Smart Charged

ELECTRIC NATION

The Results of the Electric Nation Smart Charging trial

COLLABORATION PARTNERS

ea technology · driveelectric electric car leasing · Lucy Electric · TRL

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Serving the Midlands, South West and Wales

Welcome

Roger Hey
WPD
DSO Systems & Projects Manager

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EVs are coming

Since 2016 when project started

- Many new EVs available
- More and more over next few years

Improving choice for drivers

Great driving experience

Great news for the environment

And great for the electricity industry

But this will create challenges

- For the electricity supply industry
  - Generation
  - Transmission – National Grid
  - Distribution networks

- Home charging – preferred by most
  - On street parking?
- Workplace
- Depot/Fleet
- Destination
- On route

} Fast and Rapid Chargers
Higher power

Today

- Focussing on home EV charging
- What we have learned about EV charging
  - And smart charging
- All about the Electric Nation Smart Charging Trial
- How this will help Distribution System Operators manage this new electricity demand

Introduction to the Project

ELECTRIC NATION

Ricky Duke
WPD
Innovation & Low Carbon Network Engineer

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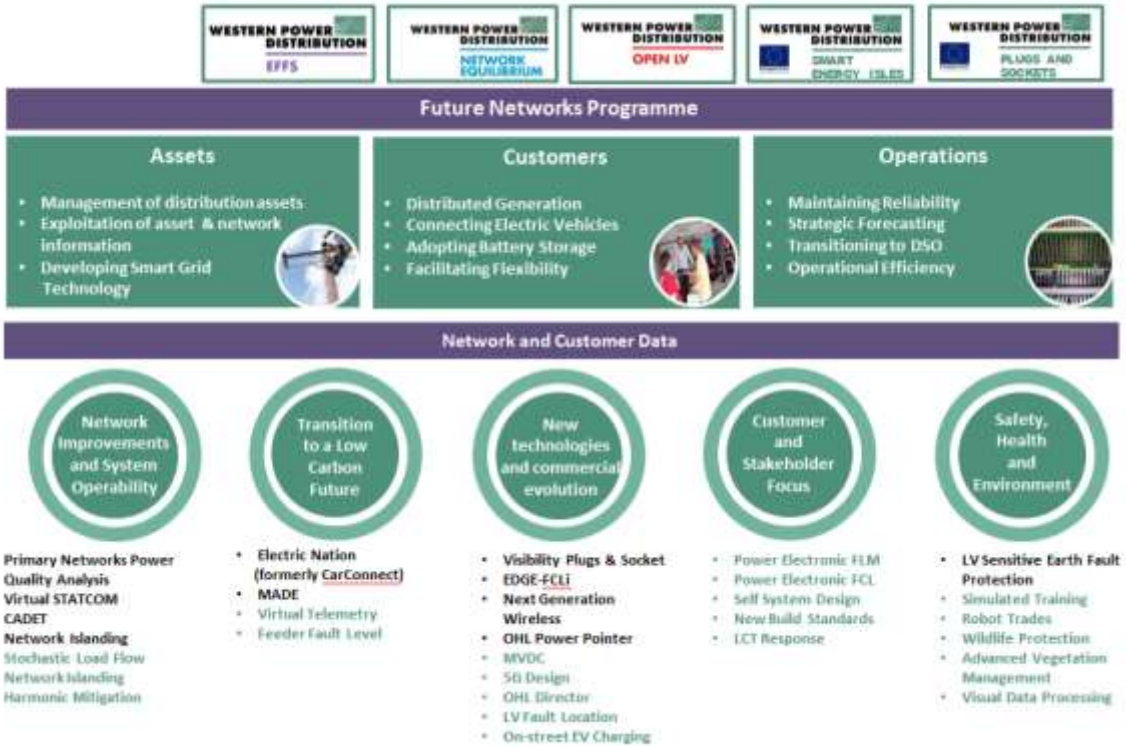
Western Power Distribution Innovation Programme



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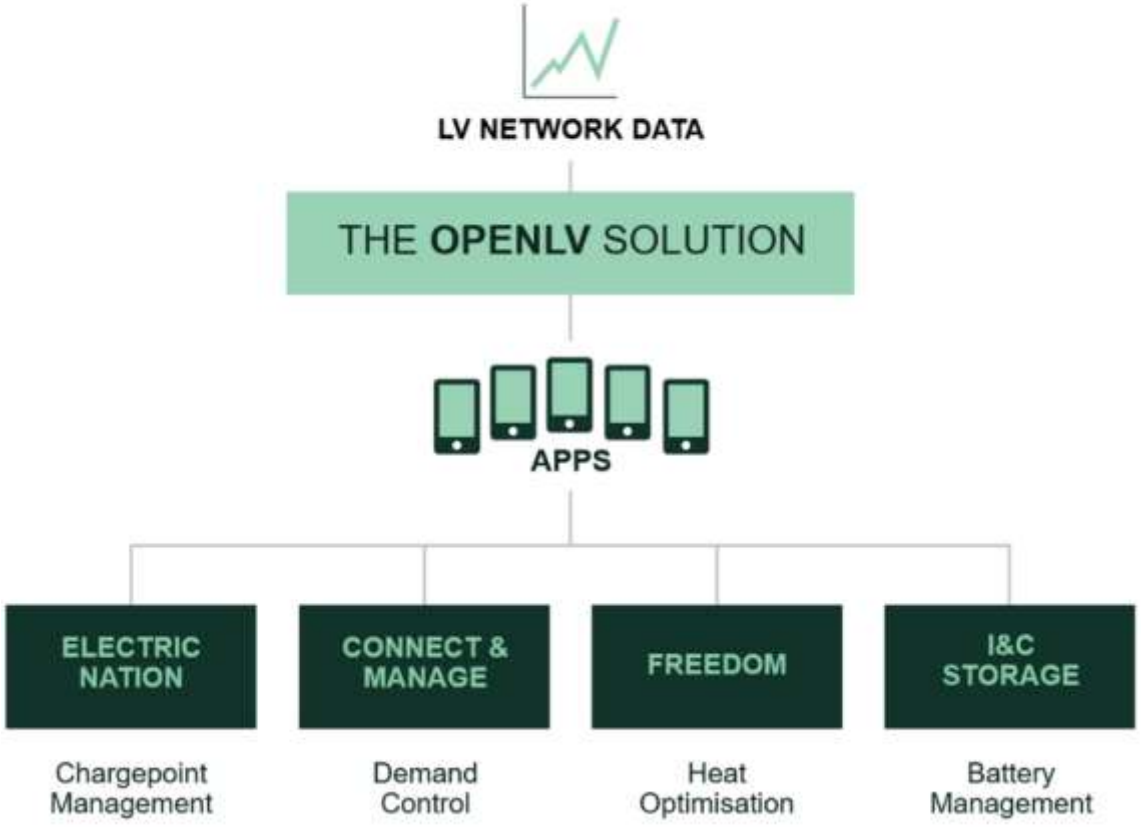
LOW VOLTAGE (LV) NETWORK INNOVATION



EVs & The Electricity Supply Chain

- EVs will require the generation and transmission of additional electricity to charge up:
  - Challenges for the generation industry and National Grid
- And Distribution Network Operators in their networks down to 11kV network level
- For Distribution Network Operator's on 11 kV and LV networks EV loads may overload these networks – in certain seasons and times of day

What can be done about this?

- Additional loading on LV networks would result in at least 30% of these networks in GB requiring investment by 2050 costing billions of pounds
- Investment = upgrade/replace these networks – disruption affecting all of us
- Costs of upgrades go onto customer bills – a hidden cost of EV ownership?
- Smart charging could reduce/delay or avoid the need to upgrade/replace networks
- UK Government is mandating smart charging
- This project aimed to provide evidence whether it will work

So, what's the problem?

- Electricity demand from
  - People's homes
  - Shops, Offices
  - Factories and warehouses
- Vary through the day/week
- & by season
  - and is weather dependent
- Worst time of year is the coldest winter day
  - When offices/shops/factories still operating
  - People coming home from work
  - Coincidental high demand

Electric Vehicle Charging

- Compared to other household appliances
  - High power 3.5/7kW
    - Similar to kettle/electric cooker/shower
  - But ON for hours
    - High energy use
    - Similar demand to a house in a year

- Charging an EV is like adding an extra house to a network

So, why can't the network **cope with this?**

- **Electricity networks designed before EVs** were a twinkle in Elon Musk's mind
- **On average designed to supply 2kW per home**
  - **Diversity in electricity use across homes allows this**
- **Adding 3.6/7kW to this average demand** doesn't go
  - **One EV on most streets OK**
  - 2, 3, 4, 5… Still OK
  - **But at some point the EV demand could breach the operational limits of a network**

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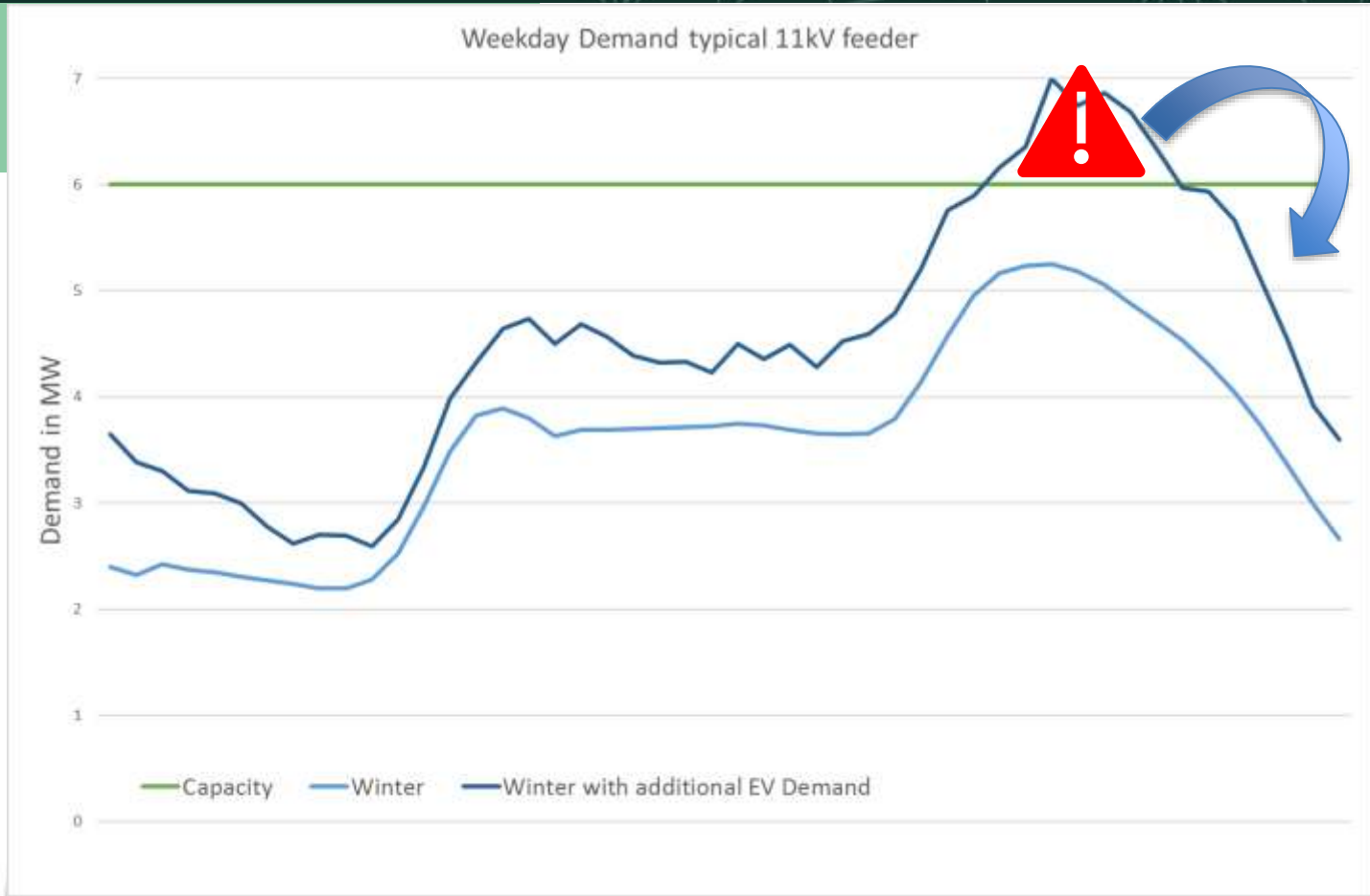
The Resulting Demand



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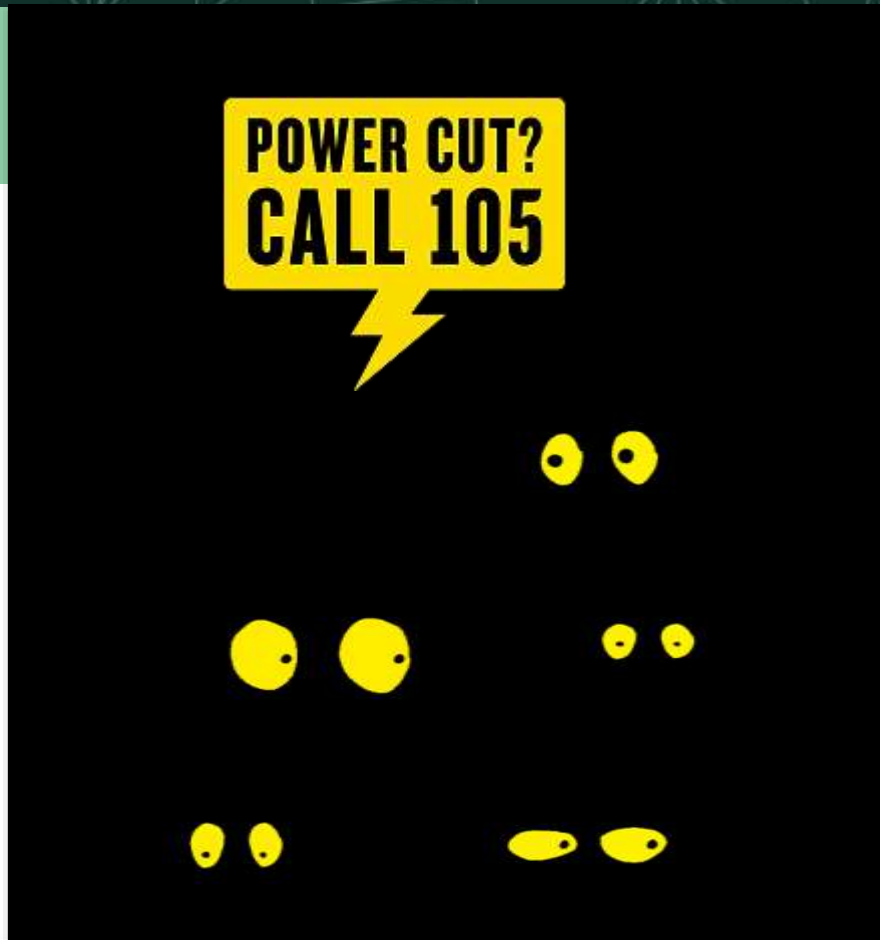
Consequences

- Supply voltage drops below statutory limit
- Transformers and cables overheat
  - Reduces lifespan
  - Wear out sooner
  - Weaknesses aggravated
  - Faults occur and repeat
  - Fuses blow
- Unhappy customers



Solutions

- Upgrade networks
  - We do this already
  - And will continue to

- Smart solutions
  - WPD's Connect & Manage
  - WPD's Constraint Managed Zones
  - Smart Charging?

Solutions

- Upgrade networks
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- Smart solutions
  - WPD's Connect & Manage
  - WPD's Constraint Managed Zones
  - Smart Charging?
- Let's investigate…

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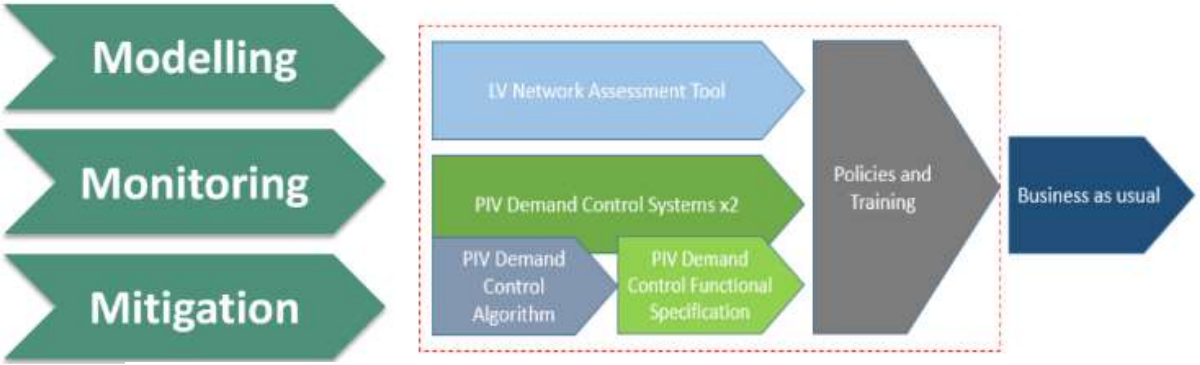
Proving the benefits of smart EV charging for both customers and local power networks

The world's largest Smart Charging trial (500-700 participants)

3 year project (2016-2019)

Involving all types of plug in vehicles (PHEV/EV)

Conceived, designed, and led by EA Technology



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Thank you for listening

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The Smart Charging Trial

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Nick Storer
EA Technology
Principal Consultant

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Electrical Distribution Networks
Engineering products, services and consultancy

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A pedigree in electrification of transport

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More recently: My Electric Avenue (2013-15)

MY ELECTRIC AVENUE

EA Technology

Electrical Distribution Networks
Engineering products, services and consultancy

A pedigree in electrification of transport

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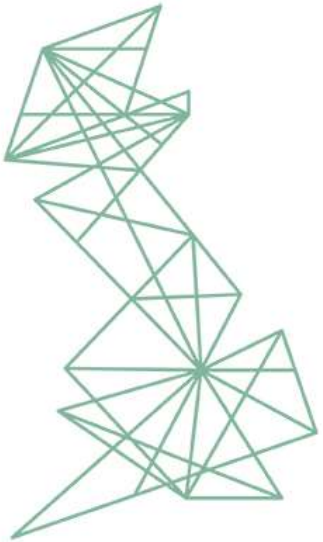
Collaboration partner on Electric Nation
Responsible for technical leadership on the project:

- The Smart Charging Trial
- Development of a Low Voltage Network Assessment Tool



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Before we start...

