Insights from Ultra-Fast Charging Network Data (Update)

2 August 2023

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Disclaimer

This report was commissioned by the Australian Renewable Energy Agency (**ARENA**). The report presents the findings of Energeia, which was prepared to share *Insights from ARENA Ultra-Fast Charging Network Data.* The report is provided as is, without any guarantee, representation, condition or warranty of any kind, either express, implied or statutory. ARENA and Energeia do not assume any liability with respect to any reliance placed on this report by third parties. If a third party relies on the report in any way, that party assumes the entire risk as to the accuracy, currency or completeness of the information contained in the report.

To the best of ARENA and *Energeia*'s knowledge, no conflict of interest arose during the course of preparing this report. While Energeia has previously conducted reports, evaluations and other work for ARENA, Energeia has not received any grant funding from ARENA.

Executive Summary – Key Learnings

- **Charging Utilisation**
  - Typical site usage patterns have remained robust over time – majority of use is in the middle of the day
  - Total use of regional (highway) fast chargers has continued to increase vs. urban chargers, majority of drivers from urban areas
  - On a per site basis, urban fast chargers experience more charge time than regional chargers
  - Holiday months have significantly higher site utilisation than other times of the year
  - Both urban and regional public fast charger site utilisation has increased significantly in the last two years, ~5x more charge time in Dec 22 compared to Dec 20 – thought this would be muddied by COVID
- **Costs**
  - Energy costs decreases significantly with site utilisation, but limit in cost reduction is reached at around 60 MWh/pa
- **Electricity System Impacts**
  - Energy provided per session has increased significantly, per session time durations have remained more stable
  - Charging site demand is averaging 75% of their own peak demand during network peak demand times
  - Public EV charging patterns could provide a solution to min demand caused by solar PV

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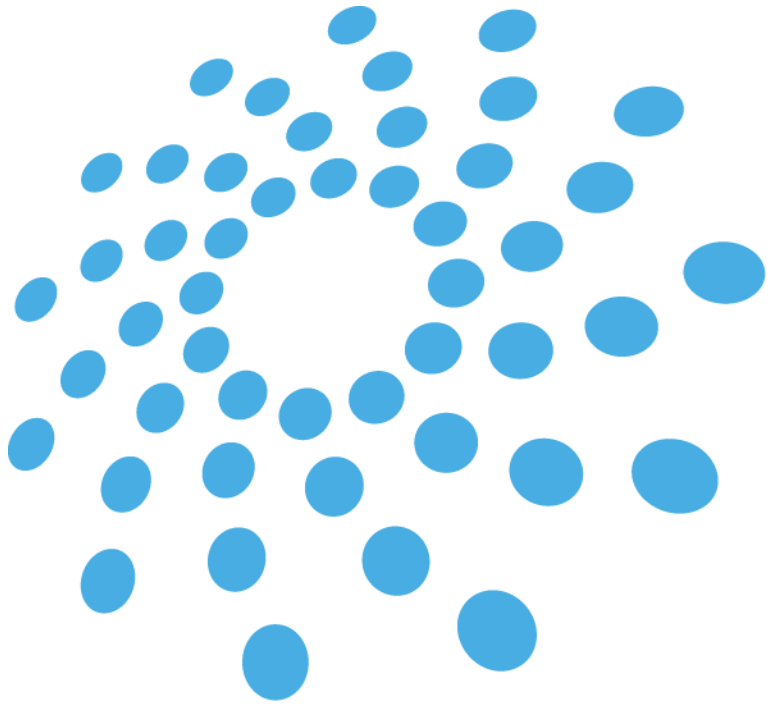

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Background

ARENA’s EV Programs

ARENA’s EV Knowledge Sharing Workstream

Key Industry Questions

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ARENA's EV Projects Included in this Insight

Start Year	Project	Funding	State	Lead Organisation	Summary
2018	Chargefox Electric Vehicle Charging Network Project	$6m	NSW, QLD, SA, VIC, WA	ChargeFox	This project enables the construction of a network of 21 ultra-rapid charging stations to reduce barries for consumer uptake of EVs
2019	National Ultrafast EV Charging Infrastructure Network	$15m	National	Evie Networks	This project enables the development and construction of a network of 42 ultra-fast charging sites nationally to reduce barriers for EV uptake

- ARENA has funded a wide range of ultra-fast charging infrastructure projects to support the uptake of electric vehicles
  - All ARENA charge point locations are powered by renewable energy
- Data from the above projects have fed into this analysis

Table of Charger Locations and Configurations

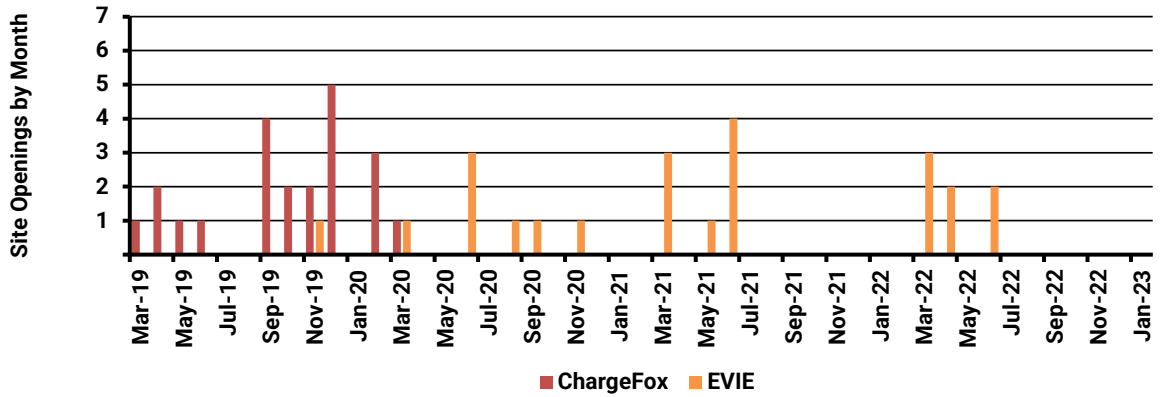
Summary Table of Charging Sites

Provider	Location	State	Power per Site kW	No of 350kW Chargepoints	No of 50kW Chargepoints	No of CC2 Hoses	No of CHAdeMO Hoses
ChargeFox	Ballina	NSW	750	2	1	3	1
ChargeFox	Coffs Harbour	NSW	700	2	0	2	2
ChargeFox	Port Macquarie	NSW	700	2	0	2	2
ChargeFox	Karuah	NSW	750	2	1	3	1
ChargeFox	Sydney	NSW	700	2	0	3	1
ChargeFox	Shell Cove	NSW	750	2	1	2	2
ChargeFox	Goulburn	NSW	750	2	1	3	3
ChargeFox	Gundagai	NSW	750	2	1	3	1
ChargeFox	Cooma	NSW	700	2	0	3	1
ChargeFox	Barnawartha North	VIC	800	2	2	4	4
ChargeFox	Euroa	VIC	800	2	2	4	4
ChargeFox	Latrobe Valley	VIC	800	2	2	4	2
ChargeFox	Torquay	VIC	800	2	2	4	4
ChargeFox	Ballarat	VIC	800	2	2	4	4
ChargeFox	Horsham	VIC	800	2	2	4	4
ChargeFox	Keith	SA	700	2	0	3	3
ChargeFox	Adelaide	SA	700	2	0	2	2
ChargeFox	Perth	WA	700	2	0	2	2
ChargeFox	Bunbury	WA	700	2	0	2	2
ChargeFox	Launceston	TAS	700	2	0	2	2
EVIE	Coochin Creek	QLD	700	2	0	2	2
EVIE	Coomera	QLD	700	2	0	2	2
EVIE	Bundamba	QLD	700	2	0	2	2
EVIE	Toowoomba	QLD	700	2	0	2	2
EVIE	Townsville	QLD	700	2	0	2	2
EVIE	Sutton Forest West	NSW	700	4	0	2	2
EVIE	Taracutta	NSW	700	2	0	2	2
EVIE	Cameron Park	NSW	700	2	0	2	2
EVIE	Taree	NSW	700	2	0	2	2
EVIE	Macksville	NSW	700	2	0	2	2
EVIE	Tyndale	NSW	700	2	0	2	2
EVIE	Jamisontown	NSW	700	2	0	2	2
EVIE	Seven Hills	NSW	700	2	0	2	2
EVIE	Northpoint	VIC	700	2	0	2	2
EVIE	Avenel	VIC	700	2	0	2	2
EVIE	Warrenheip	VIC	700	2	0	2	2
EVIE	Dandenong	VIC	700	2	0	2	2
EVIE	Taylors Lakes	VIC	700	2	0	2	2
EVIE	Tailem Bend	SA	700	2	0	2	2
EVIE	Paralowie	SA	700	2	0	2	2
EVIE	Brighton	TAS	700	2	0	2	2
EVIE	Campbell Town	TAS	700	2	0	2	2
EVIE	Westbury	TAS	700	2	0	2	2

