAU_DRNA_0hr	3,018.9	652.4	0.0	$256.08	$0.00	8.5	0.0%	0.22	0.0%	100.0%	0.0%
Sim_CE_DR500_0hr	2,633.2	395.2	257.3	$89.51	$166.56	3.4	59.9%	0.15	30.6%	87.8%	5.0%
Sim_CE_DR500_1hr	2,730.9	500.5	152.0	$194.60	$61.48	7.1	16.0%	0.18	15.2%	93.5%	1.4%
Sim_CE_OP_DR500_0hr	2,943.2	355.6	296.9	$34.15	$221.93	1.2	86.3%	0.12	44.1%	97.7%	0.0%
Sim_RRP_DR500_0hr	2,700.6	441.2	211.2	$63.78	$192.30	2.4	72.2%	0.16	24.4%	90.2%	2.2%
Sim_RRP_DR500_1hr	2,774.9	523.4	129.1	$173.91	$82.17	6.3	26.1%	0.19	12.7%	94.5%	0.7%
Sim_RRP_OP_DR500_0hr	2,948.5	406.9	245.5	($23.98)	$280.06	-0.8	109.6%	0.14	36.1%	97.8%	0.0%
2023-Q4											
Real_BAU_DRNA_0hr	2,903.1	496.8	0.0	$108.71	$0.00	3.7	0.0%	0.17	0.0%	100.0%	0.0%
Sim_CE_DR500_0hr	2,649.1	271.0	225.9	$8.70	$100.01	0.3	91.2%	0.10	40.2%	88.2%	6.6%
Sim_CE_DR500_1hr	2,755.7	388.2	108.6	$87.30	$21.41	3.2	15.4%	0.14	17.7%	93.8%	0.0%
Sim_CE_OP_DR500_0hr	2,889.7	223.5	273.4	($28.06)	$136.77	-1.0	125.9%	0.08	54.8%	99.0%	0.0%
Sim_RRP_DR500_0hr	2,657.4	348.1	148.7	($1.55)	$110.26	-0.1	101.6%	0.13	23.5%	89.6%	3.3%
Sim_RRP_DR500_1hr	2,758.7	431.9	65.0	$76.74	$31.97	2.8	25.7%	0.16	8.5%	94.5%	0.0%
Sim_RRP_OP_DR500_0hr	2,892.0	284.4	212.4	($120.78)	$229.49	-4.2	211.5%	0.10	42.5%	99.1%	0.0%
2024-Q1											
Real_BAU_DRNA_0hr	2,262.7	454.0	0.0	$153.54	$0.00	6.8	0.0%	0.20	0.0%	100.0%	0.0%
Sim_CE_DR500_0hr	2,048.7	206.3	247.7	($5.05)	$158.60	-0.2	103.6%	0.10	49.8%	88.4%	6.3%
Sim_CE_DR500_1hr	2,139.4	332.0	122.1	$31.36	$122.18	1.5	78.4%	0.16	22.7%	95.9%	0.0%
Sim_CE_OP_DR500_0hr	2,249.8	194.1	259.9	($31.68)	$185.23	-1.4	120.8%	0.09	57.0%	99.6%	0.0%
Sim_RRP_DR500_0hr	2,073.1	265.1	188.9	($13.84)	$167.38	-0.7	109.8%	0.13	36.3%	89.4%	5.4%
Sim_RRP_DR500_1hr	2,159.6	370.6	83.5	$24.64	$128.90	1.1	83.2%	0.17	14.5%	96.7%	0.0%
Sim_RRP_OP_DR500_0hr	2,258.9	246.6	207.4	($107.87)	$261.41	-4.8	170.4%	0.11	45.6%	99.7%	0.0%

Appendix 4H: Wyatt UPark customers realised and simulated comparison of charging performance (Quarterly 1 February 2023 to 1 March 2024)