Today is an overview

- **Key findings**
- **Key supporting evidence**

Everyone here today will receive link to final report & today's presentations

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Smart Charging Systems Selection

Selected Back-Office providers during project development phase

- CrowdCharge
- GreenFlux

Smart Chargers during project initiation

- CrowdCharge: APT eVolt
- GreenFlux: Alfen ICU

Charger communications within & to/from homes

The Tech Factory

CROWD charge

evolt

GreenFlux

Smart charging

ALFEN

POWER TO ADAPT

Test System

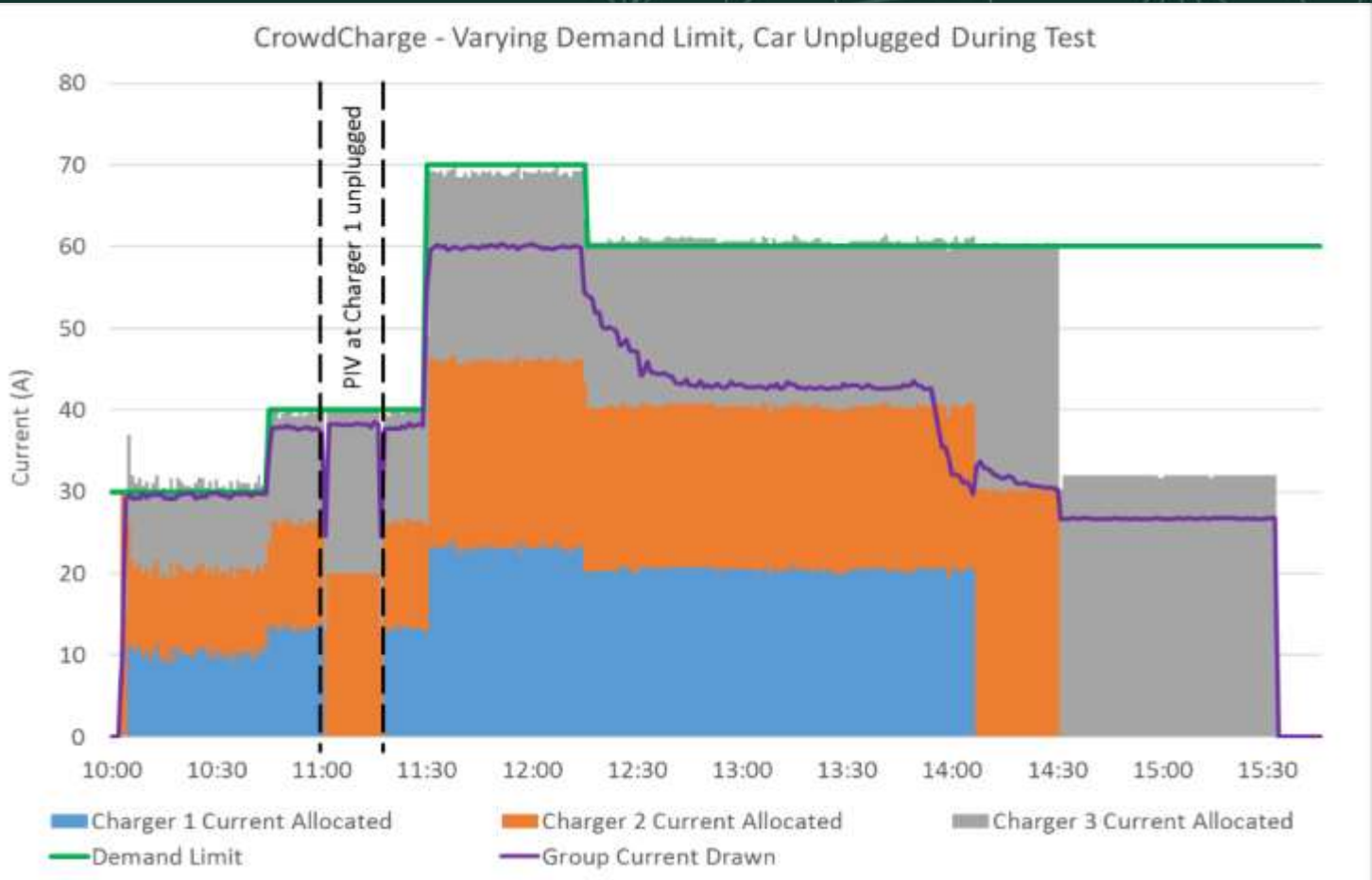
- 6 x CrowdCharge controlled chargers
- 6 x GreenFlux
- Independent monitoring of charger pilot signal and power drawn by EV
- Used to test Smart Charging algorithms

  &
- Whether EVs followed smart charging power allocation changes

Typical Test

3 Evs

Varying demand limit



Pilots

- 10 pilot installations
- Testing installation and commissioning procedures
  - Chargers
  - Communications equipment

All looking good, so far…

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Installers

- Managed by Drive Electric
- Trained: installation and commissioning
- Customer-supplied survey (via form)
- Installation visit
- Charger hardware support

ACTEMIUM

DRS Facilities & Environmental

EV CHARGING SOLUTIONS

The Phoenix Works

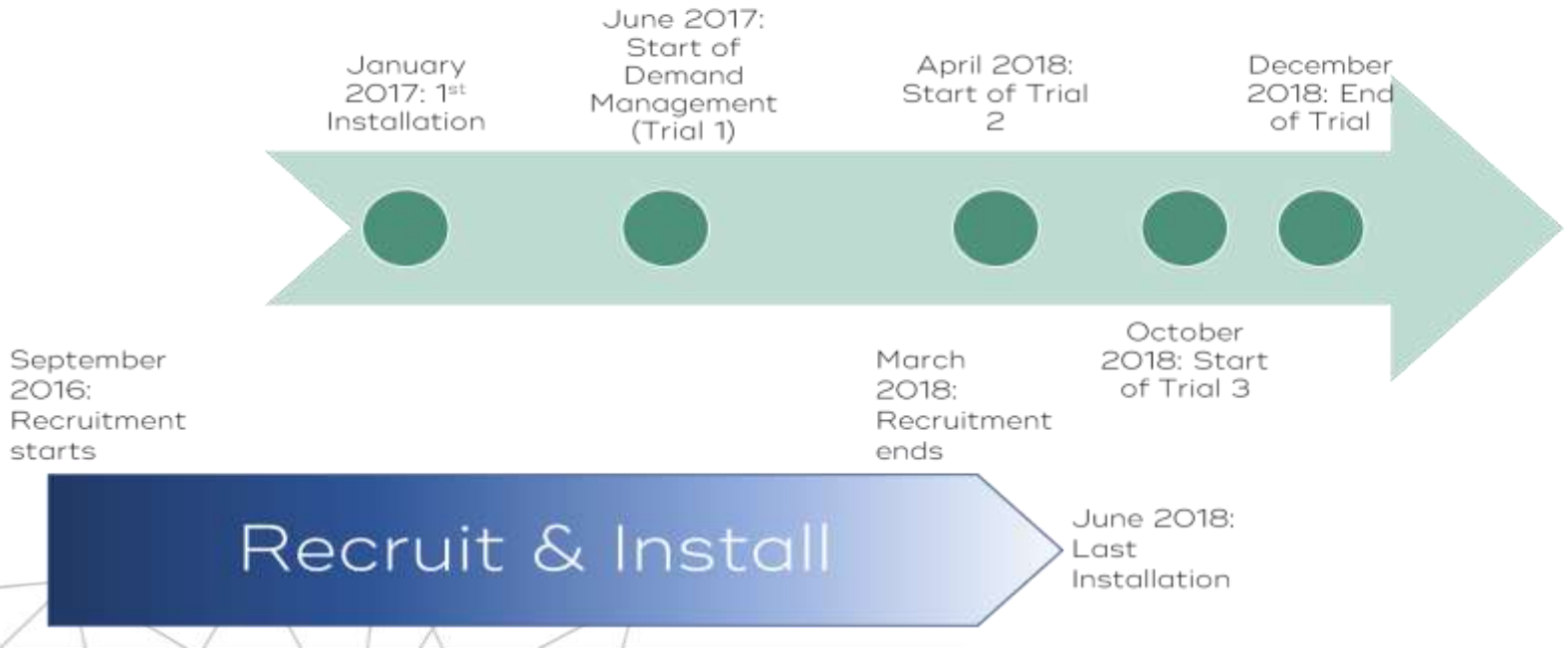
Stratford energy solutions

Recruitment of Trial Participants

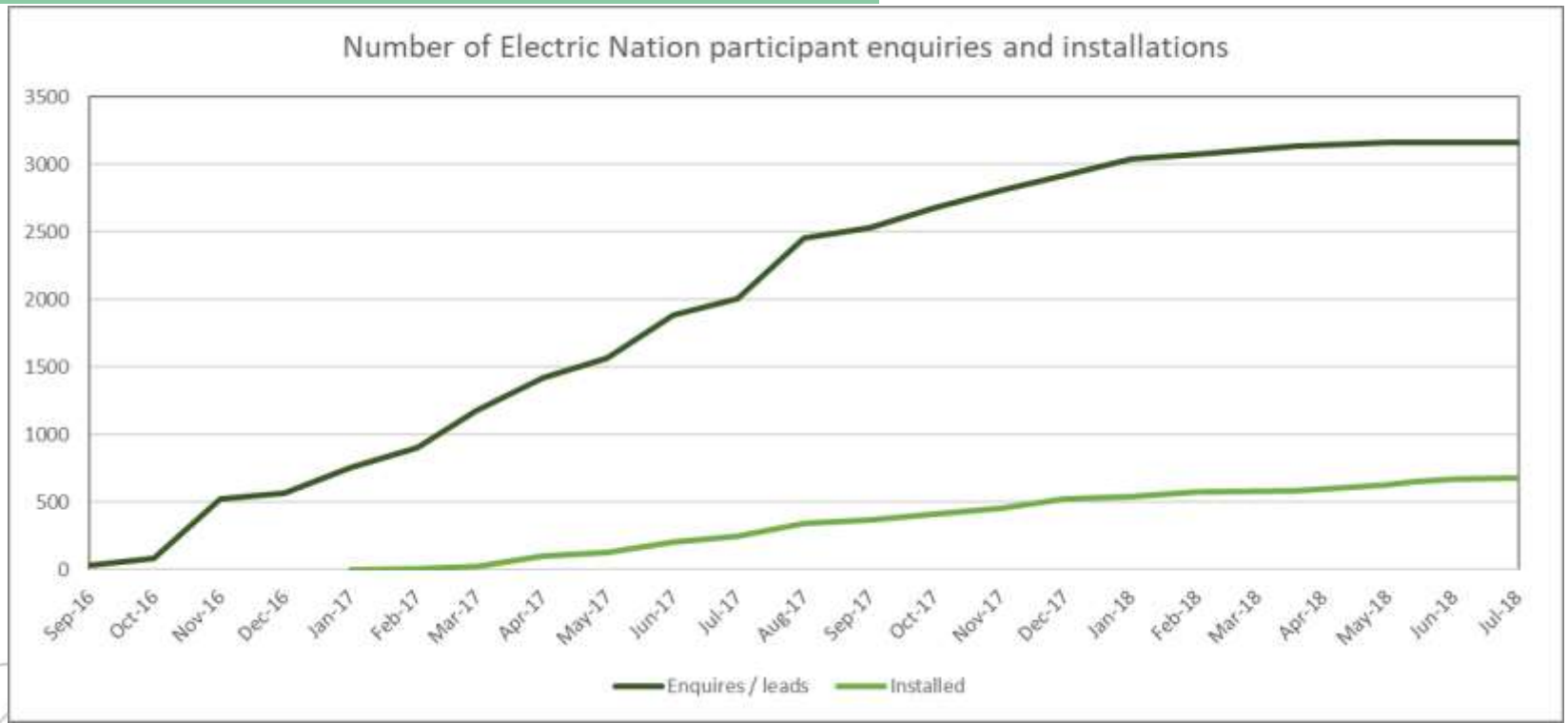
Lead by DriveElectric

- Public and company events
- Dealerships
- Go Ultra Low cities
- Press releases and media articles
- Website

Trial Timeline



Recruitment: Target 500-700 Achieved 673



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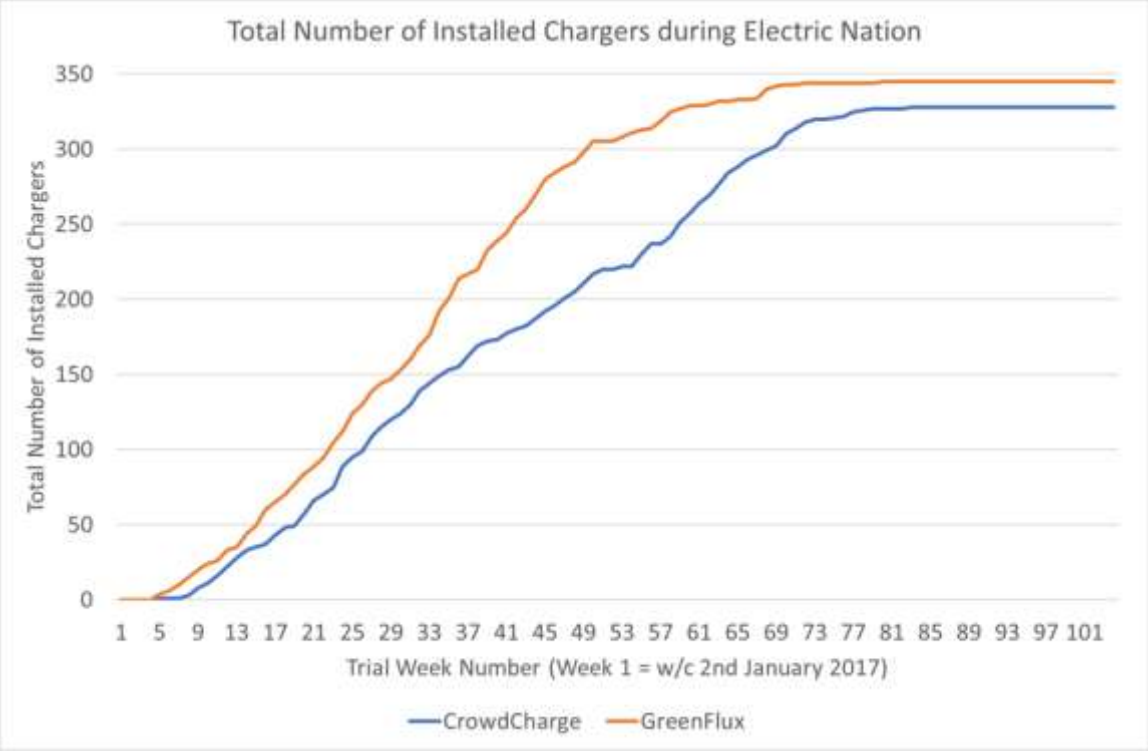
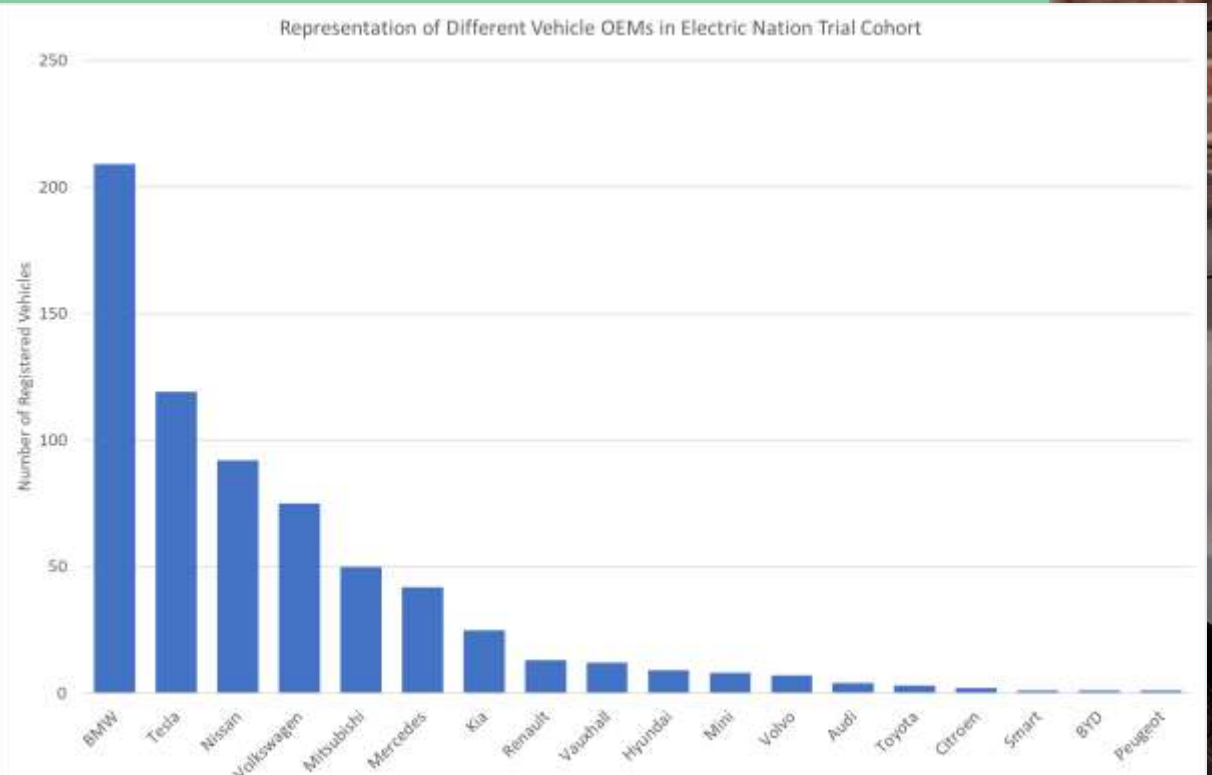