Source: ChargeFox and Evie, Note EVIE Stations per site estimated from plugshare

- More Evie Ultrafast charging sites rolled out since last update
- EVIE has opened new sites since the conclusion of the first data update in February 21

Site Openings



Source: ChargeFox and Evie, Note: Opening date of Evie sites not available. First available bill date used as an approximation

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The Role of the Knowledge Sharing Agent

- The ARENA Act specifies Knowledge Sharing as a function of ARENA and requires ARENA to:
  - Store and share information and knowledge about renewable energy technologies;
  - Collect, analyse, interpret and disseminate information and knowledge relating to renewable energy technologies and projects; and
  - Promote the sharing of information and knowledge about renewable energy technologies.
- Energeia, as ARENA's knowledge sharing agent for its EV portfolio, provides services including:
  - Reviewing current data arrangements from existing portfolios to maximise their value
  - Ensuring that the data requirements in future EV funding agreements can provide valuable insights for the EV portfolio
  - Coordinating data collection and storage for the whole EV portfolio
  - *Analysing data collected through individual projects to provide aggregated insights on charging performance, customer behaviour and value*
  - *Producing aggregated insights and key themes emerging from the data in a form that is digestible and relevant to the industry*.

Key Industry Questions about Public DC Fast Charging

The analysis for this Knowledge Sharing Insight has been designed to address the key questions facing the industry **and how these insights have changed over time**

Investment and Operational Costs

- How do different tariffs impact on electricity costs?
- How does different utilisation levels impact electricity costs?

Charging Activity

- What is the daily profile of charging activity, and does it vary by day type, month, or location?
- How long do vehicles typically charge for?
- How fast is station utilisation growing over time?

Electricity Grid Impact

- How much will fast charging stations contribute to grid peak demand?
- What is the load factor of a fast-charging station?

Key Insights

Charging Session Timing

Utilisation Rates

Site Electricity Costs

Site Peak Demand Impacts

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Charging Session Times

Driver Residence

Site Location

Day Type

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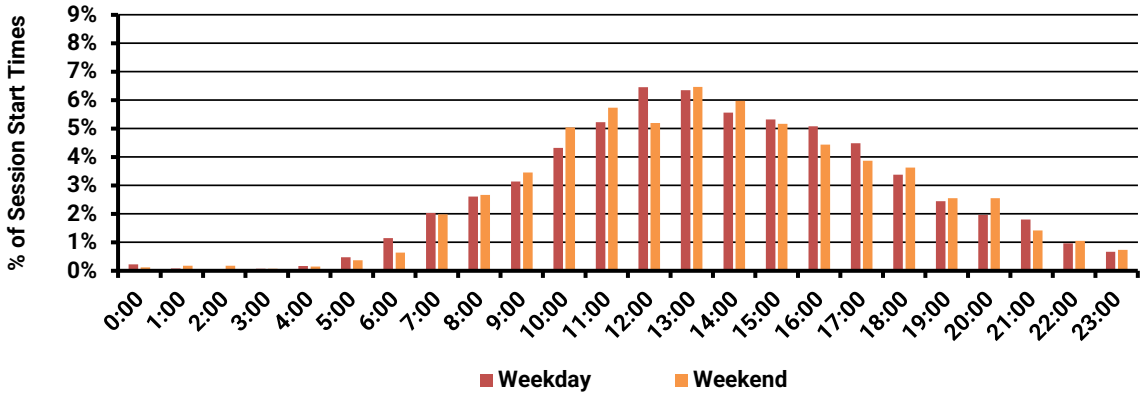
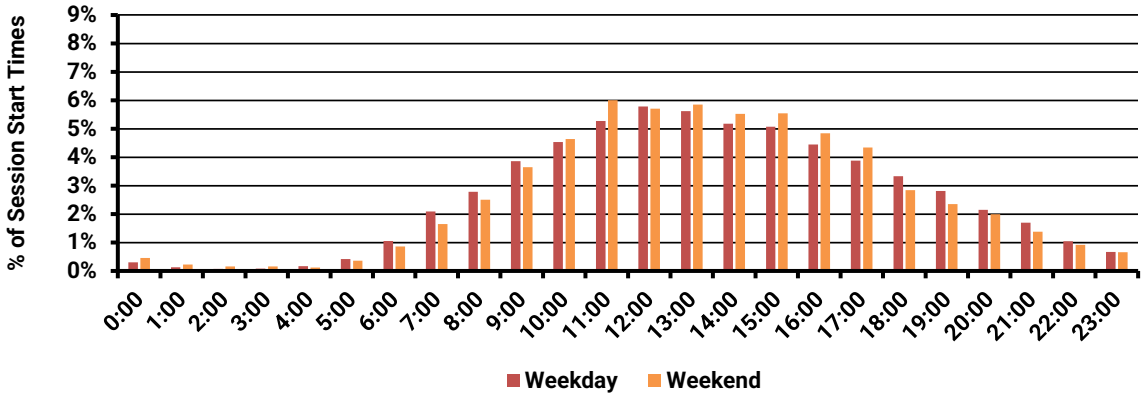
Session Start Time by Driver Residence and Day Type (1/2)

Start Time by Day Type for Urban Drivers – 2021



Source: ChargeFox, Energeia, Note: Where driver location data was available, Session Data from Oct 18 – Feb 21

Start Time by Day Type for Urban Drivers – 2023



Source: ChargeFox, Energeia, Note: Where driver location data was available, Session Data from Jan 22 – Mar 23

- The charts show normalised session start times by driver residence and day type (urban drivers only)
- The results show minimal difference in driver usage by weekday vs weekend for urban drivers
- 2023 analysis shows a slight modification of charging behaviour towards more charging in 1pm-3pm period