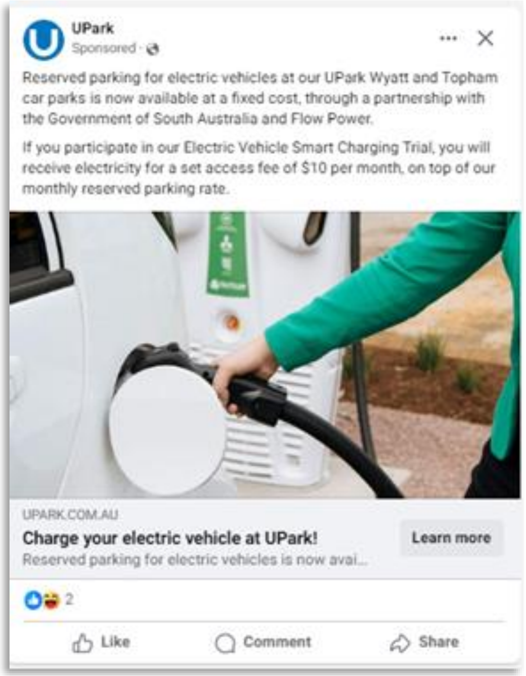
Site	Charged Energy (kWh)	Carbon Emission (kg)	Carbon Reduction (kg)	Charge Cost ($)	Cost Saving ($)	Ave Cost (¢/kWh)	Ave Cost Saving (%)	Ave Carbon Emission (kg/kWh)	Ave Carbon reduction (%)	Effective Charge Ratio	Under-charged Ratio
UPark Topham Mall											
All Dates											
Real_BAU_DRNA_0hr	18,967.1	4,947.6	0.0	$1,468.65	$0.00	7.7	0.0%	0.26	0.0%	100.0%	0.0%
Sim_CE_DR500_0hr	13,747.3	2,517.9	2,429.7	$669.33	$799.32	4.9	37.1%	0.18	29.8%	77.2%	11.9%
Sim_CE_DR500_1hr	15,511.8	3,447.5	1,500.1	$1,026.97	$441.68	6.6	14.5%	0.22	14.8%	88.0%	1.1%
Sim_CE_OP_DR500_0hr	18,028.2	3,583.4	1,364.2	$885.97	$582.68	4.9	36.5%	0.20	23.8%	96.1%	0.0%
Sim_RRP_DR500_0hr	14,787.8	3,293.8	1,653.8	$667.95	$800.70	4.5	41.7%	0.22	14.6%	82.7%	6.3%
Sim_RRP_DR500_1hr	16,208.2	3,934.9	1,012.7	$1,028.54	$440.11	6.3	18.0%	0.24	6.9%	90.6%	0.3%
Sim_RRP_OP_DR500_0hr	18,067.1	4,030.7	916.8	$574.36	$894.29	3.2	58.9%	0.22	14.5%	96.2%	0.0%
UPark Wyatt Street											
All Dates											
Real_BAU_DRNA_0hr	12,385.2	2,576.5	0.0	$898.51	$0.00	7.3	0.0%	0.21	0.0%	100.0%	0.0%
Sim_CE_DR500_0hr	10,716.2	1,358.5	1,217.9	$259.19	$639.33	2.4	66.7%	0.13	39.1%	86.4%	6.8%
Sim_CE_DR500_1hr	11,201.6	1,891.1	685.4	$558.52	$340.00	5.0	31.3%	0.17	18.8%	93.1%	0.9%
Sim_CE_OP_DR500_0hr	12,007.5	1,302.7	1,273.7	$90.71	$807.81	0.8	89.6%	0.11	47.8%	97.9%	0.0%
Sim_RRP_DR500_0hr	10,936.8	1,631.8	944.7	$187.62	$710.89	1.7	76.4%	0.15	28.3%	88.2%	4.6%
Sim_RRP_DR500_1hr	11,373.4	2,066.1	510.3	$508.25	$390.26	4.5	38.4%	0.18	12.7%	94.2%	0.4%
Sim_RRP_OP_DR500_0hr	12,035.4	1,532.4	1,044.1	($210.14)	$1,108.65	-1.7	124.1%	0.13	38.8%	98.1%	0.0%

Appendix 4I: UPark customers realised and simulated comparison of charging performance (Summary – 1 February 2023 to 1 March 2024)