673 EV drivers recruited into trial



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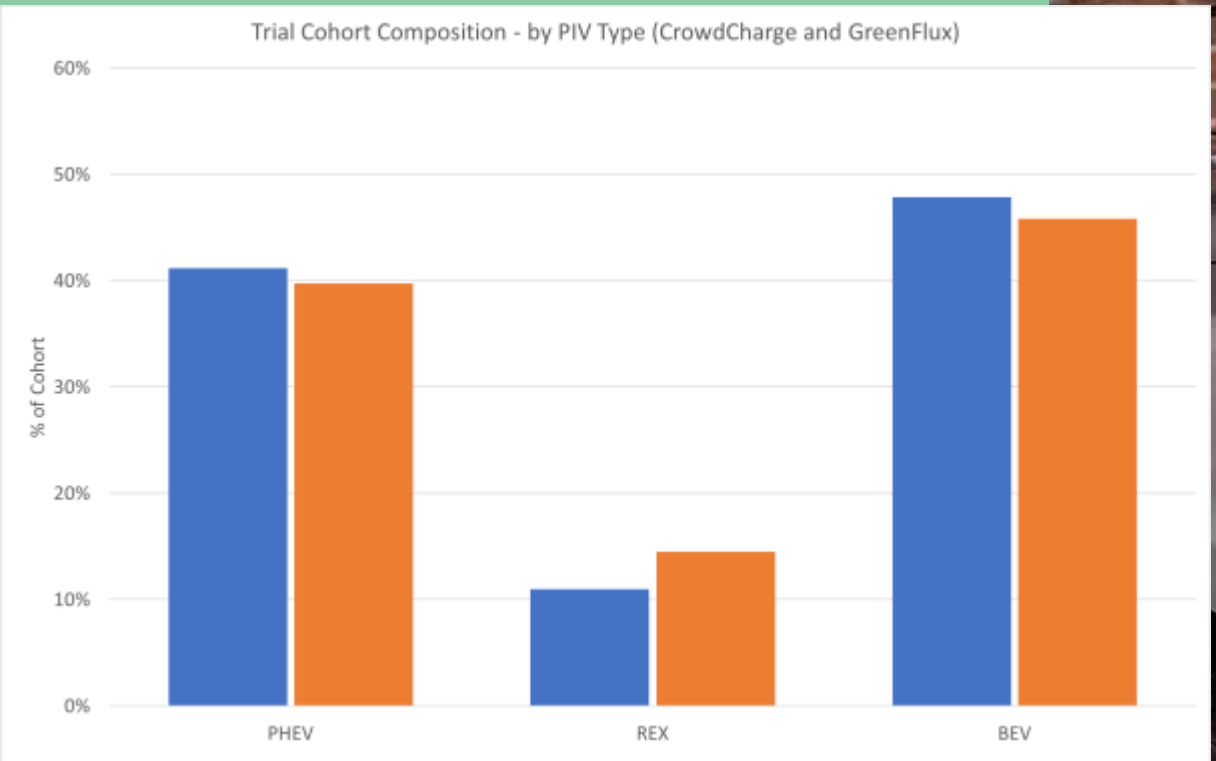

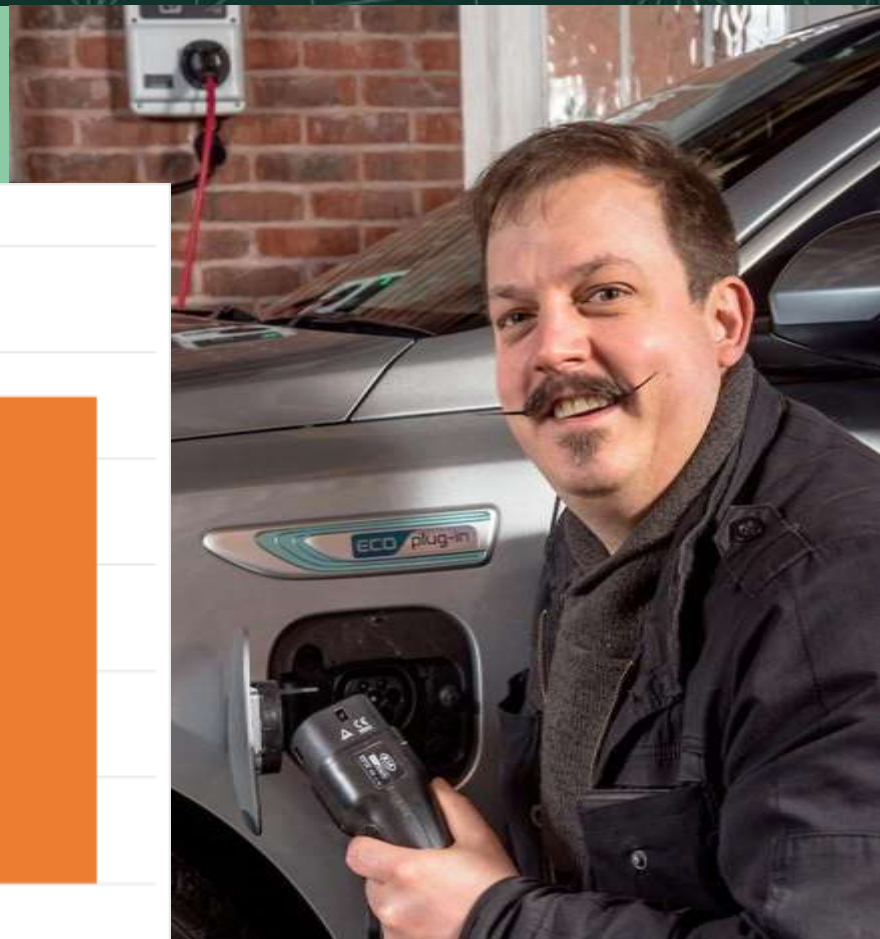

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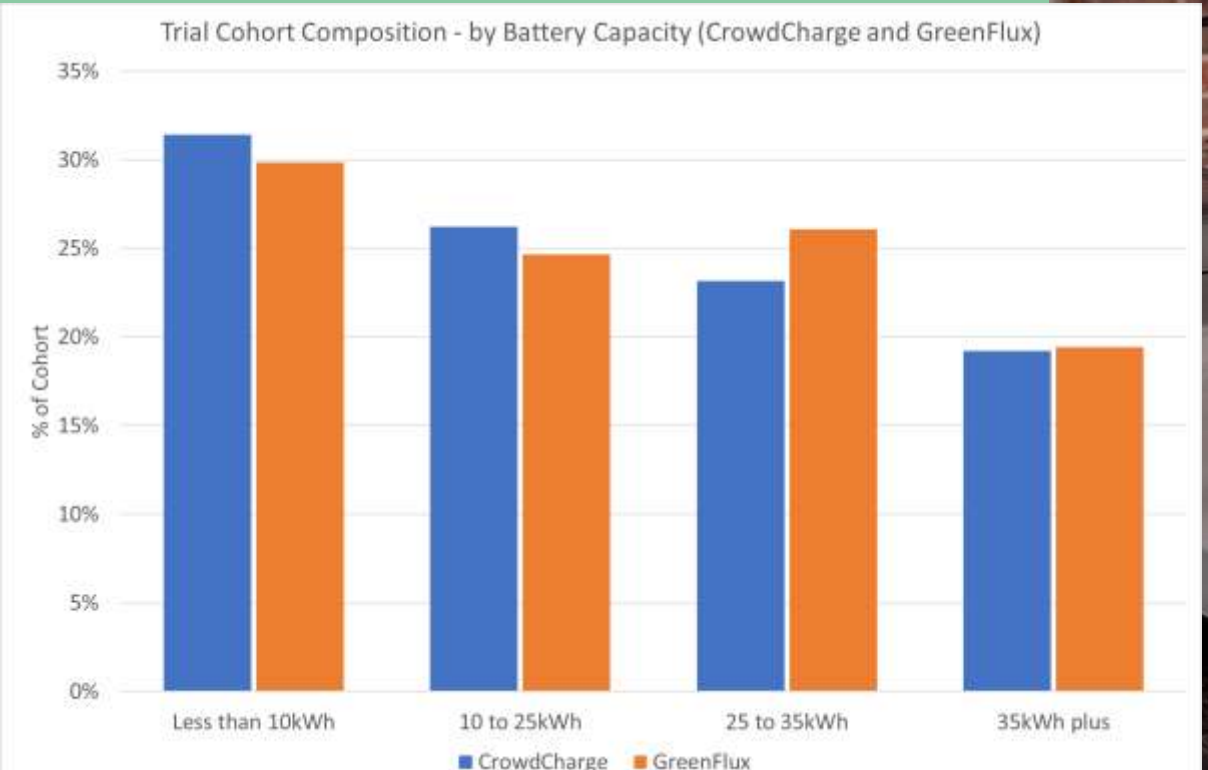

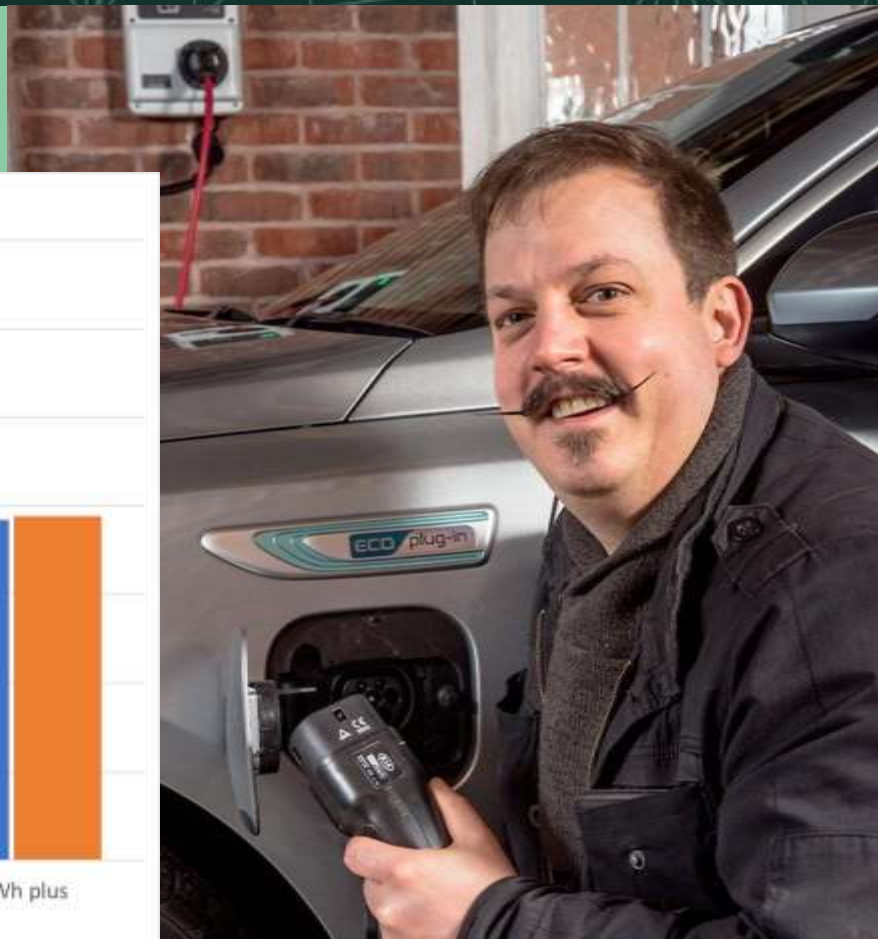

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Customer Research

Surveys

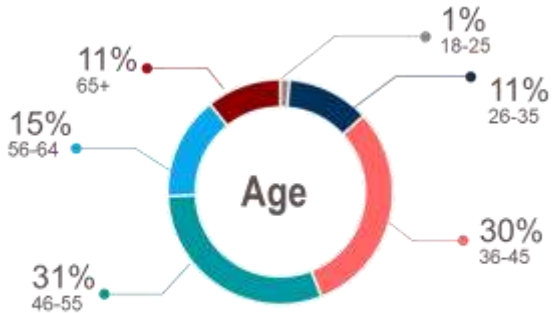
- Recruitment
- Baseline
- Trial 1
- Trial 2
- Trial 3
- Post Trial & Focus Groups

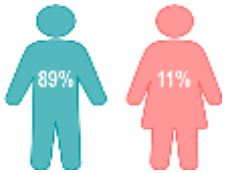
IMPACT

FROM INSIGHT TO INFLUENCE

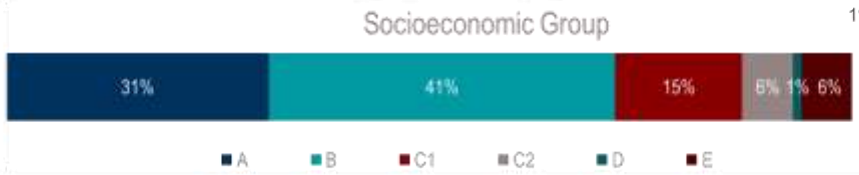
Trial Population

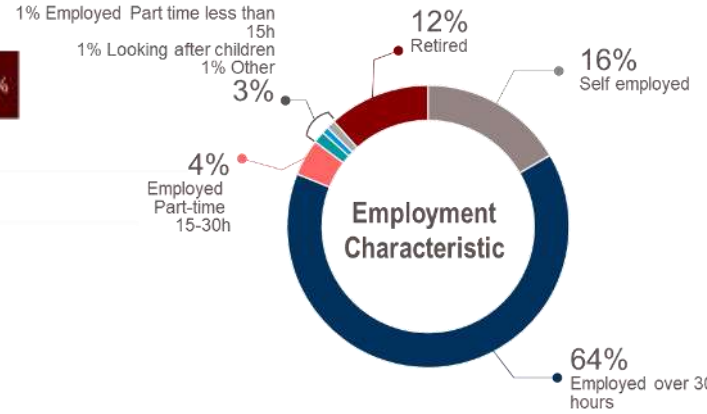
- Focuses on demographics
- Numbers presented here are for the whole trial population (GF and CC)

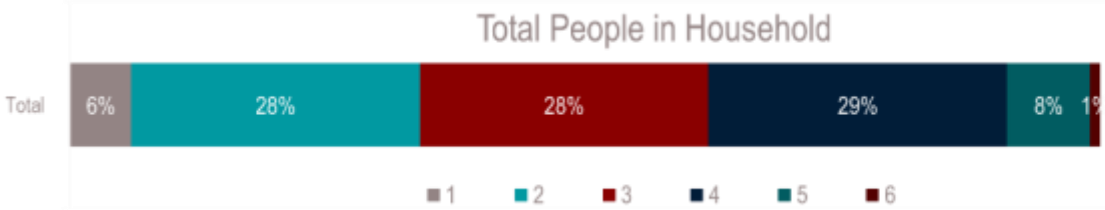




There are representatives from all socio-economic groups, but the majority of the sample are in Class A or B with 51% earning £60,000pa or over per annum.







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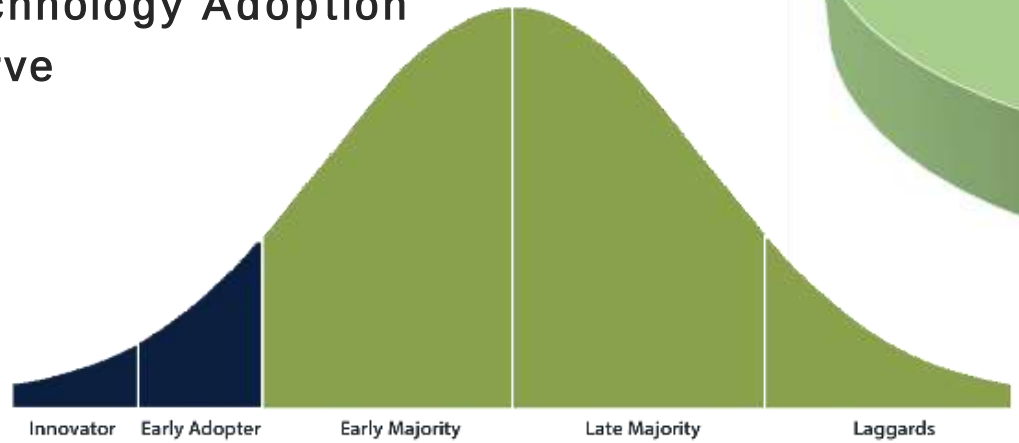
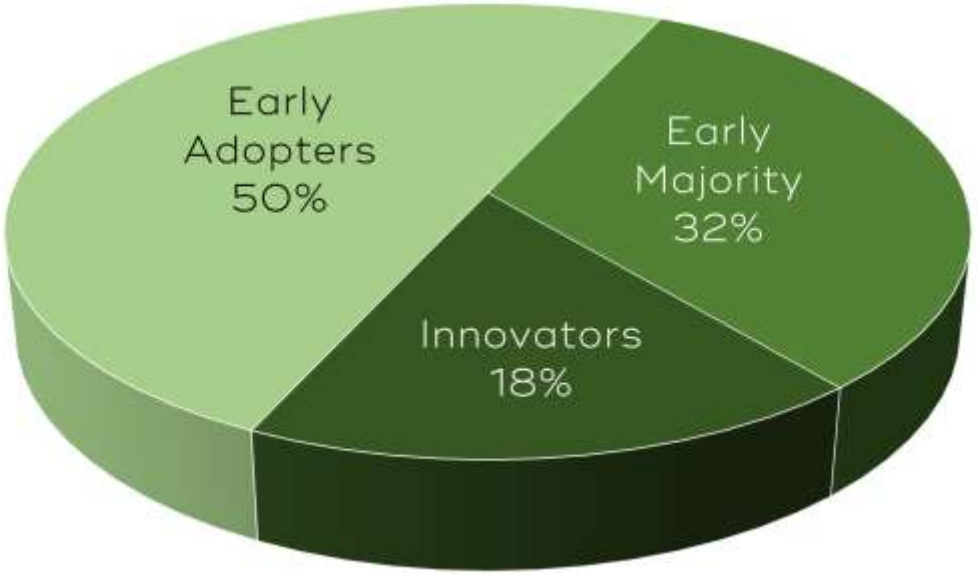
Trial Participants