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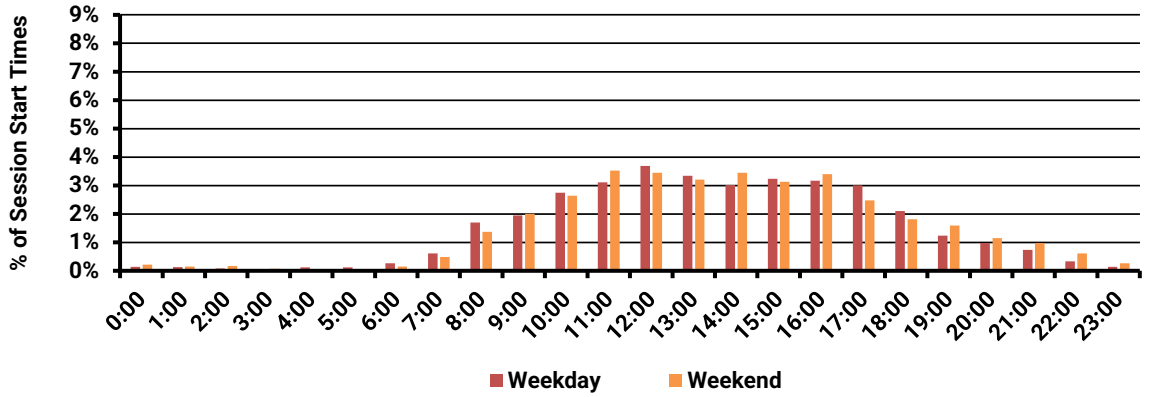
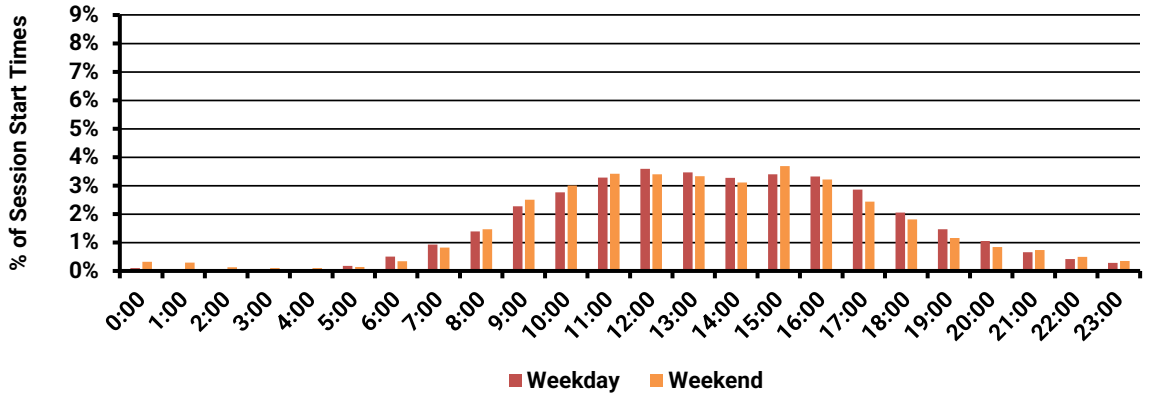
Session Start Time by Driver Residence and Day Type (2/2)

Start Time by Day Type for Regional Drivers – 2021



Source: ChargeFox, Energeia, Note: Where driver location data was available, Session Data from Oct 18 – Feb

Start Time by Day Type for Regional Drivers – 2023



Source: ChargeFox, Energeia, Note: Where driver location data was available, Session Data from Jan 22 – Mar 23

- The charts show normalised session start times by driver residence and day type (regional drivers only)
- The results reflect the lower usage rates of regional drivers
- No significant changes seen in the 2023 update

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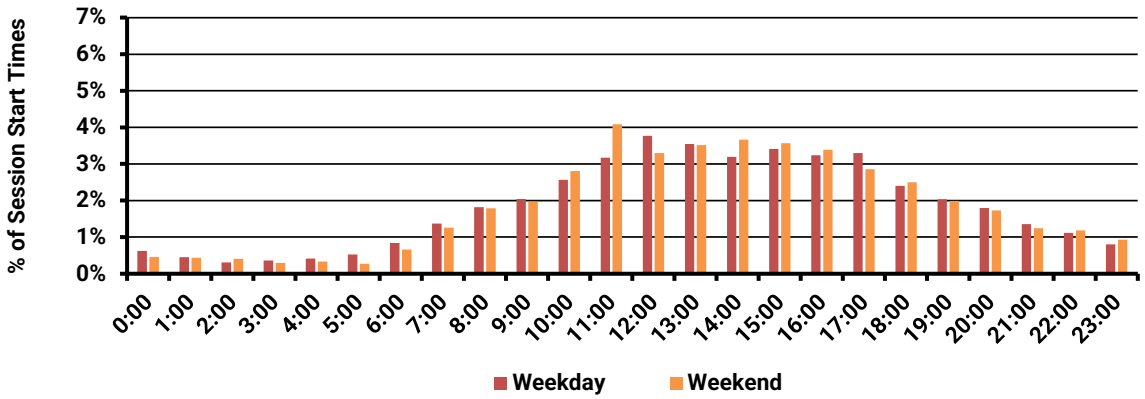
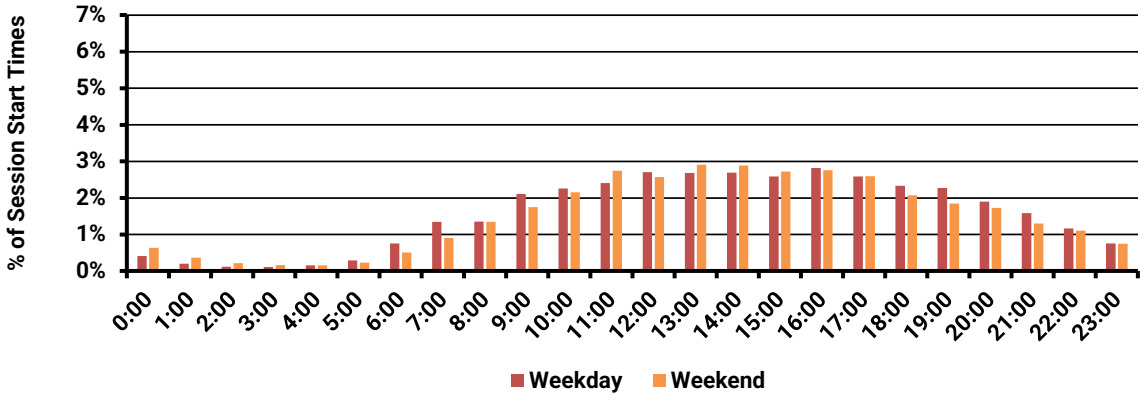
Session Start Time by Site Location and Day Type (1/2)

Start Time by Day Type for Urban Sites – 2021



Source: ChargeFox, Evie, Energeia, Note: Session Data from Oct 18 – Feb 21

Start Time by Day Type for Urban Sites – 2023



Source: ChargeFox, Evie, Energeia, Note: Session Data from Apr 22 – Mar 23

- The charts show normalised session start times by location of the site and day type (urban sites only)
- The results show the impact of commuter behaviours with higher utilisation for weekdays during 6-10pm
- The 2023 update shows relatively less charging during the 11am to 5pm period