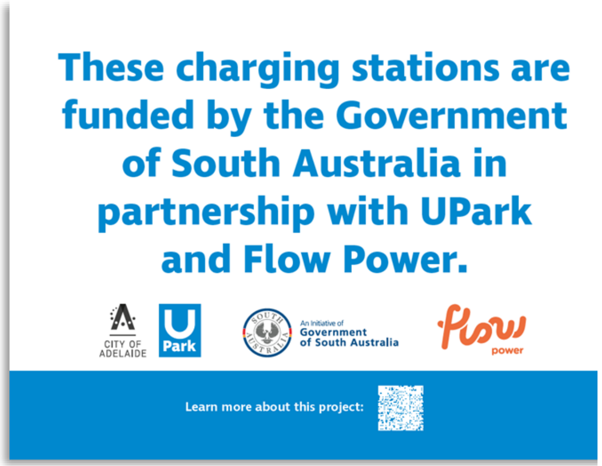
Charge Strategy by Customer Type	Cost (c/kWh)	Cost reduction (%)	Carbon intensity	Carbon reduction (%)	Effective charge ratio	Under-charge ratio	Idle time ratio
Fleets							
BAU	8.84	N/A	0.21	N/A	100%	0.0%	96.4%
Optimised RRP	-9.46	207%	0.05	76%	100%	0.0%	96.4%
Optimised carbon	-3.64	141%	0.02	90%	100%	0.0%	96.4%
Residents							
BAU	11.58	N/A	0.29	N/A	100%	0.0%	58.8%
RRP w DR 500	4.78	59%	0.20	31%	88.3%	2.7%	45.6%
Carbon w DR 500	5.77	50%	0.18	38%	86.5%	4.6%	46.2%
Optimised RRP	1.23	89%	0.15	48%	100%	0.0%	58.8%
Optimised carbon	2.80	76%	0.13	55%	99.9%	0.0%	58.8%
Visitors							
BAU	8.99	N/A	0.20	N/A	100%	0.0%	0.0%
RRP w DR 500	4.67	48%	0.17	15%	60.5%	18.7%	13.3%
Carbon w DR 500	5.84	35%	0.16	20%	63.2%	17.0%	9.7%
Optimised RRP	7.32	19%	0.20	0%	99.1%	0.3%	0.9%
Optimised carbon	7.32	19%	0.20	0%	99.1%	0.3%	0.9%
Workers							
BAU	3.78	N/A	0.126	N/A	100%	0.0%	50.0%
RRP w DR 500	1.16	69%	0.106	16%	92.8%	1.4%	38.3%
Carbon w DR 500	2.33	38%	0.105	17%	97.4%	0.2%	35.0%
Optimised RRP	-2.89	176%	0.092	27%	100%	0.0%	50.0%
Optimised carbon	1.01	73%	0.079	37%	99.8%	0.0%	50.1%

Appendix 4J:: Business case modelling for specific user types utilising trial charging strategies

Appendix 5: Recruitment



Appendix 5A: paid facebook advertisement from 2023



Appendix 5B: decals installed in Topham Mall and Wyatt UParks

Appendix 5C: electronic direct mail (eDM) distributed from October 2022 to May 2023

Appendix 6: Expenditure (Confidential)

Table 8: UPark EV Fleet Smart Charging Trial expenditure

	DEM Smart Charging Trials Grant Funding	Applicant Expenditure	Flow Power	TOTAL
Capital Expenditure	EV units: $42,805.70 Meter & kWatch installation: $33,995.50	EV units: $21,194	kWatch controller: $7,107.07	$105,102.27
Operational Expenditure	Software programming: $4,198.80	Data Reporting: $4,070	Nil	$8,268.80
In Kind Contributions	-	Project management installation: $28,800 Project management product development and analysis: $9,600 Marketing and promotion: $4,800	kWatch software development: $3,400 Project management product development and analysis: $5,520	$52,120
TOTAL	**$81,000**	**$68,464**	**$16,027.07**	**$165,491.07**