Rogers et al

Technology Adoption Curve





Where do people charge

All Participants

Most Frequent Charging Location:	87% Home	13% Away from Home		
Use of Other Charging Facilities:	66% Home Only	19% Charging at Work	14% Charging Elsewhere	
Typical Weekly Mileage:	0 - 75 miles a week 13%	75 - 200 miles a week 45%	200 - 350 miles a week 28%	350+ miles a week 14%

Customer Journey through Trial

Customer Research Surveys

Get an EV

Smart Charger Installed

Charge at will

Experience Smart Charging (Trial 1)

Smart Charging + App (Trial 2)

Smart Charging + App + Time of Use Incentive (Trial 3)

Charging Transaction Data

Data Gathered

Via Smart Charging Systems:

- Transaction data
  - Plug in
  - Energy Consumed
  - Plug out
    - Greenflux - all
    - CrowdCharge - only if online
- Meter data
  - 1 or 3 minute meter readings during transaction
  - Only captured if online
- Online/offline

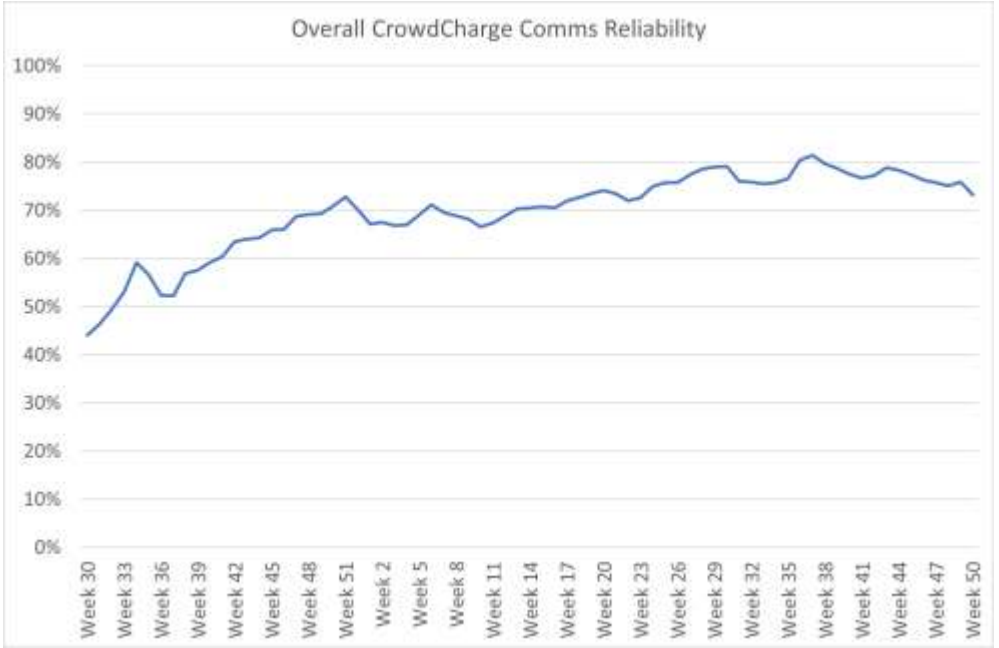
Via Customer Research:

- Participant profiles (gender, age, etc)
- Satisfaction with charging arrangements
- Acceptability of smart charging
- Reflections of experience during trial

Communications

Host of challenges during the project

- Installation issues
- Charger & controller configuration
  - Manufacturing errors
  - Updates
  - WiFi bridge
- Broadband internet reliability
  - It isn't
- Mobile data reliability
  - Greenflux only
  - Isn't great
  - But was useful as a back-up



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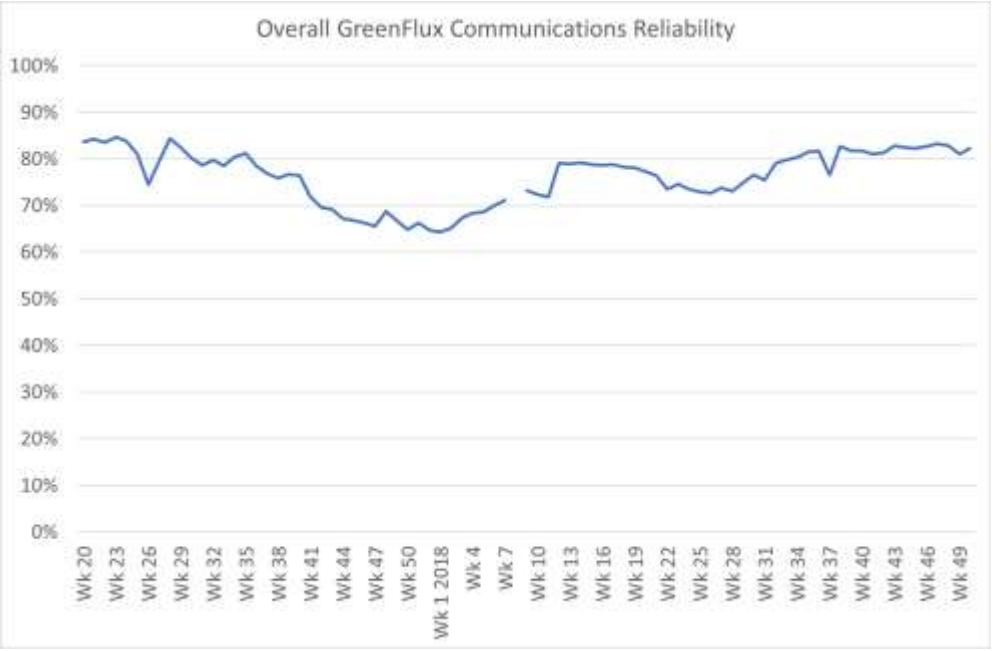

Lessons learned

Smart chargers must a consumer ready appliance

- Firmware stability
  - Updates without user intervention
- Communications stability

Communications reliability is key to success

- Broadband internet connections - not reliable
- Mobile data connections - patchy
  - Configuring to work together - not as easy as it should be

Installers need more time (£) and improved skills for the roll out of home smart chargers

Thank you for listening

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CrowdCharge Smart Charging System

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Mike Potter
CrowdCharge
Chief Executive

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Our Story

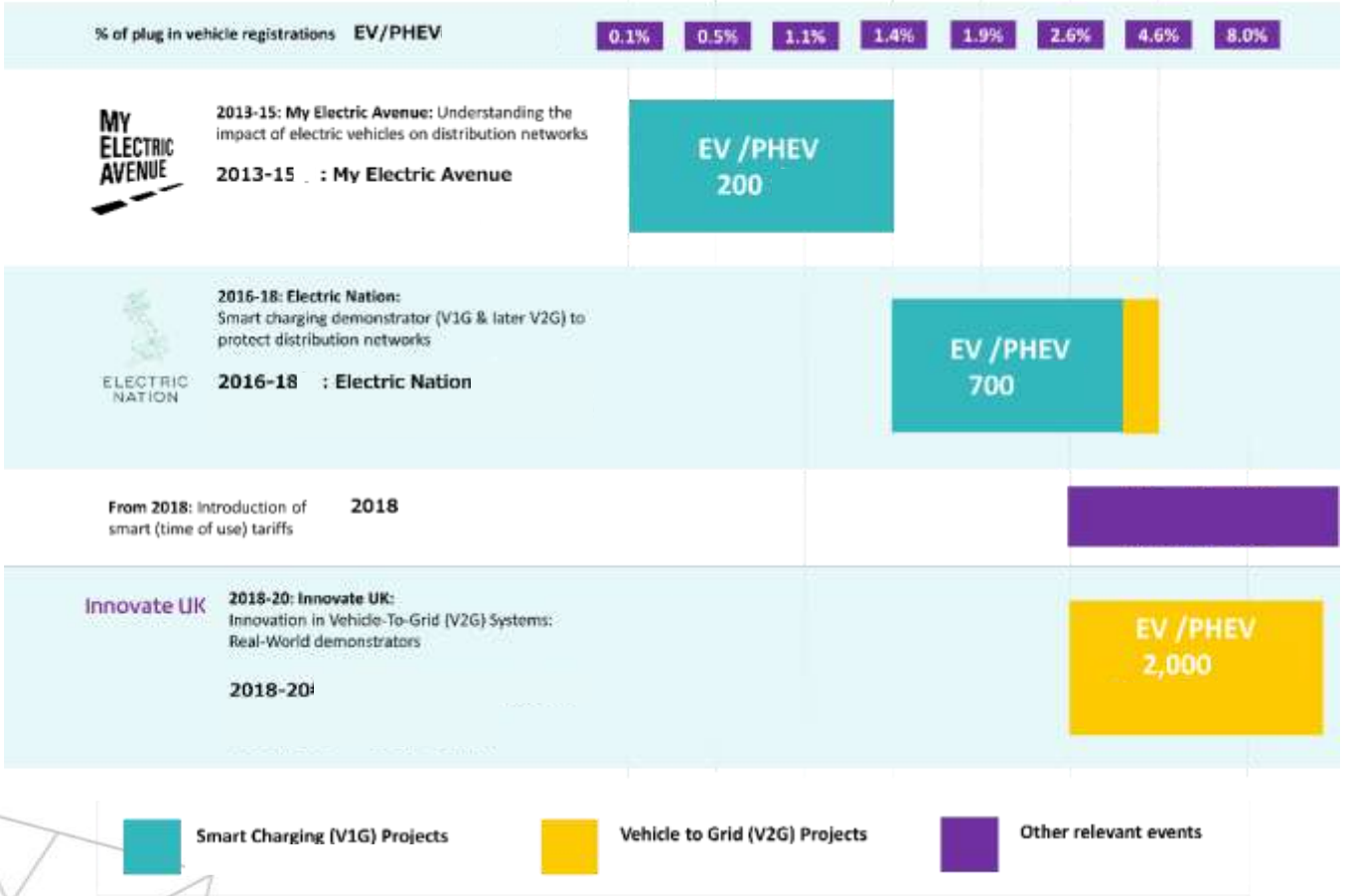
DriveElectric

- Vehicle leasing for 25 years;
- First company to lease a Tesla in the UK back in 2008;
- UK's leading specialist EV leasing company – 10% market share;
- Leading edge innovation partner for EV managed charging;
- Created smart EV charging platform company – Crowd Charge.

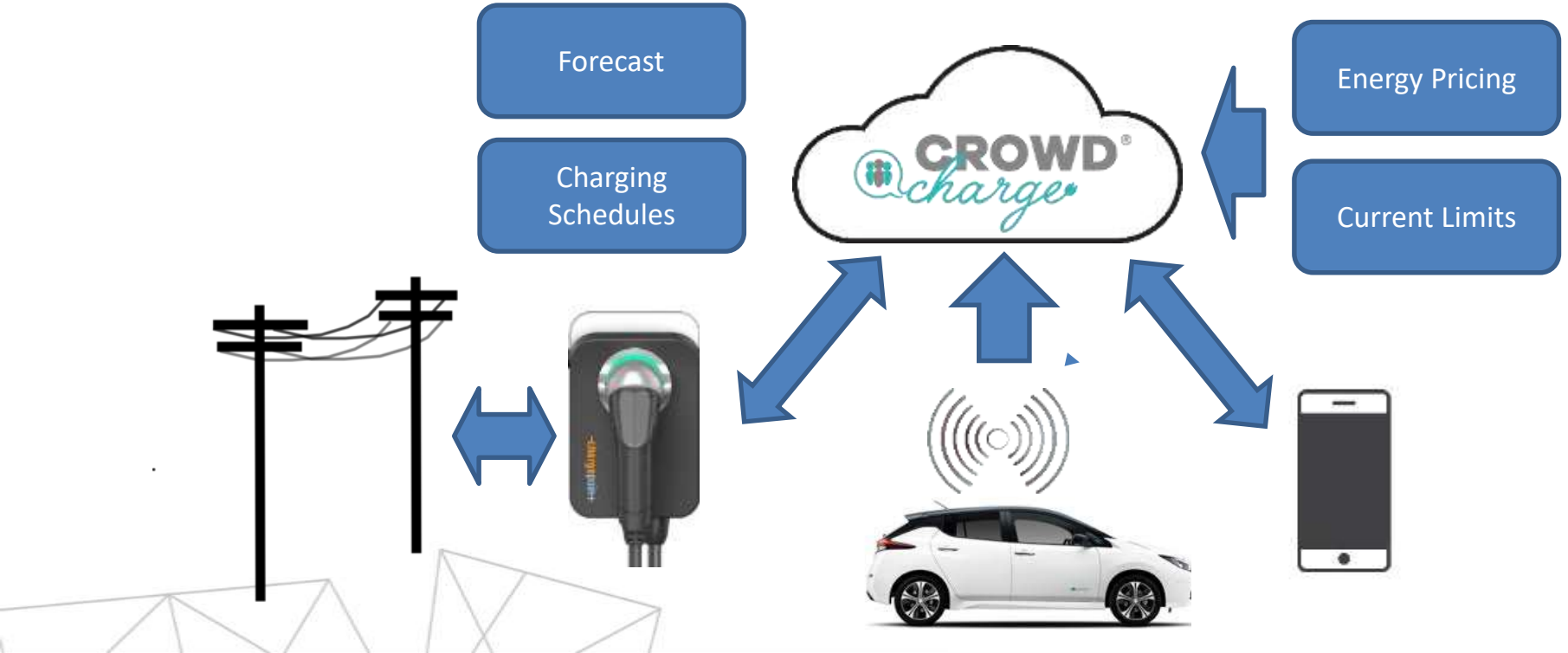
CROWD charge

- Company established to develop smart charging and V2G platform and solutions;
- Installed and operated 350 smart chargers on WPD innovation project 'Electric Nation';
- Successfully deployed a range of algorithms, optimising DNO capacity, time of use tariffs and driver needs;
- Specialist team covering charger design, DNO innovation, energy systems, battery management and AI;
- Working with Japanese partner - have the first G99 compliant domestic V2G charger on sales in the UK.

Evolution of Smart Charging in the UK



Our platform - operating since 2016



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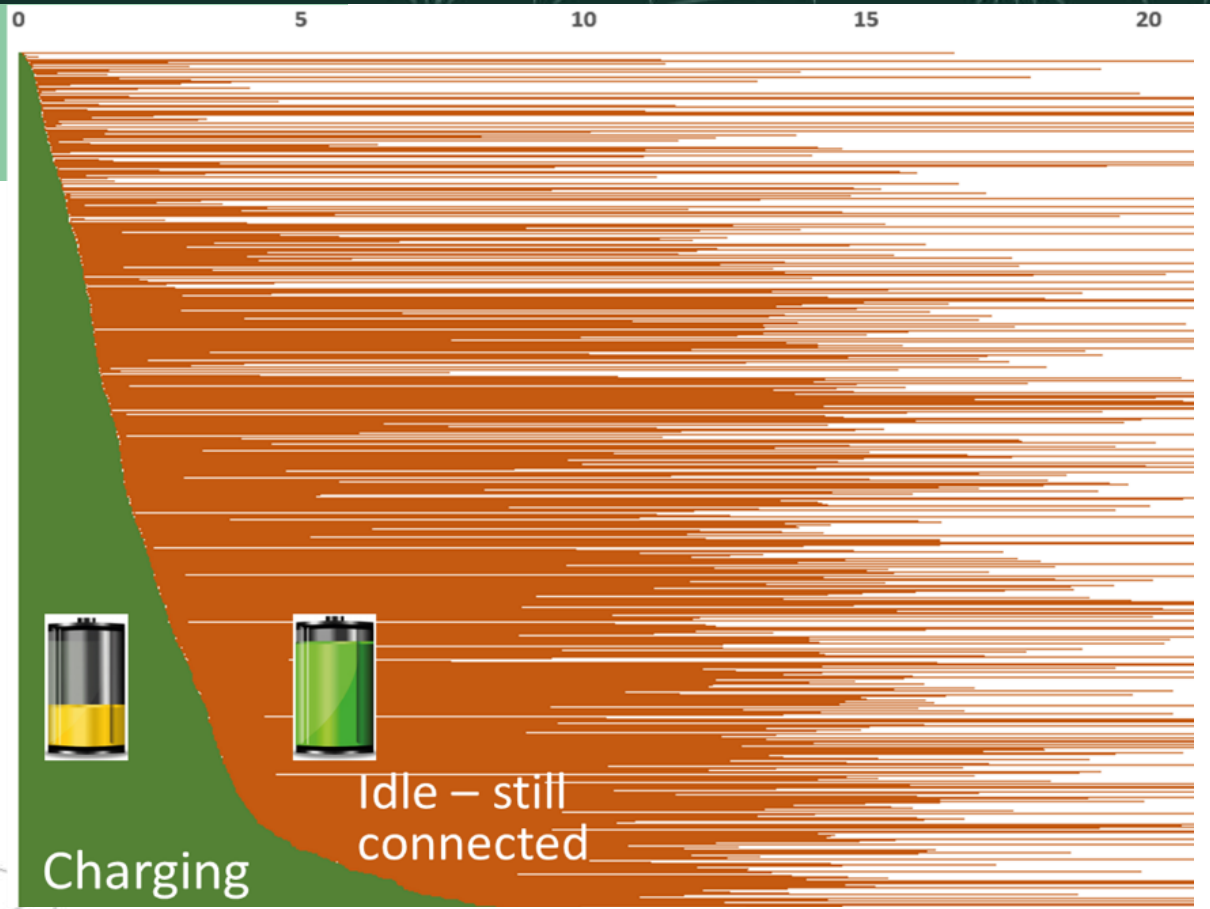
Flexibility from EV charging