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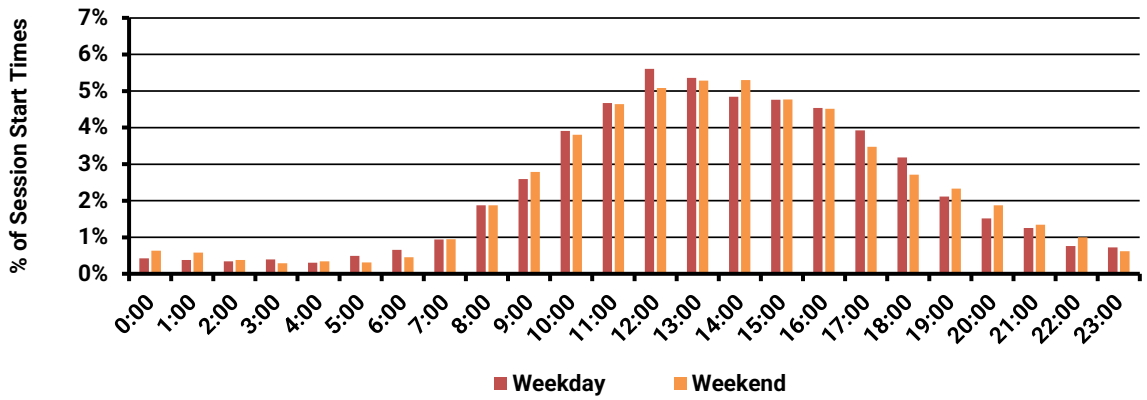
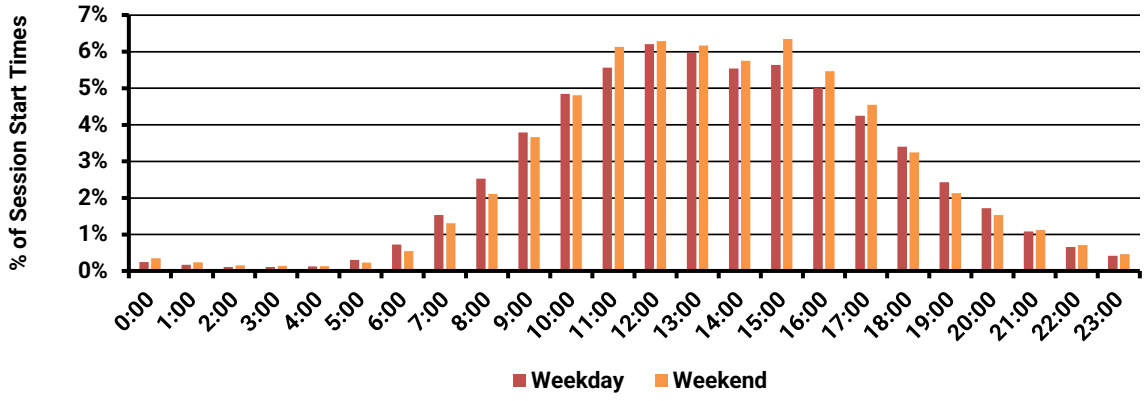
Session Start Time by Site Location and Day Type (2/2)

Start Time by Day Type for Regional Sites – 2021



Source: ChargeFox, Evie, Energeia, Note: Session Data from Oct 18 – Feb 21

Start Time by Day Type for Regional Sites – 2023



Source: ChargeFox, Evie, Energeia , Note: Session Data from Apr 22 – Mar 23

- The charts show normalised session start times by driver residence and day type (regional sites only)
- The results reflect the higher usage rates of regional drivers, noting that regional sites account from approx. 70% of installed sites
- Weekday commuter behaviours can be similar observed in regional sites
- The 2023 update shows relatively more charging in the 11am-4pm period, and less in the early morning

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Utilisation

Site Location

Day Type

Charge Time vs Energy Provided

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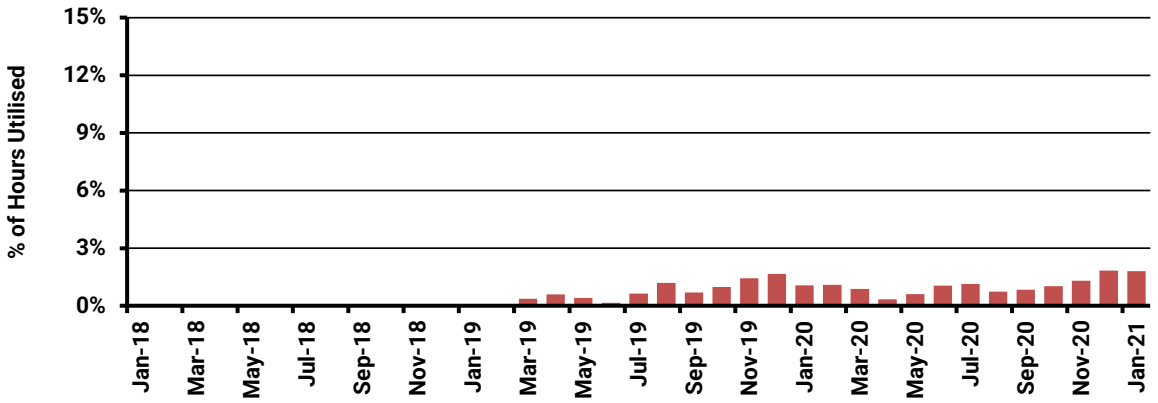
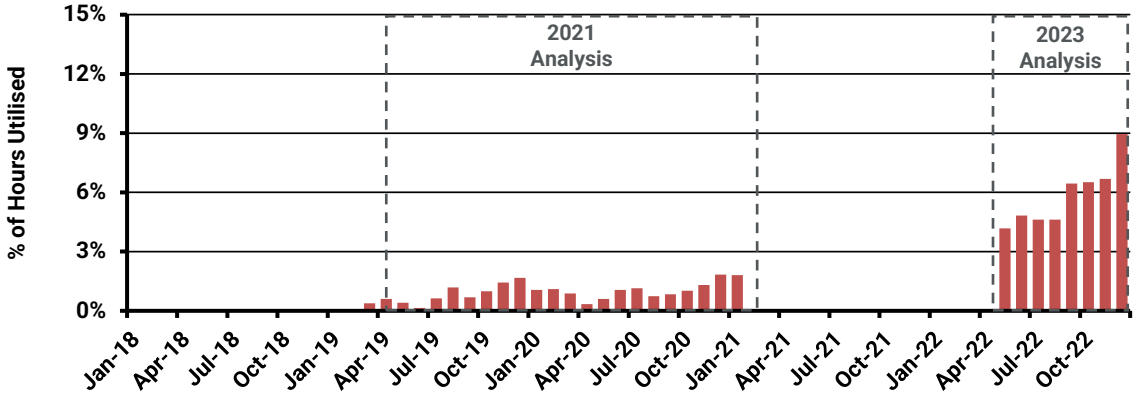
Site Usage Over Time – All

User Frequency Over Time – 2021



Source: ChargeFox and Evie

User Frequency Over Time – 2023



Source: ChargeFox and Evie

- The figures indicate the change in utilisation over time
  - Utilisation is calculated as the percent of available hours where a site is in use
- 2021 analysis showed significant seasonal variation, with a gradual rise in utilisation year on year, impacted significantly by the onset of COVID-19
- 2023 data shows recovery as well as a jump in year-on-year growth
  - Utilisation is ~5x higher in Dec 22 compared to Dec 20
  - Most of this change a reflection of significant EV uptake in that time

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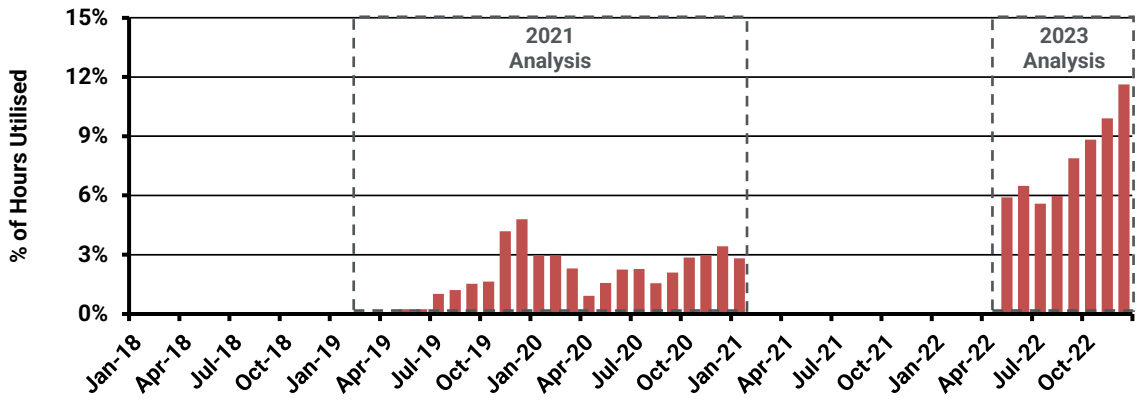
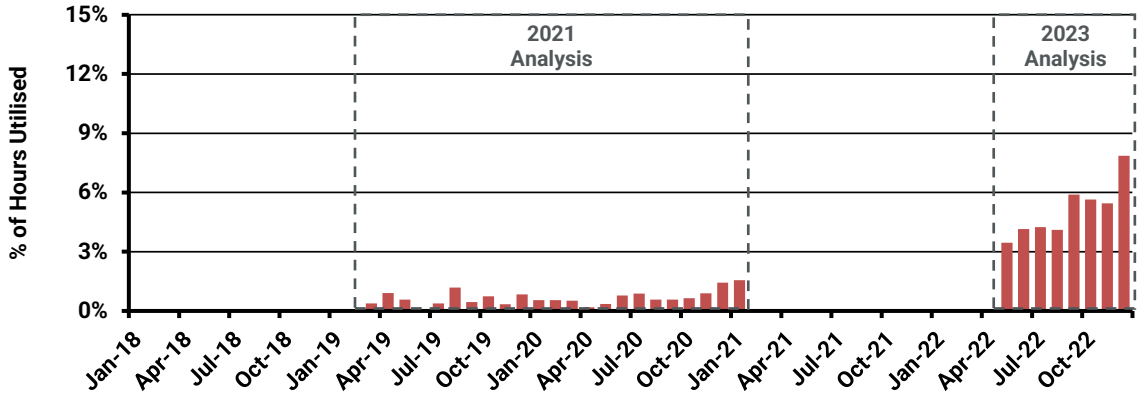
Per Site Usage Over Time – by Site Location