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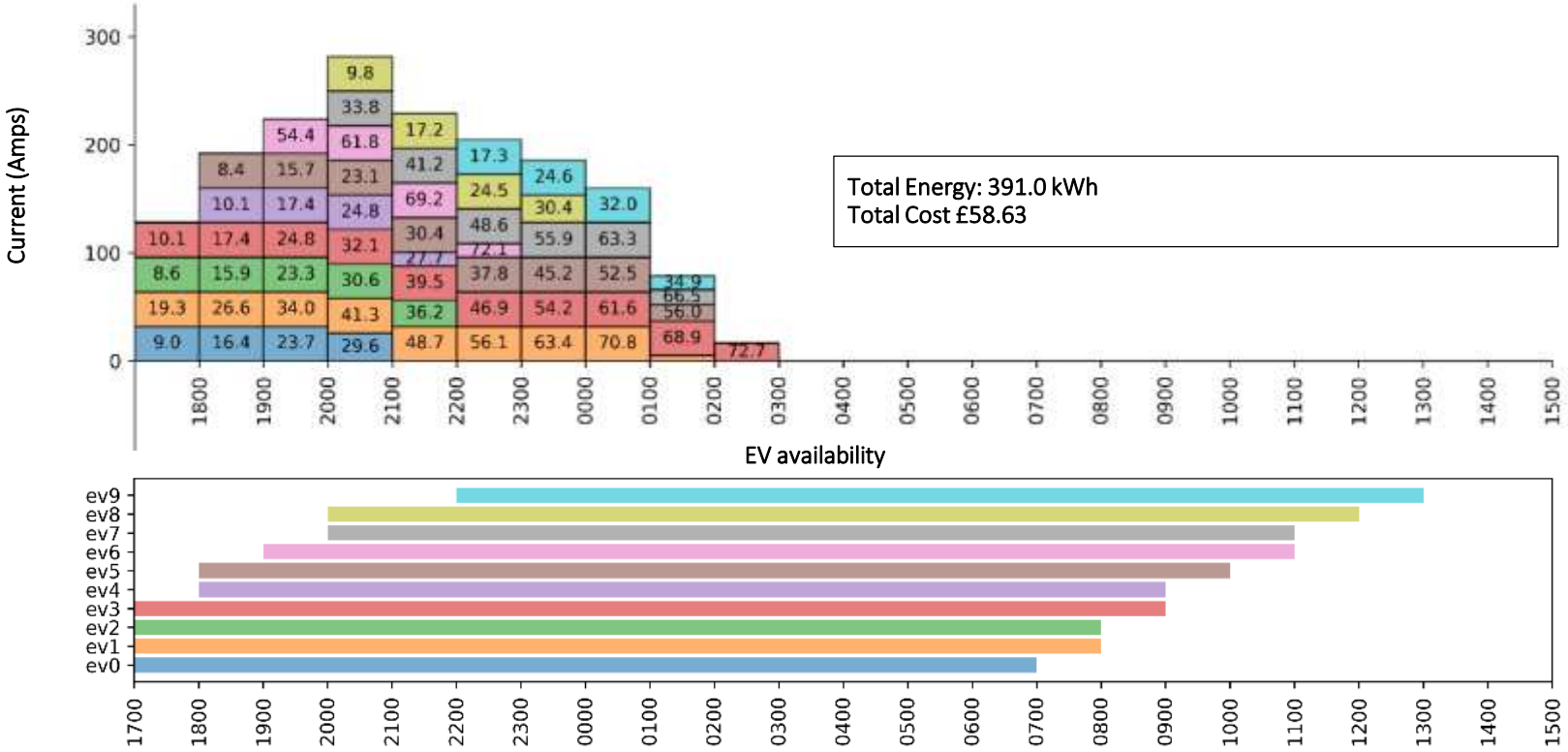
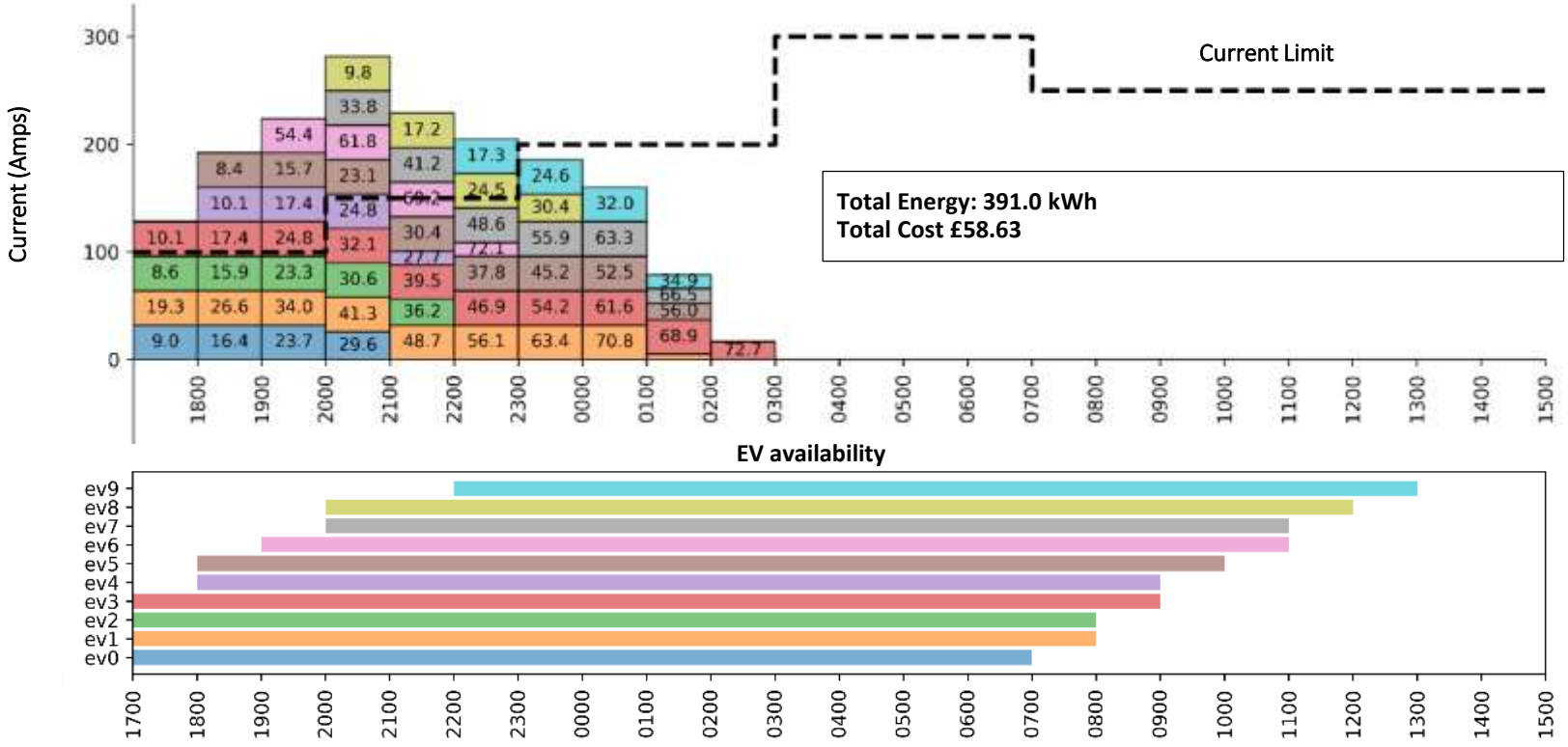
Flexibility from EV charging