User Frequency Over Time – Urban



Source: ChargeFox and Evie

User Frequency Over Time – Regional



Source: ChargeFox and Evie

- Actual utilisation rates are shown on a per chargepoint basis by location
  - The results indicate that urban sites have a higher usage rate than regional sites
- Urban sites appear to benefit from:
  - Convenient locations
  - High road traffic, including local traffic
- Actual data provides a different perspective on urban vs. rural charging as time-based utilisation
  - Earlier analysis showed drivers having a higher usage of regional sites, with the highest session counts

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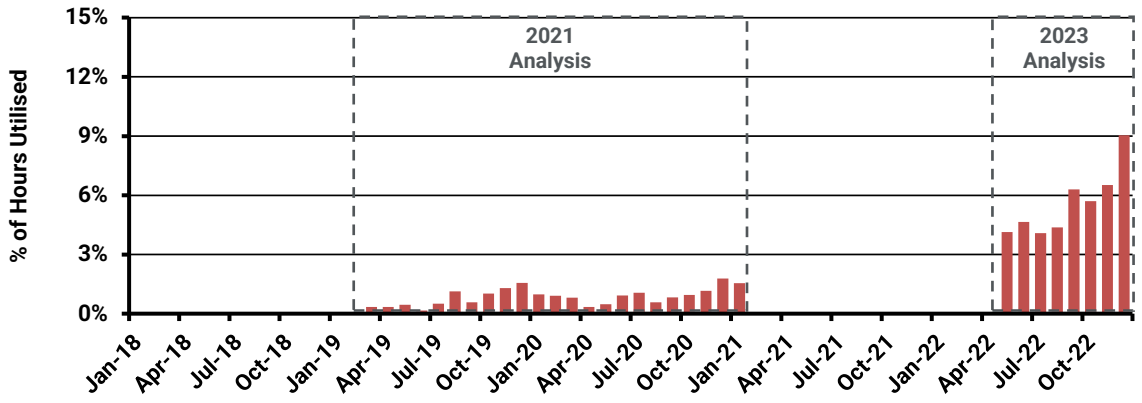
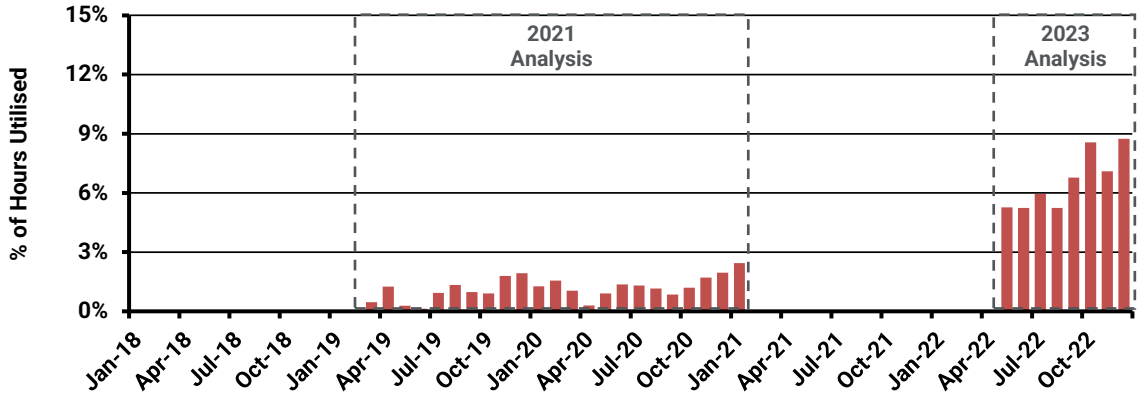
Per Site Usage Over Time – by Day Type

User Frequency Over Time – Weekday



Source: ChargeFox and Evie

User Frequency Over Time – Weekend



Source: ChargeFox and Evie

- Actual utilisation rates are shown on a per chargepoint basis by day type
- The results indicate that day type has a small impact on utilisation rate, with weekends marginally higher in non-holiday months
- Highway utilisation is dependent on commuter vs visitor behaviours
  - These splits vary by road, and connected urban and regional hubs

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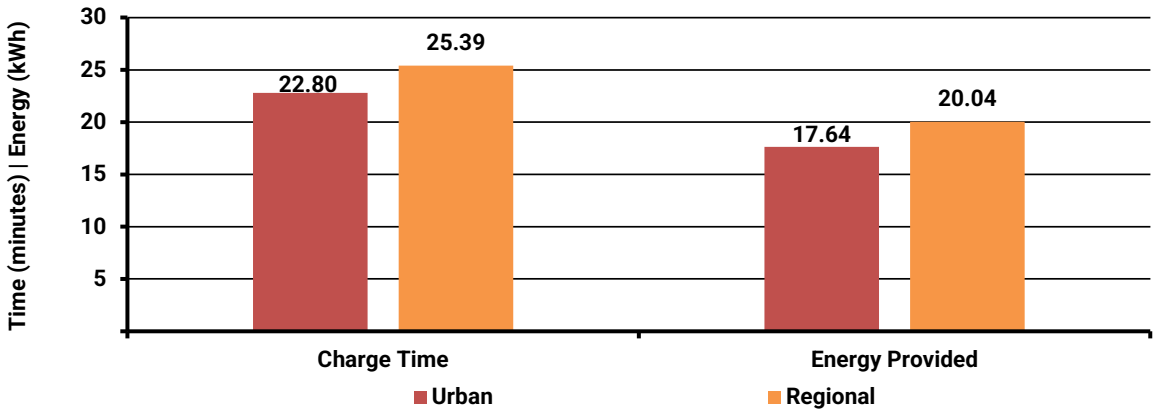
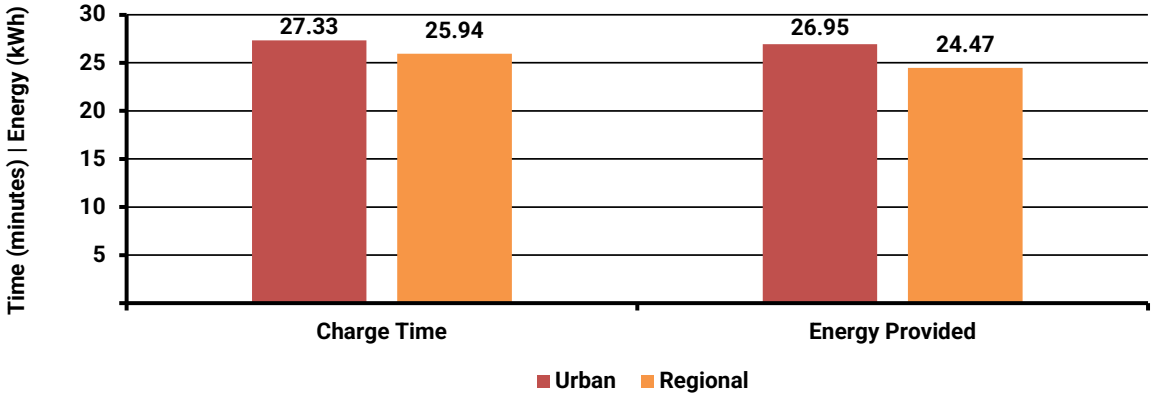
Session Duration Breakdown