EV – Charging at Will

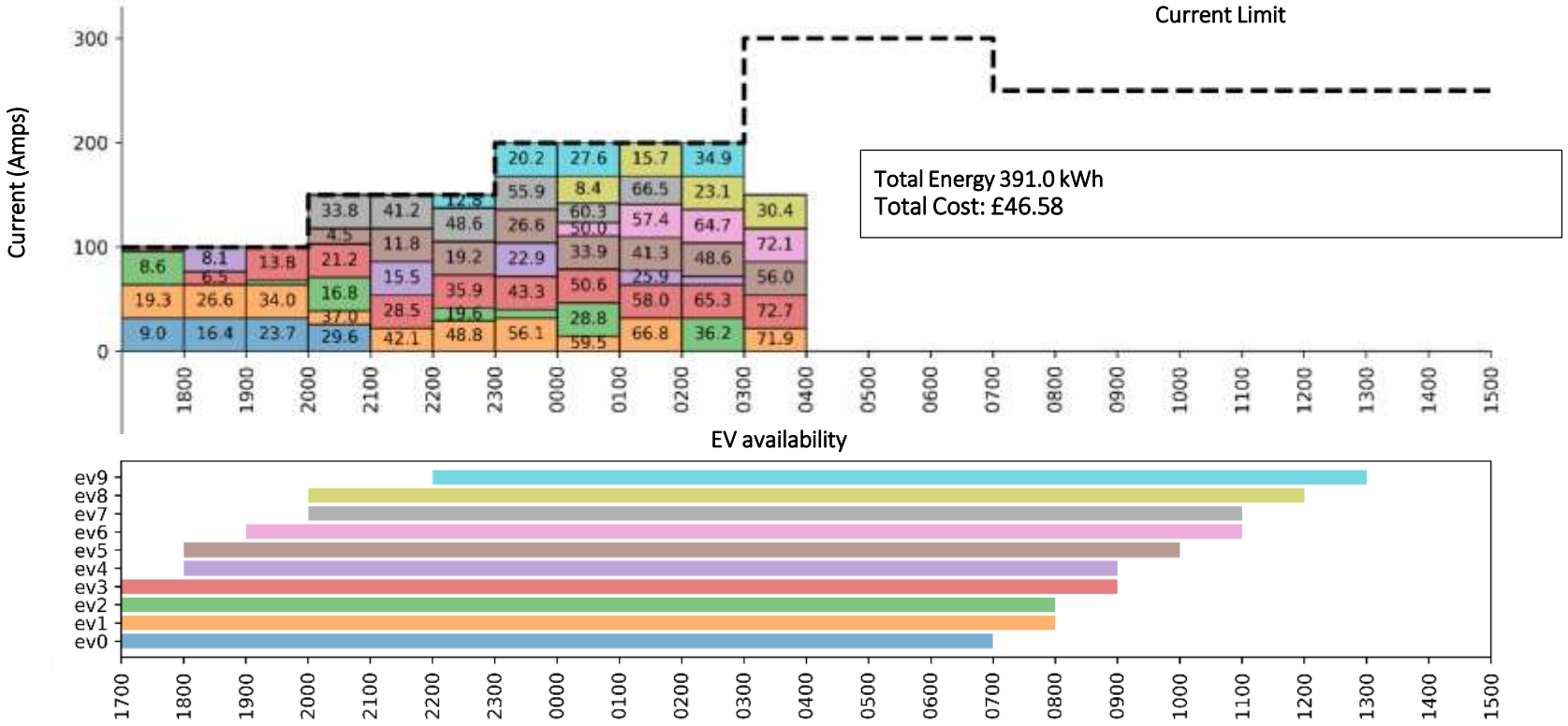


Total Energy: 391.0 kWh
Total Cost £58.63

EV – Charging at Will

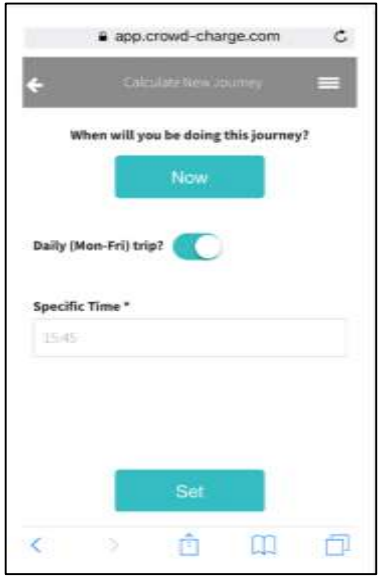


Maintain Current Limit

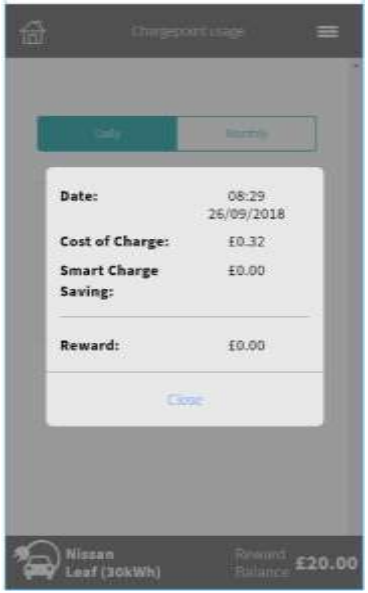


User Journey

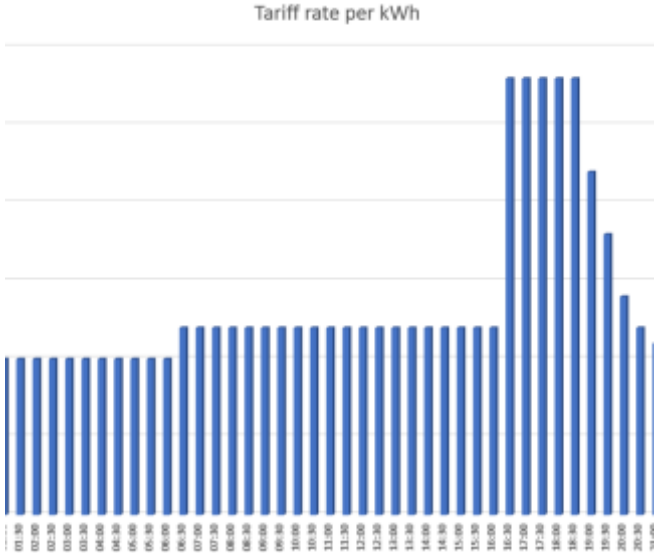
Plug In



Adjust

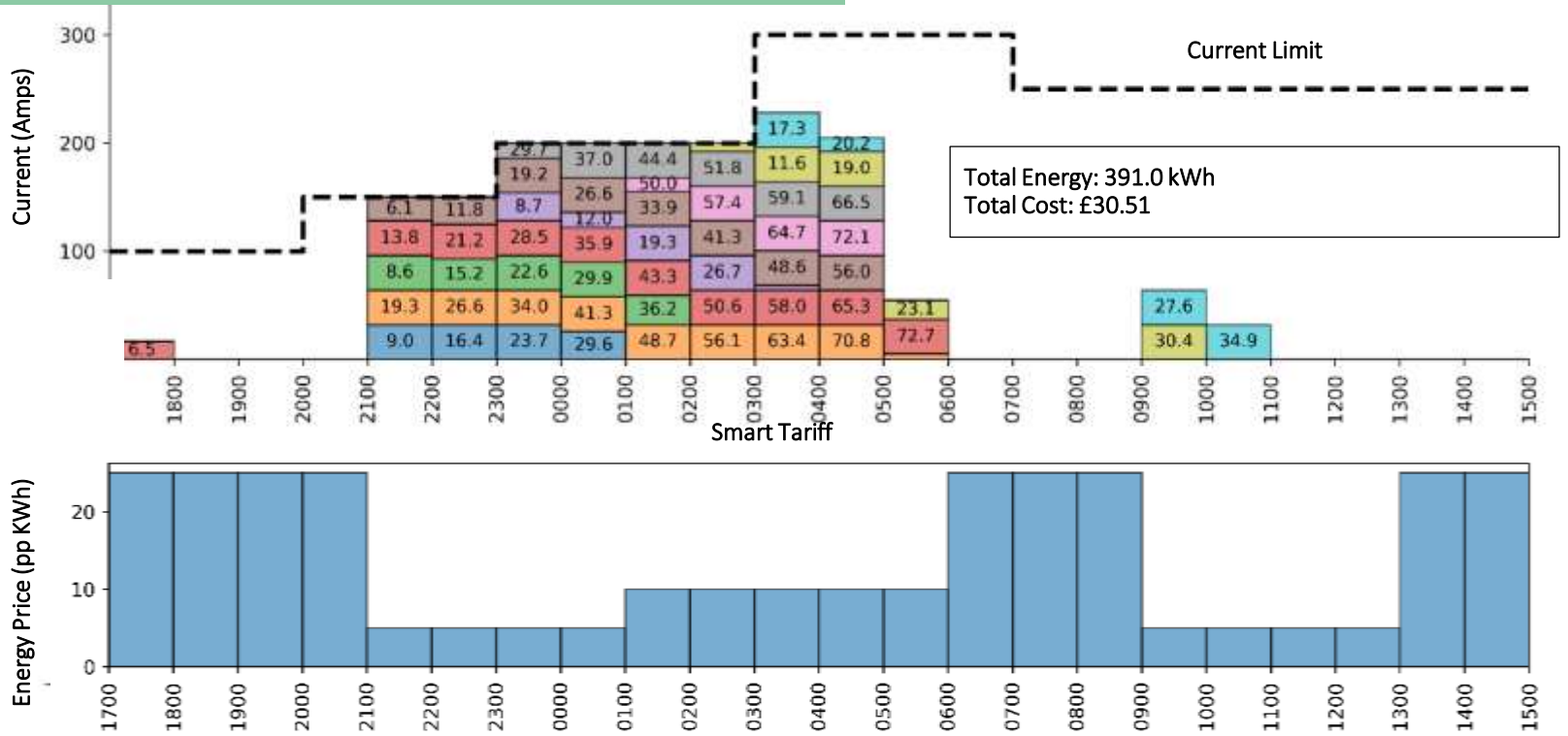


Rewards

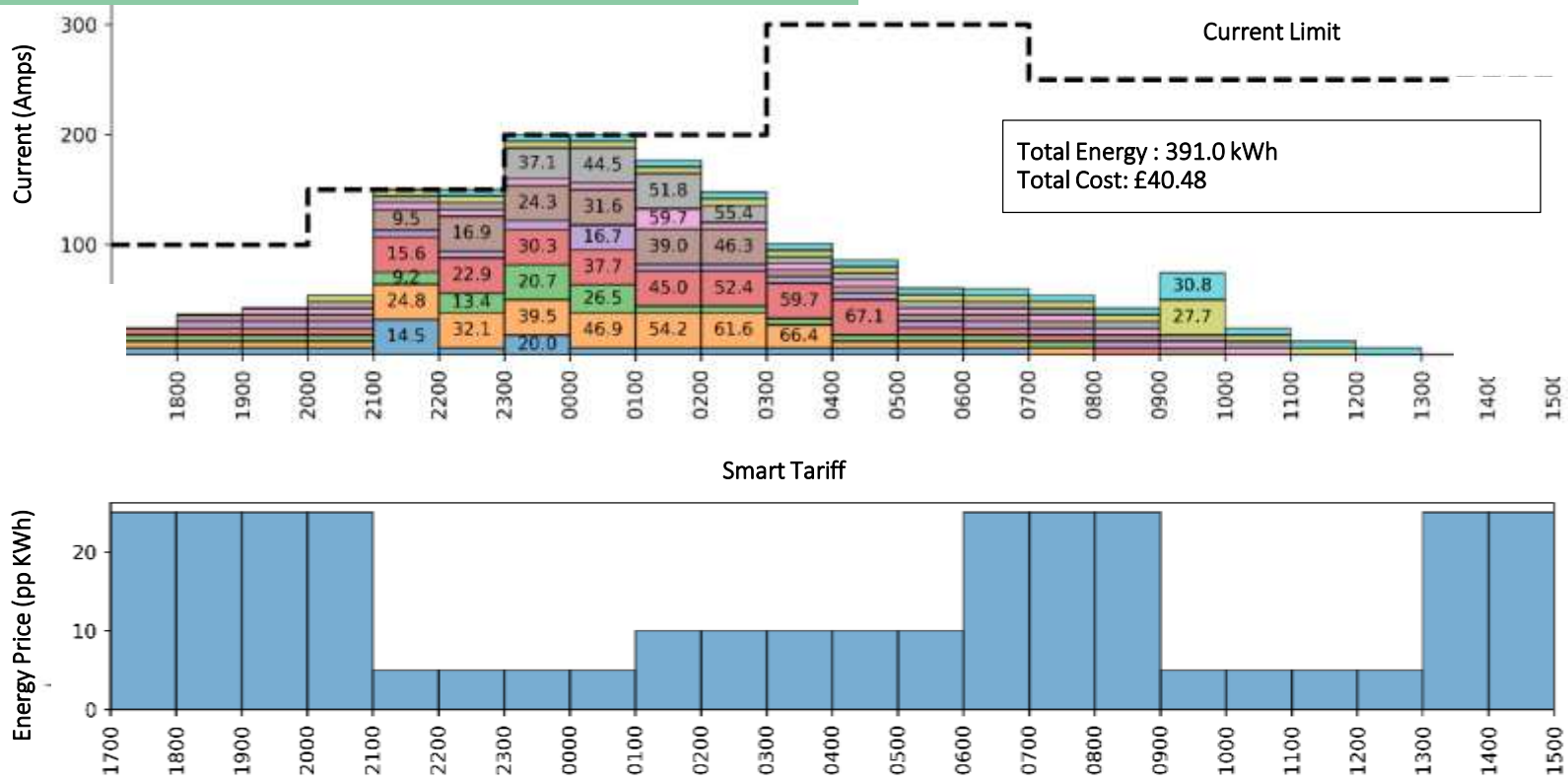


Price

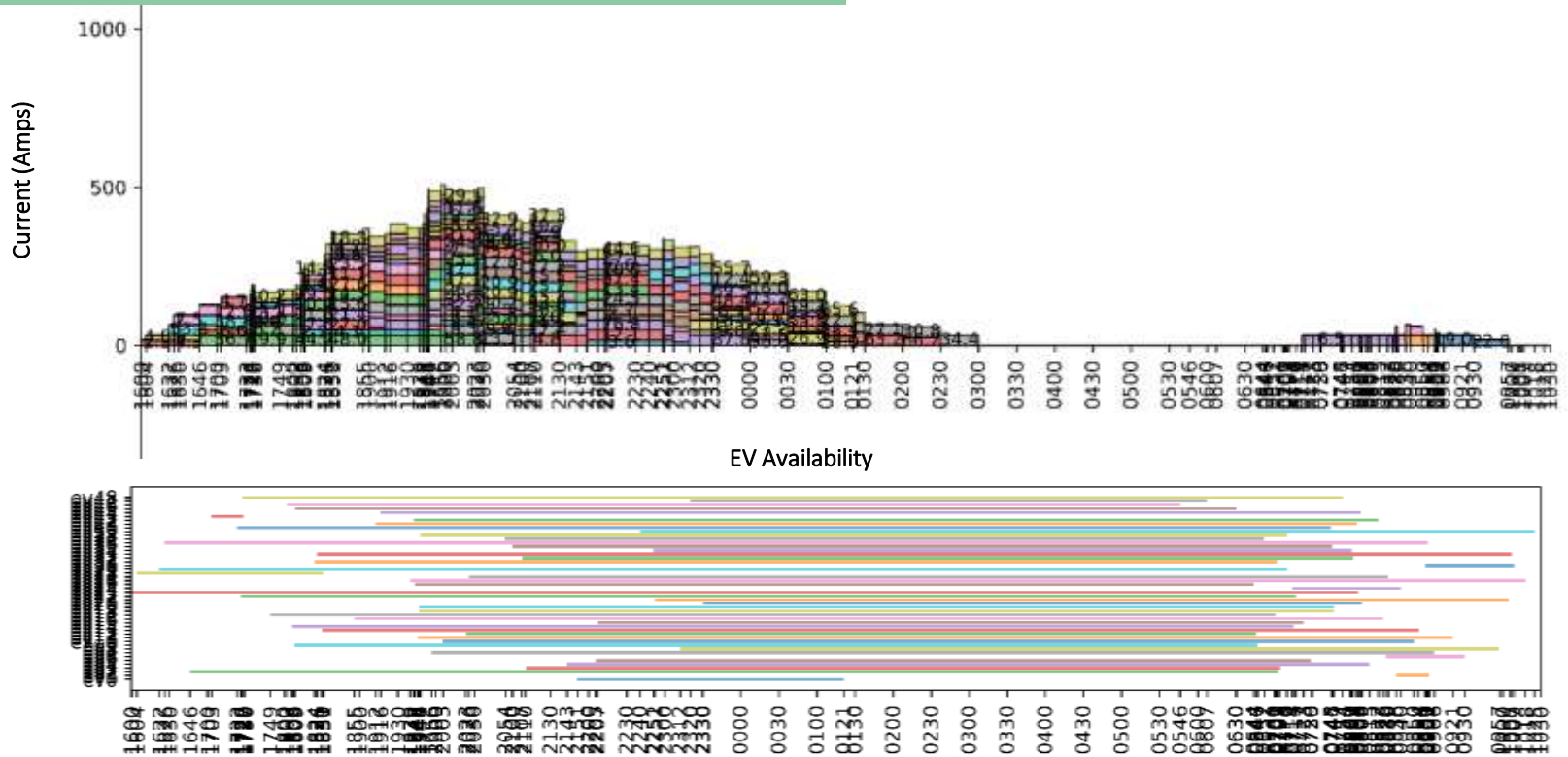
Energy Price and Current Limit



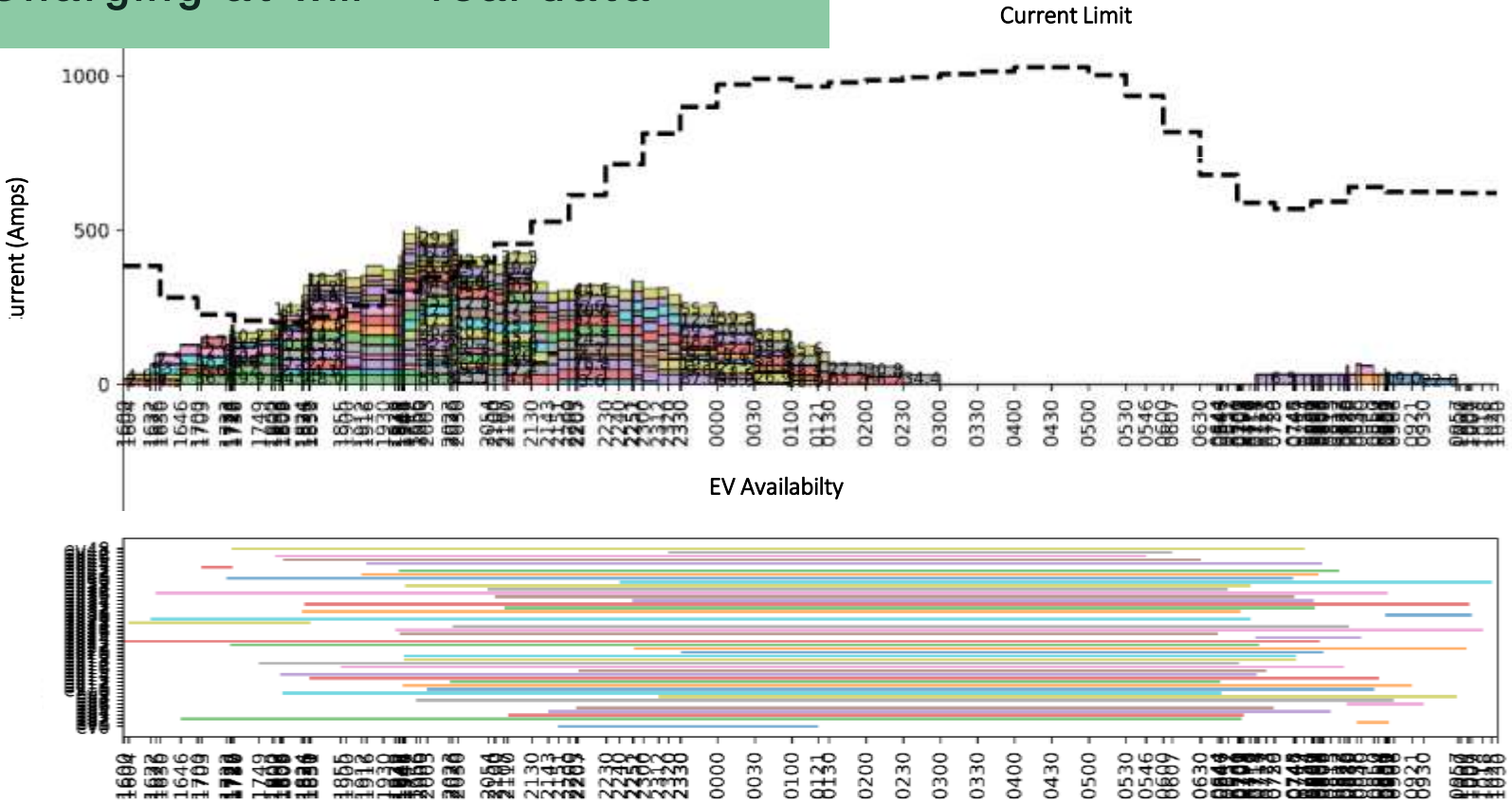
Energy Price and Current Limit – without stopping



EV Charging at will – real data



EV Charging at will – real data



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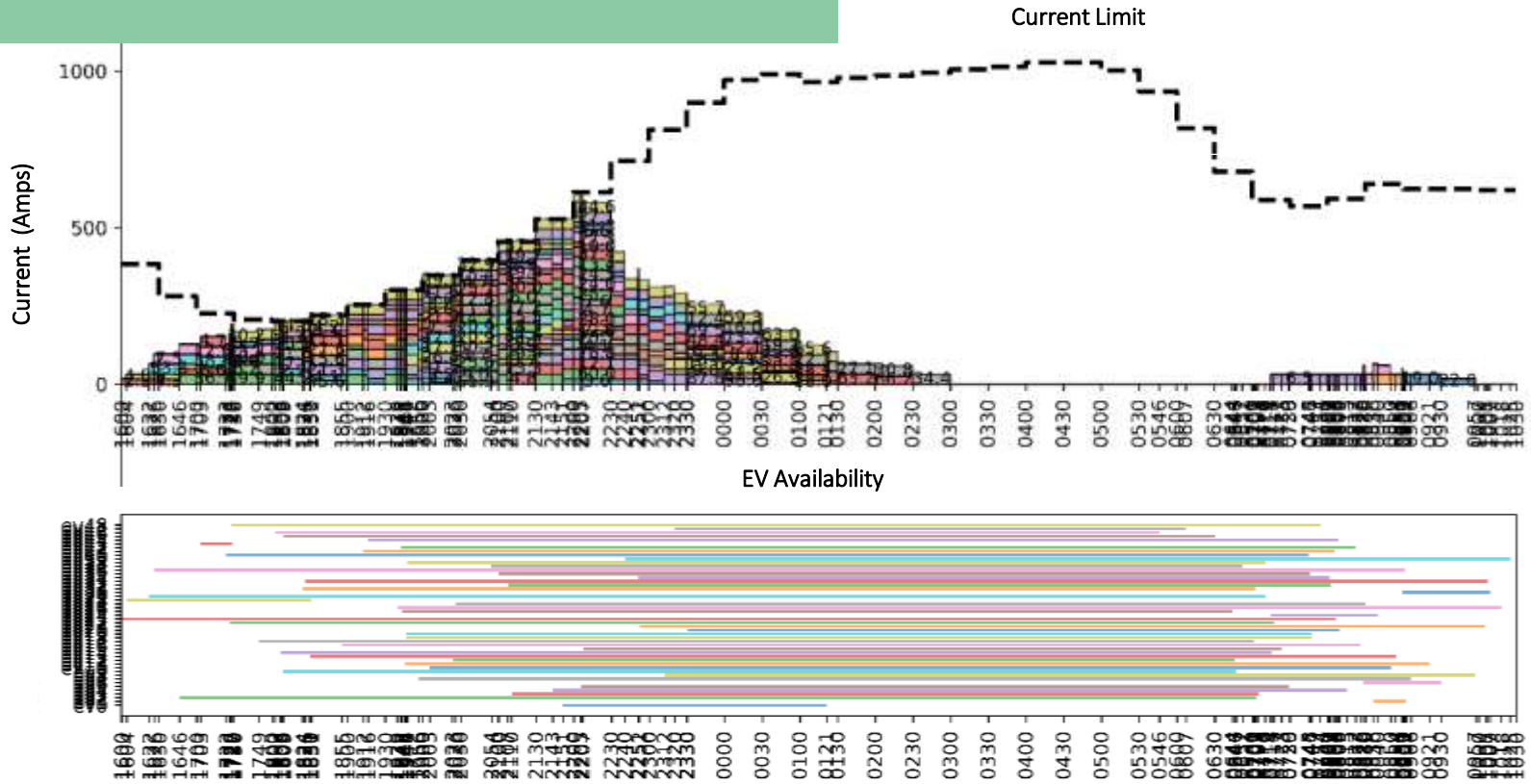
With Current Limit



Key Challenges/Learning

- Comms uptime is a key measure
- Users need very simple instructions / UX
- Telematics data is too expensive for smart charging
- And you don't necessarily need it
- User behaviour can be adjusted
- Solving for lowest total cost is possible
- We can isolate the DNO action from pricing

Thank you for listening

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GreenFlux Smart Charging System

Hans de Boer
GreenFlux
Chief Executive

COLLABORATION PARTNERS

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Leading Smart Charging

GreenFlux Smart charging





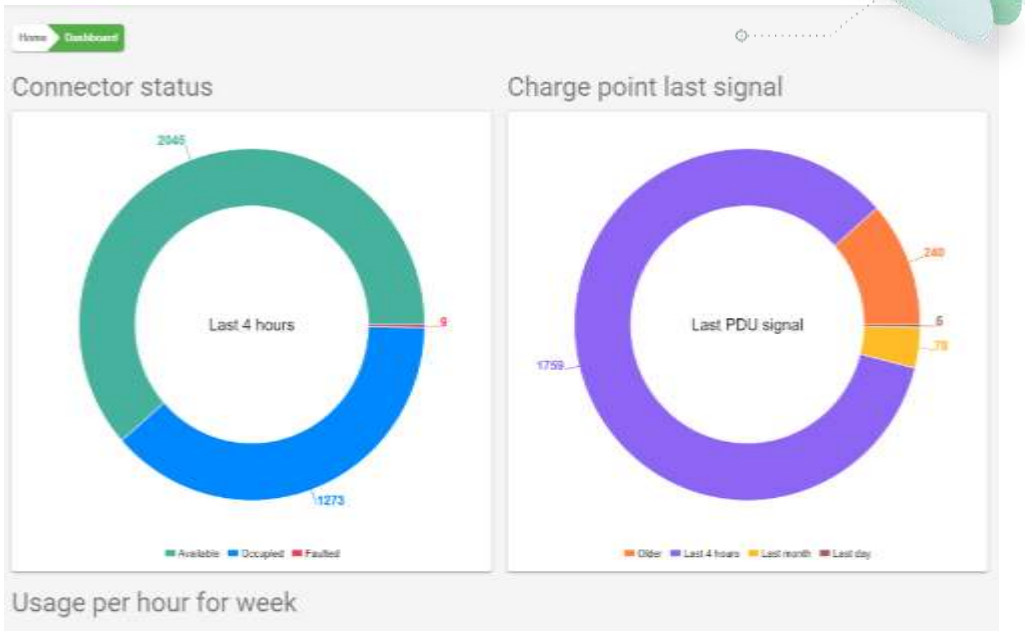
Vision

ELECTRIC NATION

Proud to be GreenFlux

Leader in EV smart charging solutions

White label CPO & eMSP platform



- Remote management and support
- Billing and transaction management
- Global Roaming via open standards
- Smart Energy Management (Smart Charging)
- App
- Interfaces / API

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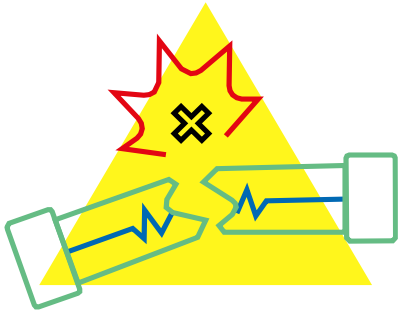
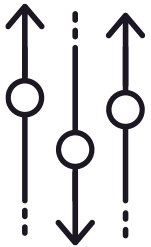
What is Smart Charging?



Increase/decrease maximum charge rate



Why do you do Smart Charging?

DYNAMIC ENERGY PRICES

GRID CONSTRAINTS

USER REQUIREMENTS

LOCAL RENEWABLE ENERGY

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How we do it

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Cloud-based solution

Infinitely scalable

Unlimited number of chargers

Blazingly **fast** response

Interoperable

Works with **any charging station**

Communicates through **open standards**

Independent

User input possible, not required

Any location, any charger, any EV

Intelligent

Cloud-based intelligence

Ongoing **updates** and optimizations

How do we do it

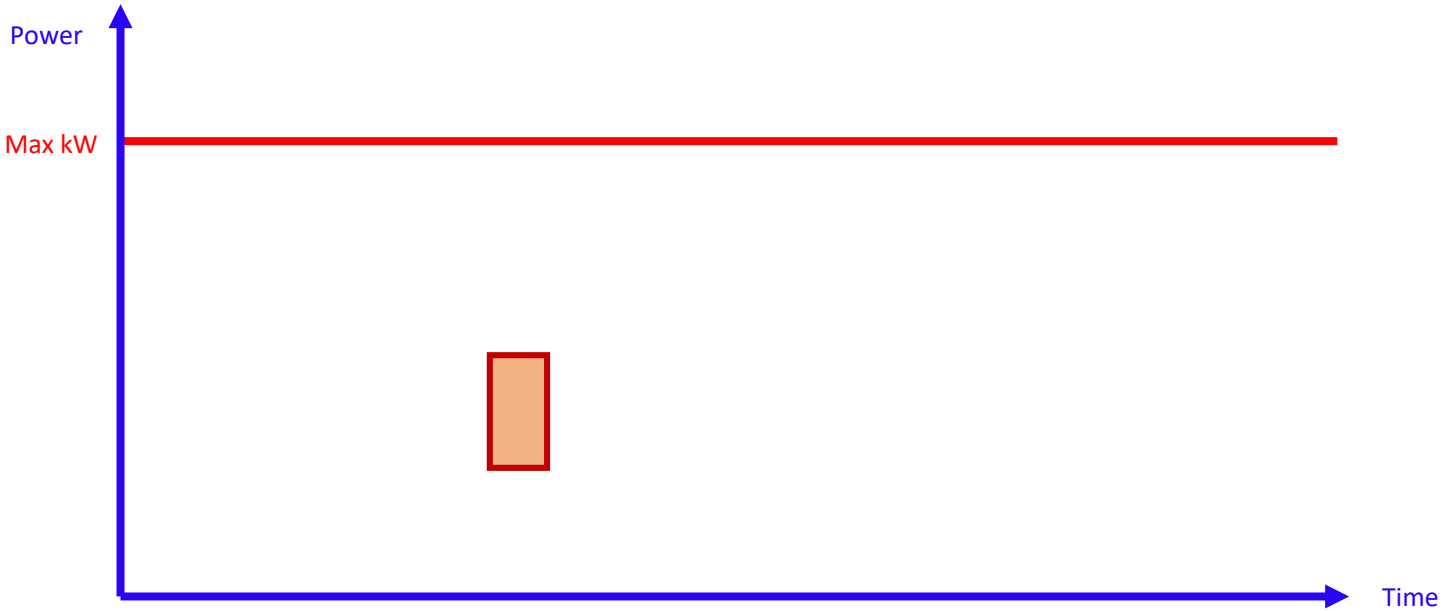
STEP 1

We set the available capacity over time

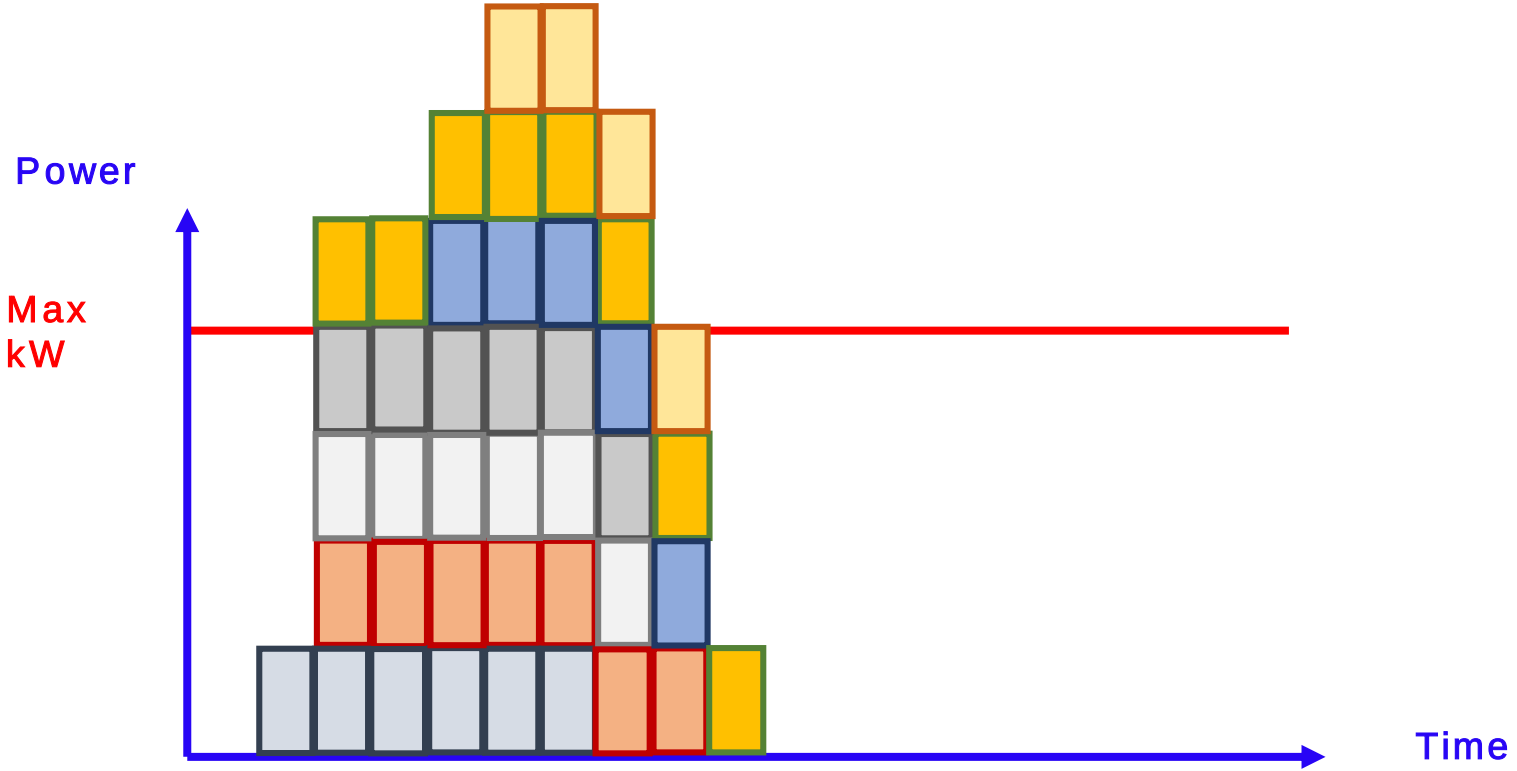
How do we do it

STEP 2

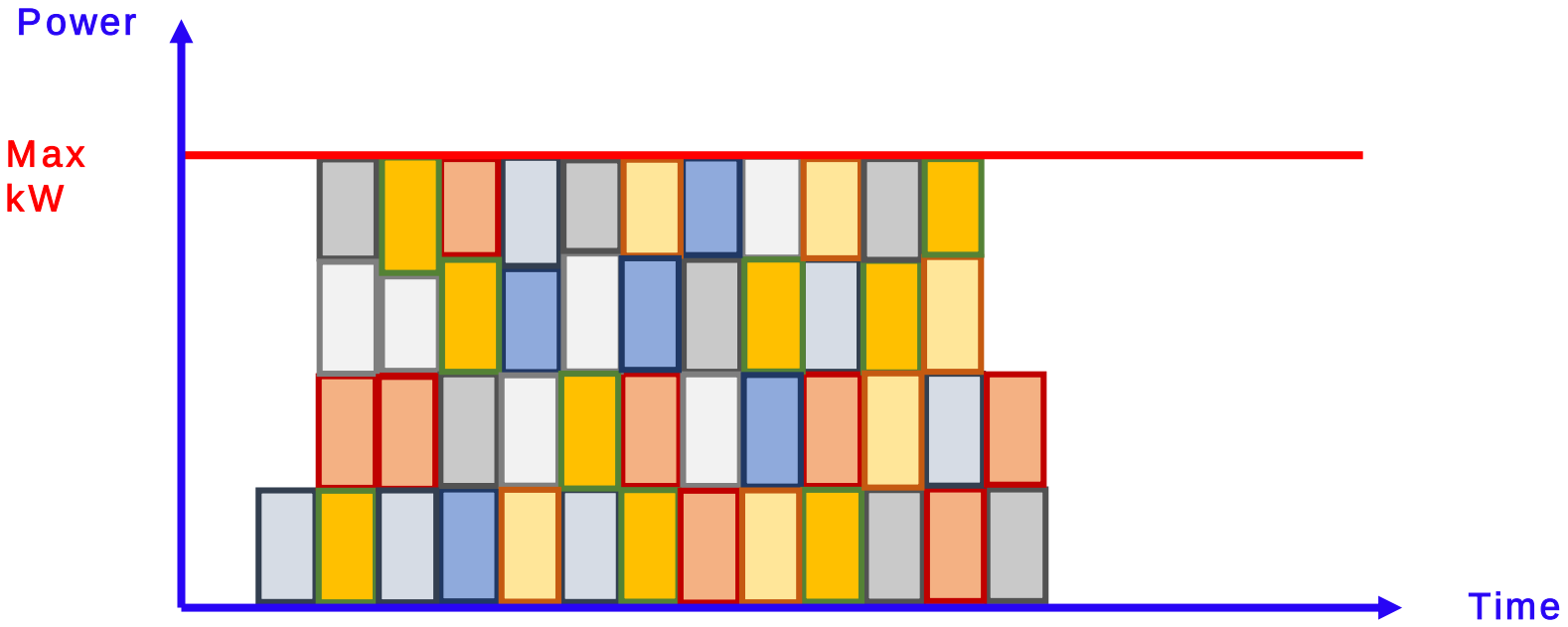
We distribute energy over time



How do we do it



How do we do it



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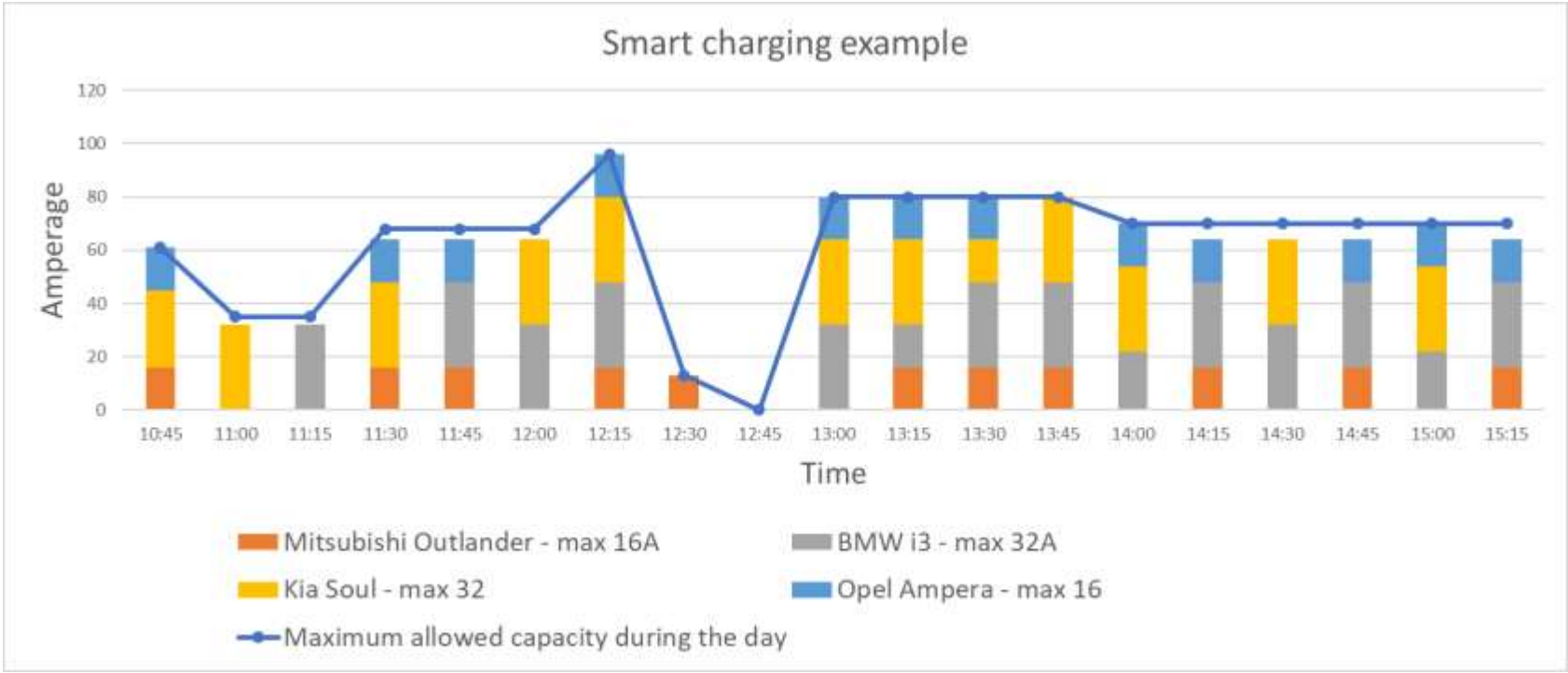
How do we do it



Use case

Head office of largest Dutch grid operator

2013: 16 chargers at 250A
2018: 100 chargers at 400A

Smart charging saved ~€250.000 on infrastructural costs

Smart charging is active ~10% of the time, resulting in a 90% higher charge rate for an EV

Use case
- Electric Nation Project

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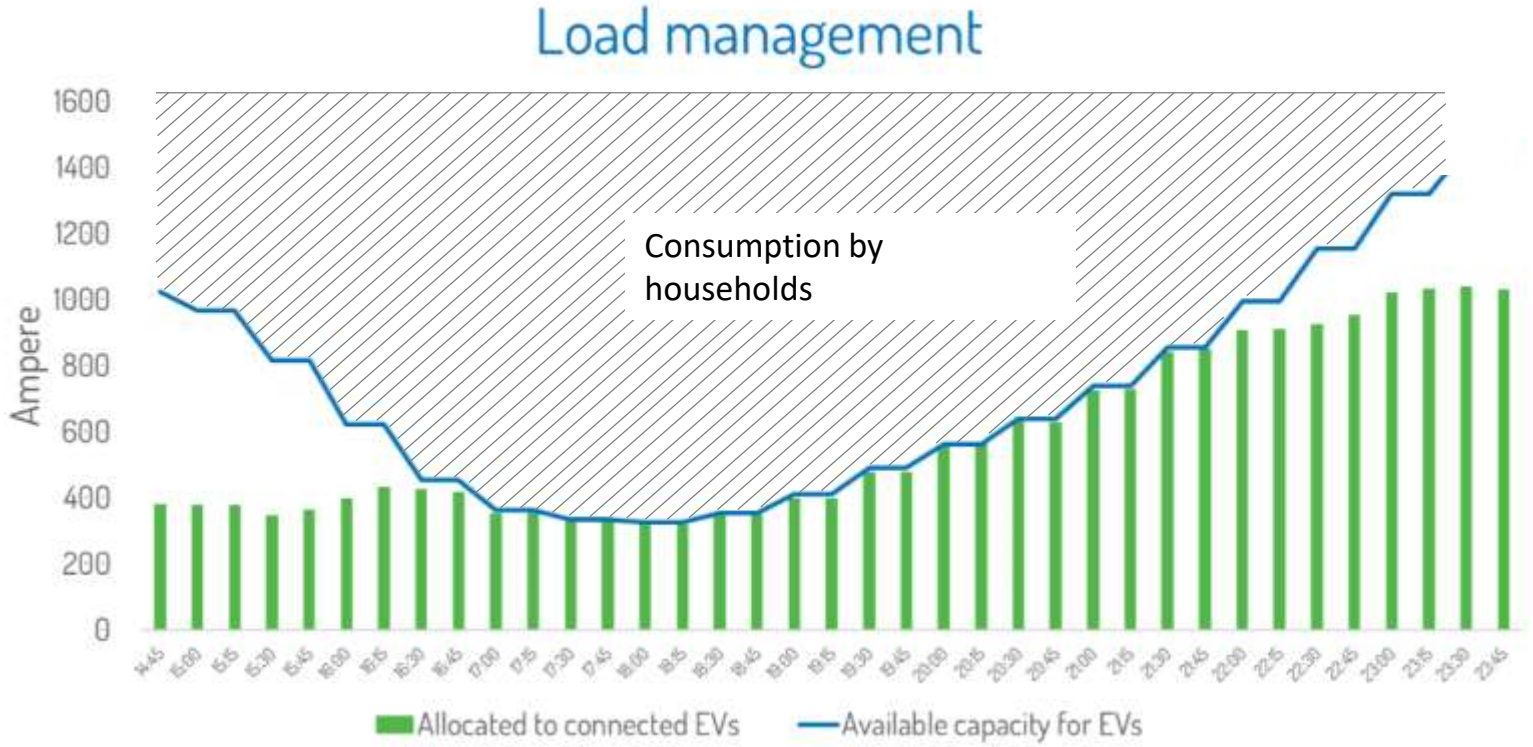
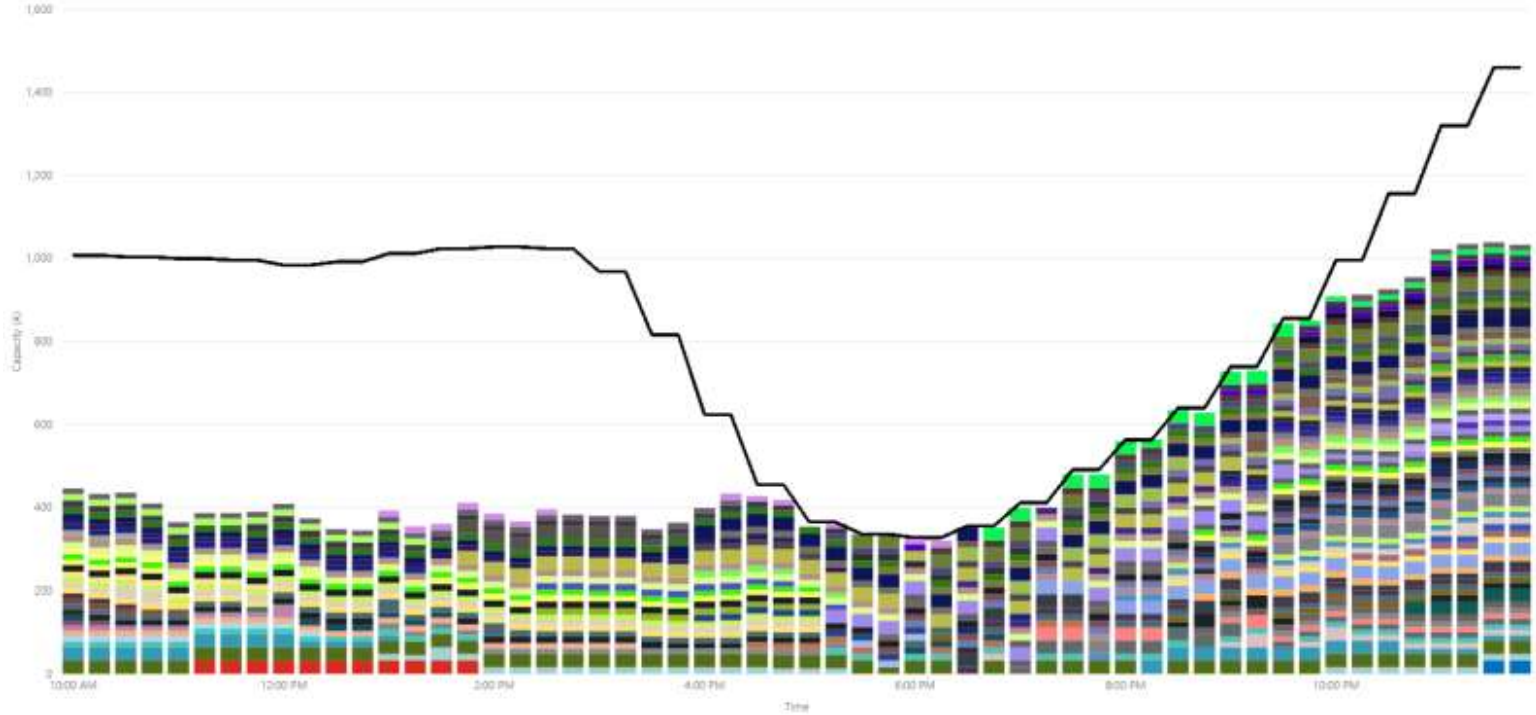
YOUR ELECTRIC VEHICLE YOUR SMART CHARGE