Average Charge Time vs. Energy Provided – 2021



Source: ChargeFox, Evie, Note: Where driver location data was available, Session Data from Oct 18 – Feb 21

Average Charge Time vs. Energy Provided – 2023



Source: ChargeFox, Evie, Note: Contains session data from Apr 22 – Dec 22

- Updated data shows that there is less of a contrast between urban and regional charging sessions in terms of duration or energy provided
  - Regional was higher before due to greater average distances travelled
- Energy provided per session has increased significantly
  - Probably due to larger batteries

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Electricity Costs

Site Tariff Type

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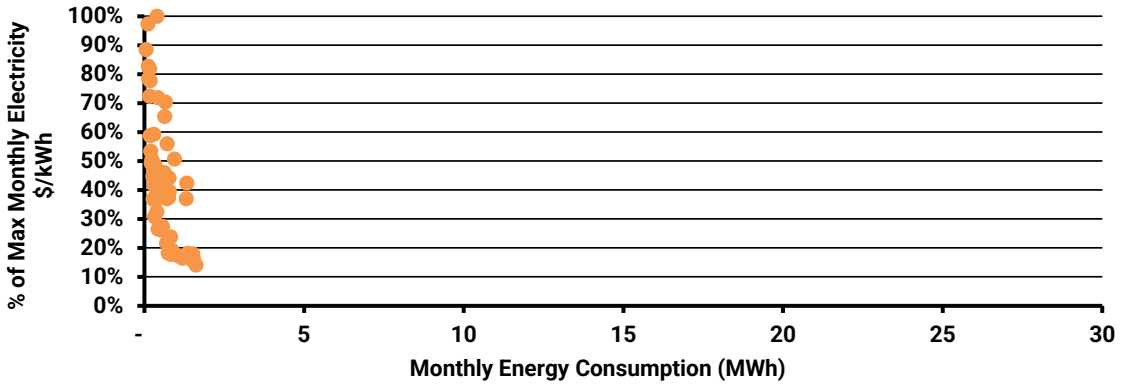
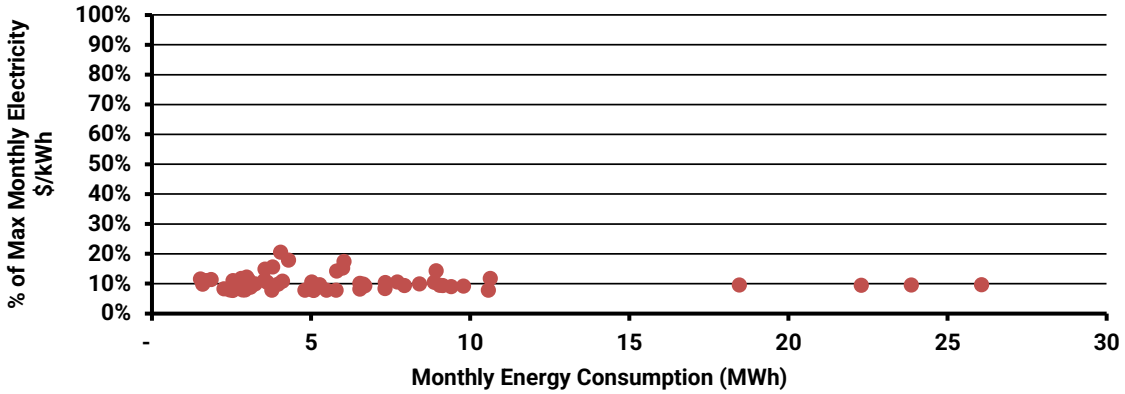
Site Energy Cost Breakdown

Monthly Site Electricity $/kWh by Energy Consumption (2021)



Source: Evie Networks, Note: Where bill and consumption values were available

Monthly Site Electricity $/kWh by Energy Consumption (2023)



Source: Evie Networks

- Charts show all monthly energy bills where the maximum monthly bill over both studies = 100%
- Analysis shows that cost per kWh falls on average with higher kWhs per site per month
  - Utilisation is the key for keeping net running costs low
  - Energy costs flattened on a per kWh basis against the initial analysis, as predicted

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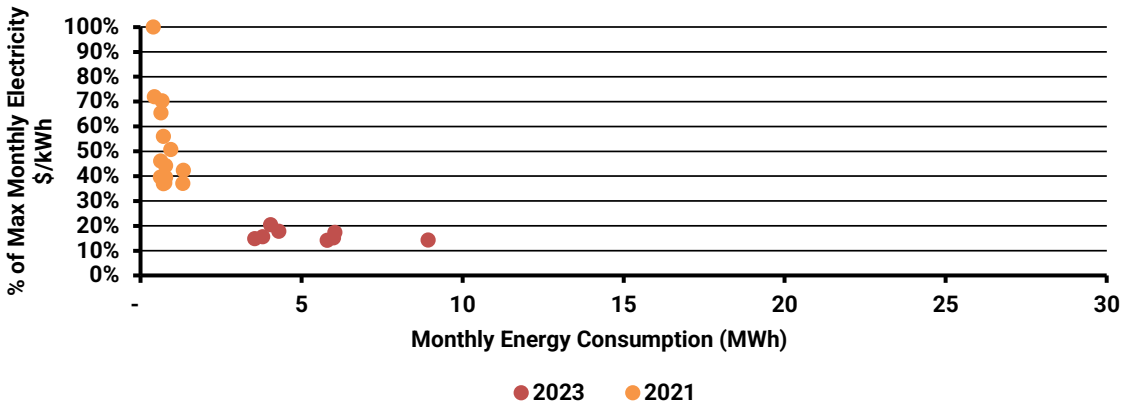
Site Energy Cost Breakdown – By Tariff

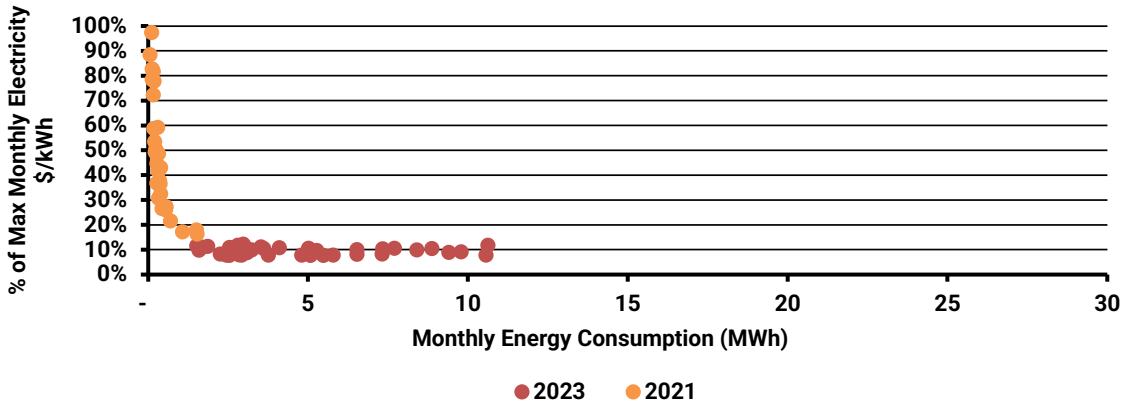
MD Tariff - Electricity $/kWh by Energy Consumption



Source: Evie Networks

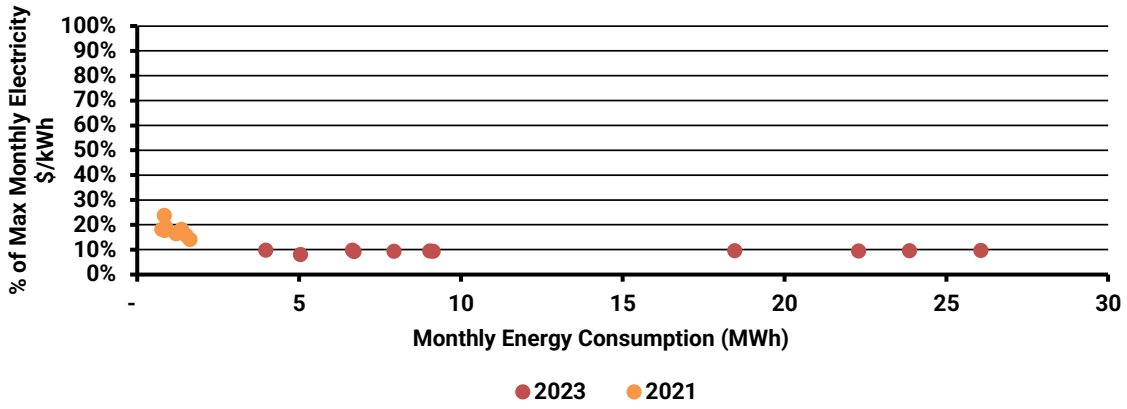
- Costs have generally fallen on a per kWh basis, indicating higher utilisation
- MD costs have also fallen as consumption rises, but is higher than other tariffs for equivalent consumption
- ToU bills are higher on a per kWh basis than the flat bills, however costs appear converge at higher kWhs
- Flat $/kWh lowest of all, potentially a result of differences in distribution network cost structures between those offering flat vs. ToU or MD rates

ToU Tariff - Electricity $/kWh by Energy Consumption



Source: Evie Networks

Flat/BT Tariff - $/kWh by Energy Consumption



Source: Evie Networks

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Peak Demand Impacts

Contribution to System Peak Demand

Load Factor

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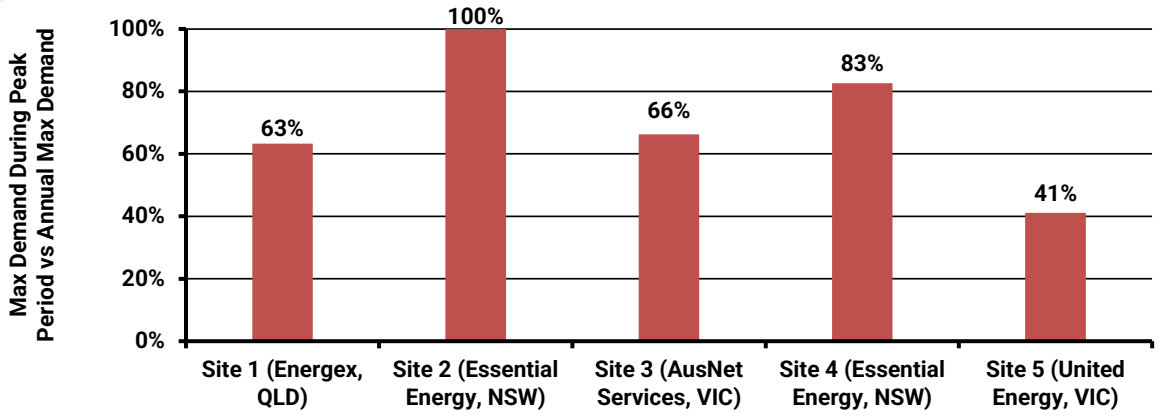
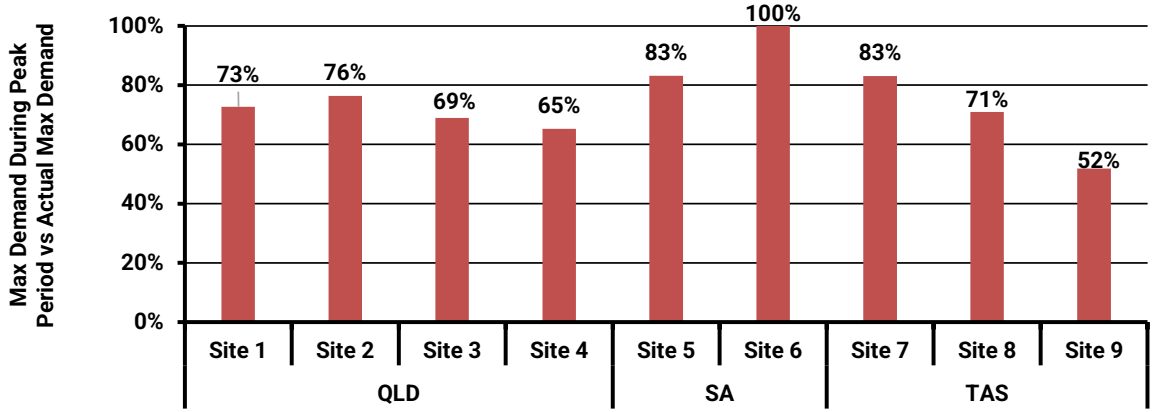
Electricity System Impacts

Contribution to System Peak Demand per kW by Station – 2021



Source: Evie Meter Data

Contribution to System Peak Demand per kW by Station – 2023



Source: Evie Meter Data

- Public charging has the potential to drive significant upstream network upgrades if not managed correctly
- 1 out of the 5 old stations observed peaked during the peak network time, assumed to be 3-9pm on summer weeknights as a simplification
  - 1 out of the 9 new stations observed this in the 2023 analysis
- The 9 new sites have an average peak demand correlation of 75%

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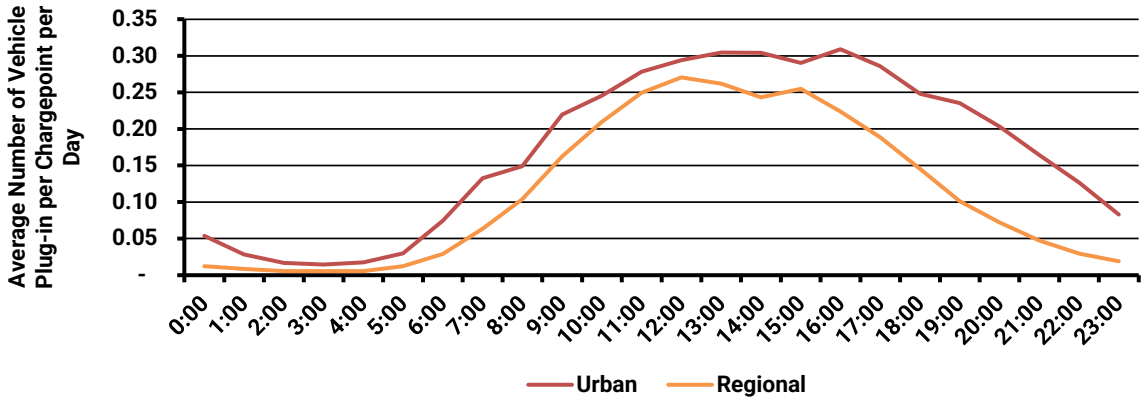
Electricity System Impacts

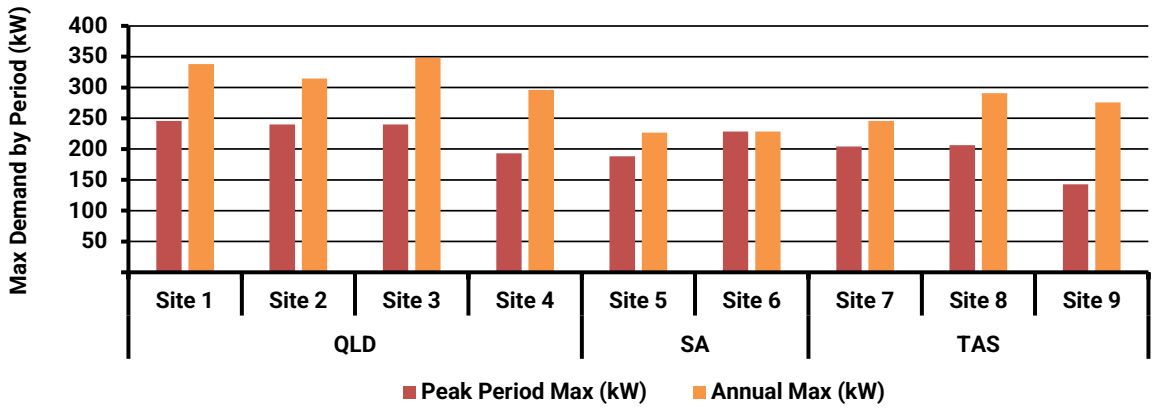
Typical Plug in Volume by Hour and Location - 2023



Source: ChargeFox and Evie

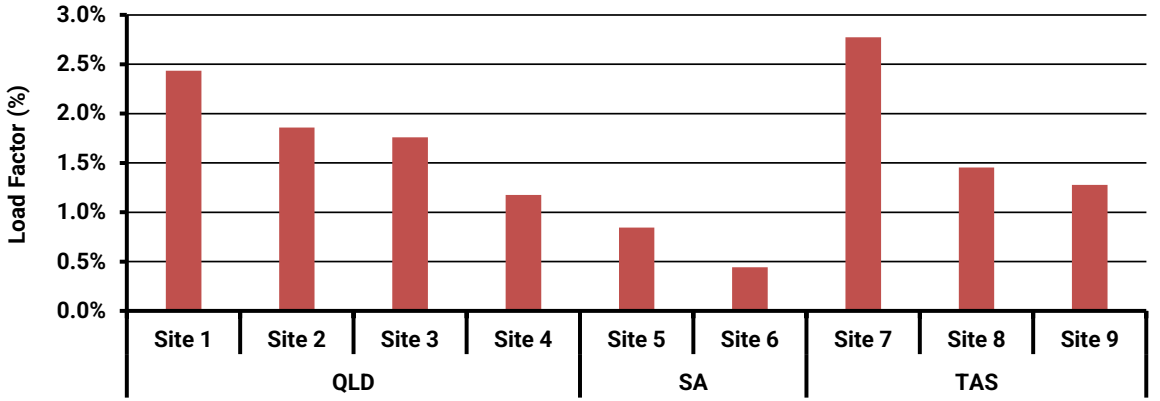
- Urban sites have higher utilisation, occurring later into the evening
  - This utilisation results in greater contribution to peak demand
- Most sites provided showed that charging stations don't charge at rated capacity
  - Ability to charge at charger rated capacity is limited by the maximum rate of the vehicle
  - Kia EV6 and Hyundai Ioniq 5 are capable of charging at 350 kW

Contribution to System Peak Demand per kW by Station – 2023



Source: Evie Meter Data

Load Factor by Site – 2023



Source: Evie Meter Data

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Thank You!

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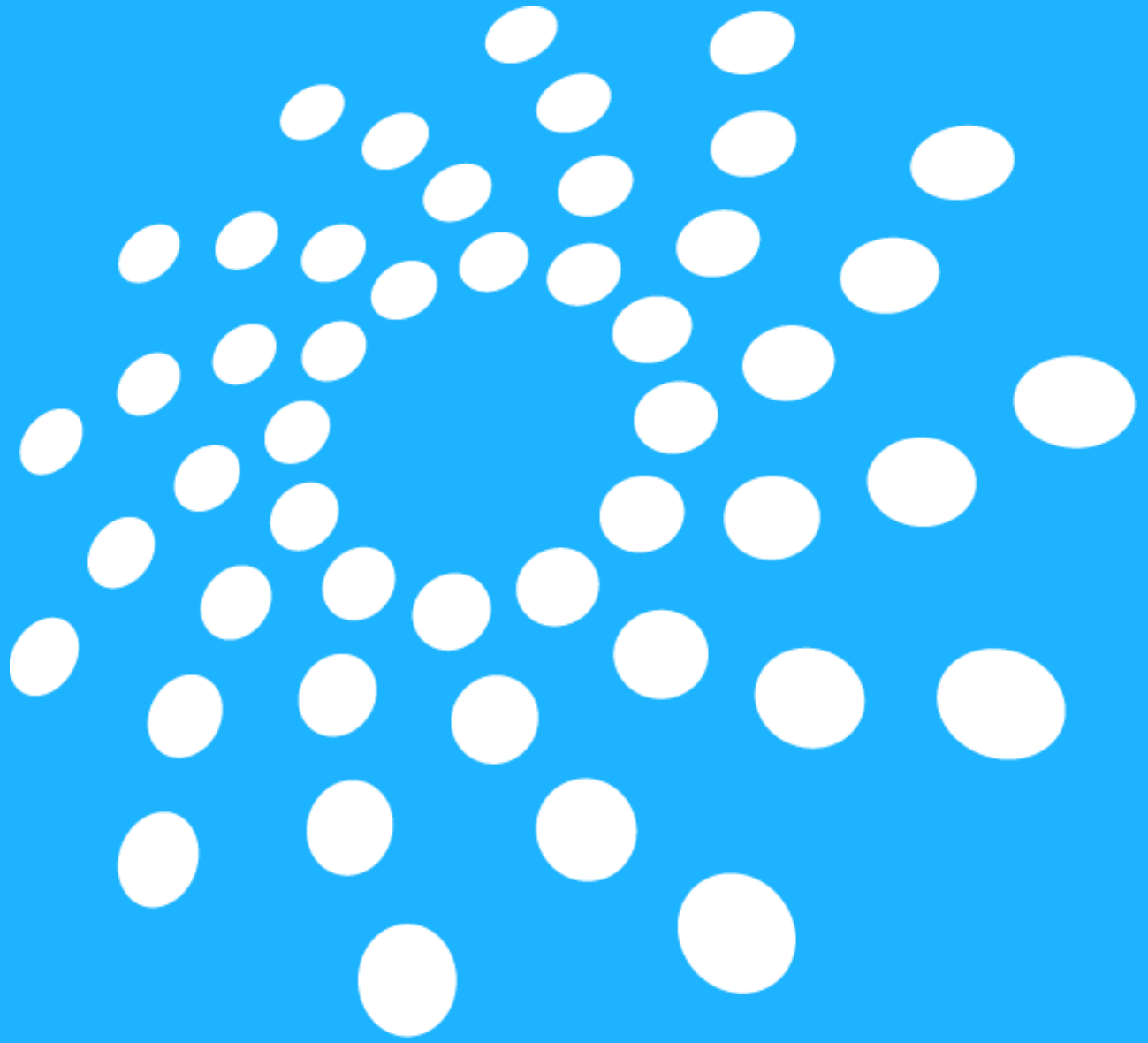

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