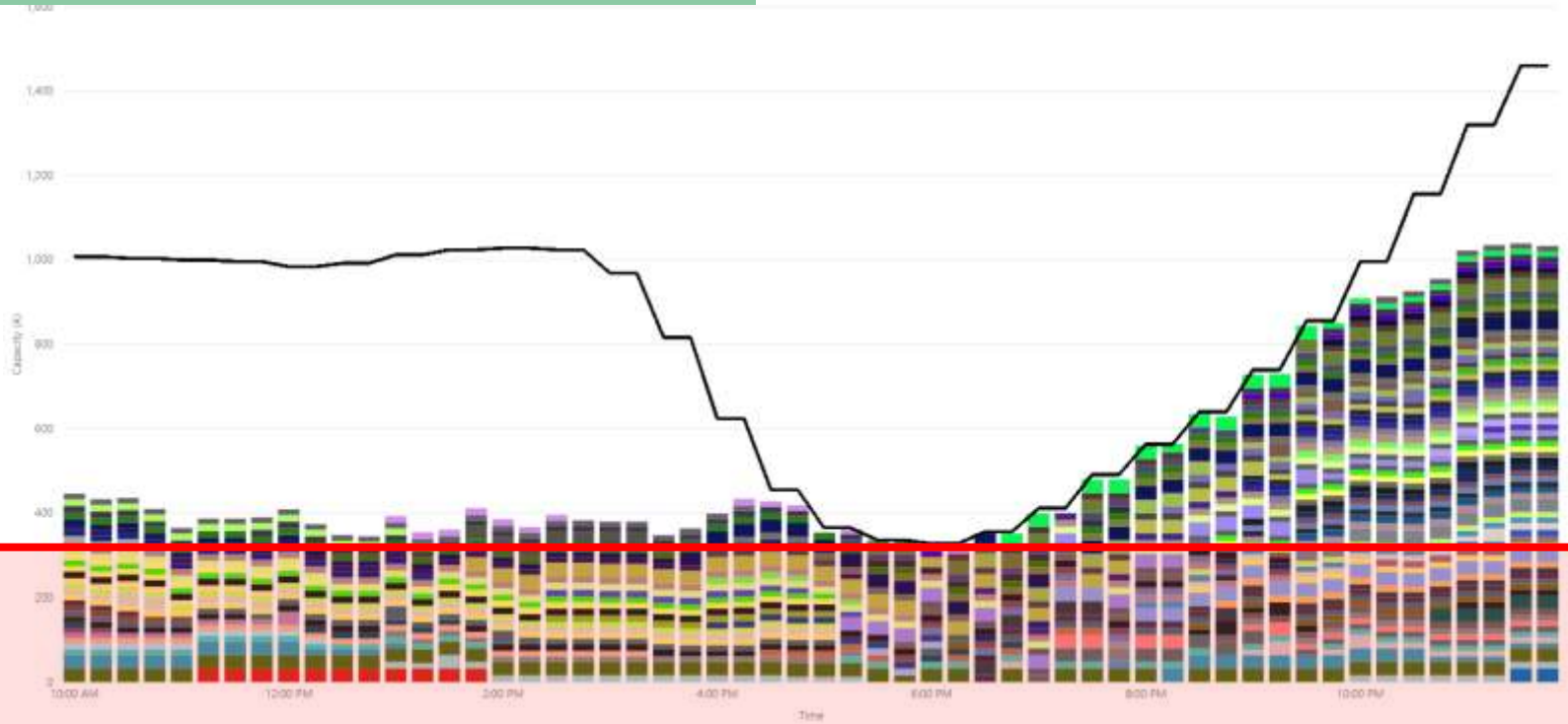
Use case
- Electric Nation Project



Use case
- Electric Nation Project

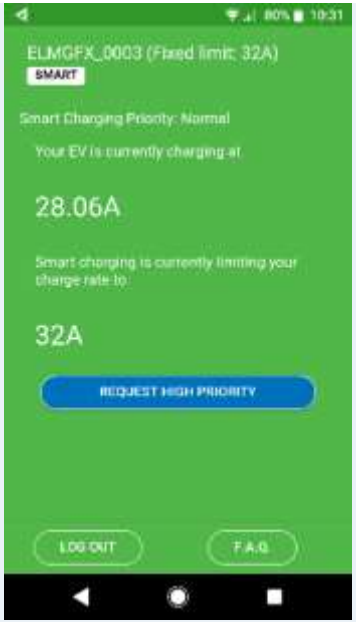


Use case
- Electric Nation Project

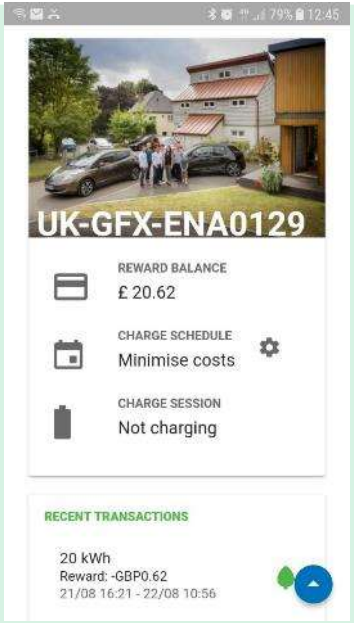


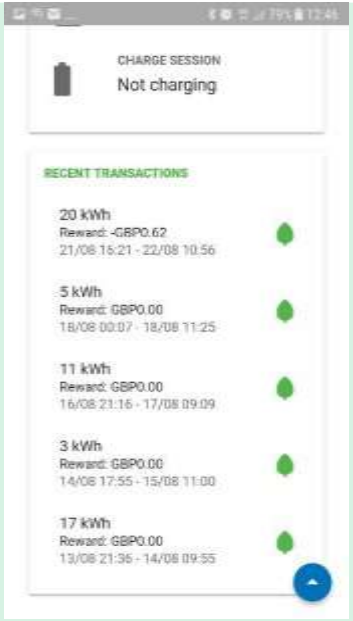
Use case
- Electric Nation Project

Second iteration



Third iteration





Electric Nation Project Learning

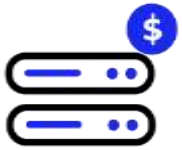
Smart charging can be a challenge

1. Data is crucial and not always available

2. Some cars do not respond to smart charging signals

3. Some cars are on timers

4. Possible network failure requires fallback scenario's



5. Data costs can ruin your business case

6. Limited bandwidth with 2G

Electric Nation Project Learning

1. Smart charging is highly appreciated
2. An app is crucial
3. Smart charging = faster charging
4. We can apply this today

Beyond Electric Nation

Continuously updating the algorithms

Further integration with apps, metering platforms, charging stations, etc.

Rolling this out commercially together with UK-utilities

Thank you for listening

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Charging Behaviour Findings

Nick Storer
EA Technology
Principal Consultant

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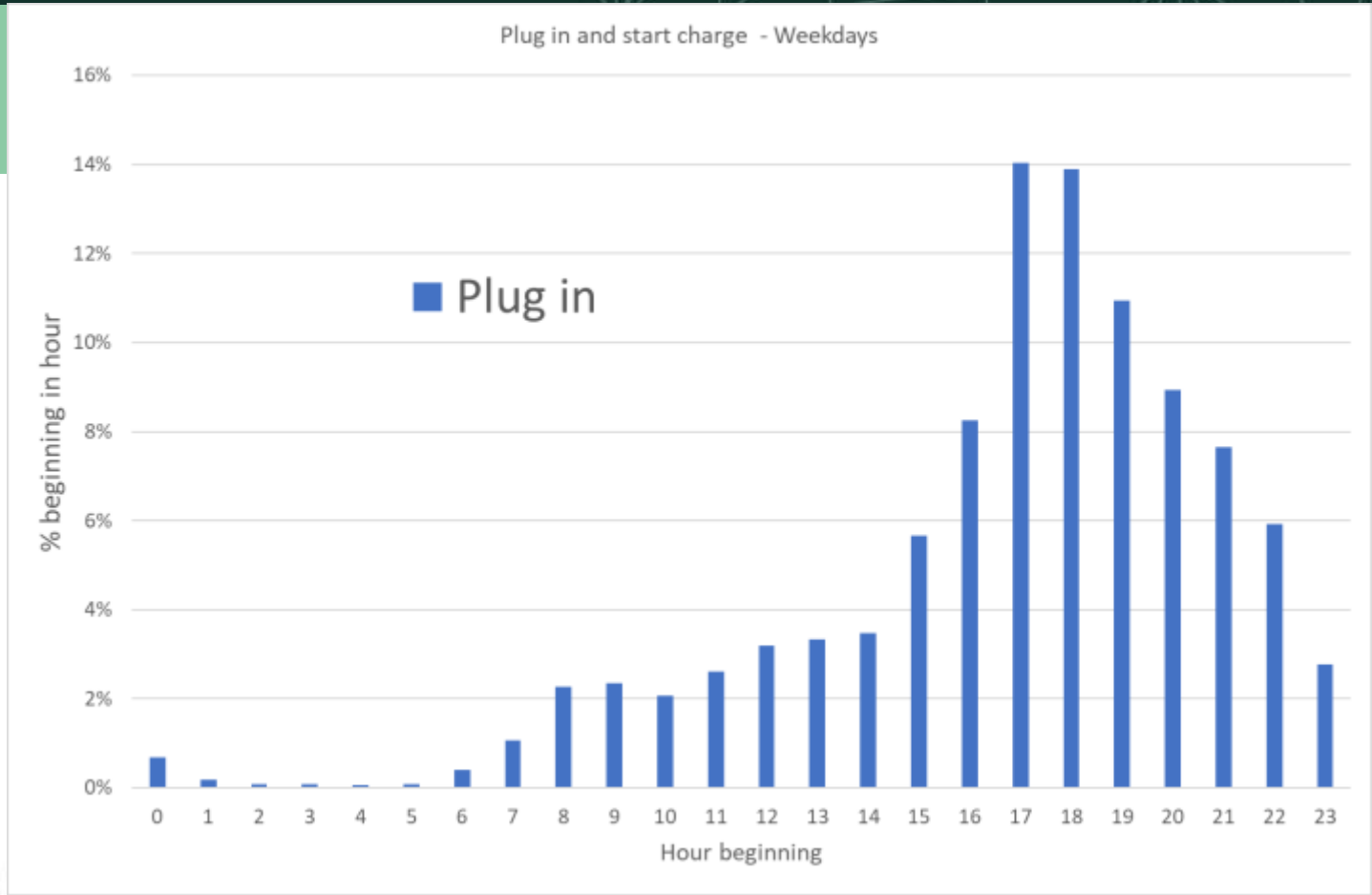
Questions

- When do people charge their vehicles?
- How frequently?
- For how long?
- Does this vary over the week/weekend and seasonally?
- Does this vary by EV type and battery size?
  - And by vehicle usage?
- Is there flexibility in charging?
  - Could it be managed?
  - Whilst not affecting vehicle use?

When do people charge their EVs?

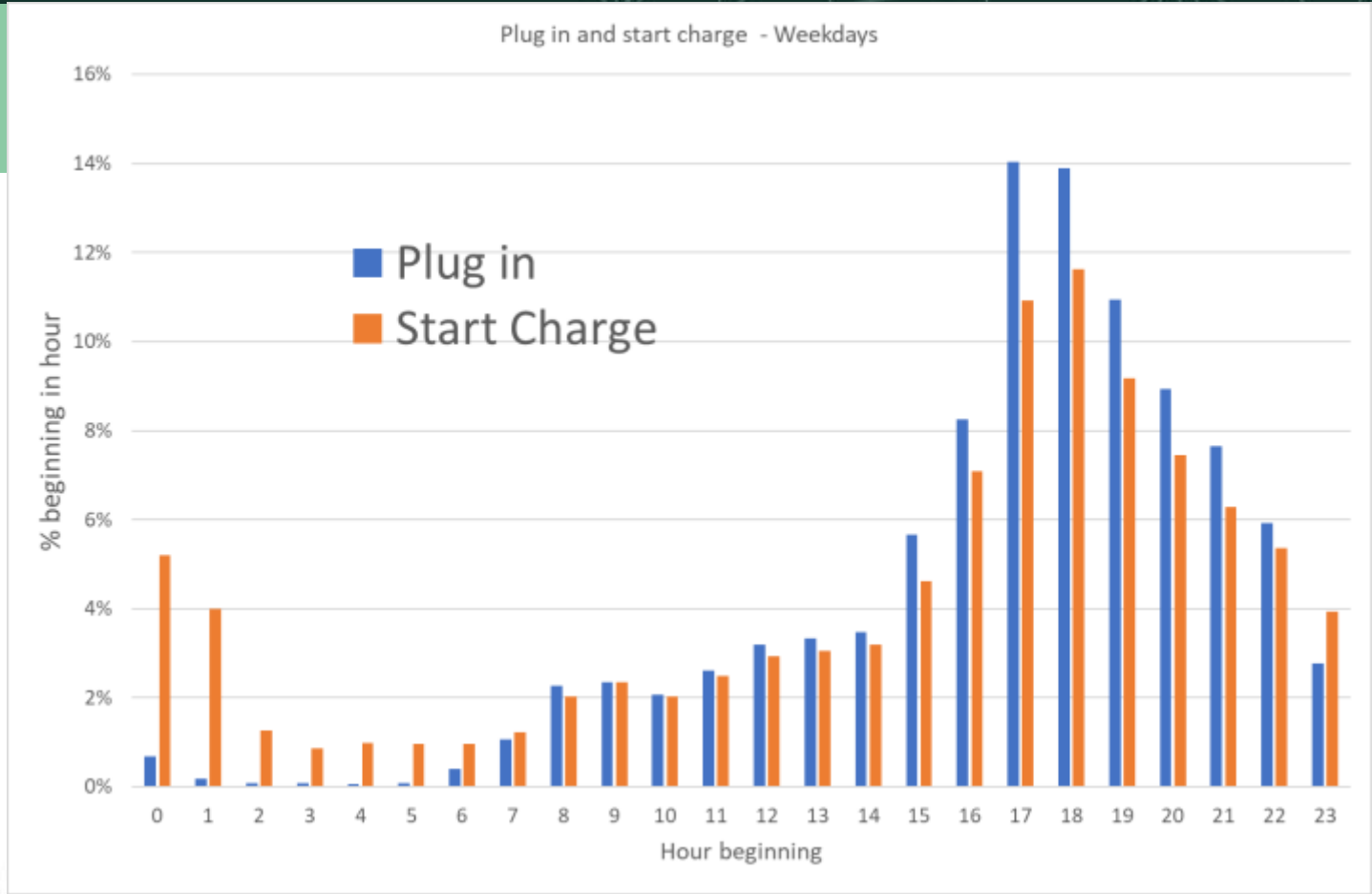
- Plug in – start of transaction



Plug-in based on 134,197 events
Start charged based on 94,519 events

When do people charge their EVs?

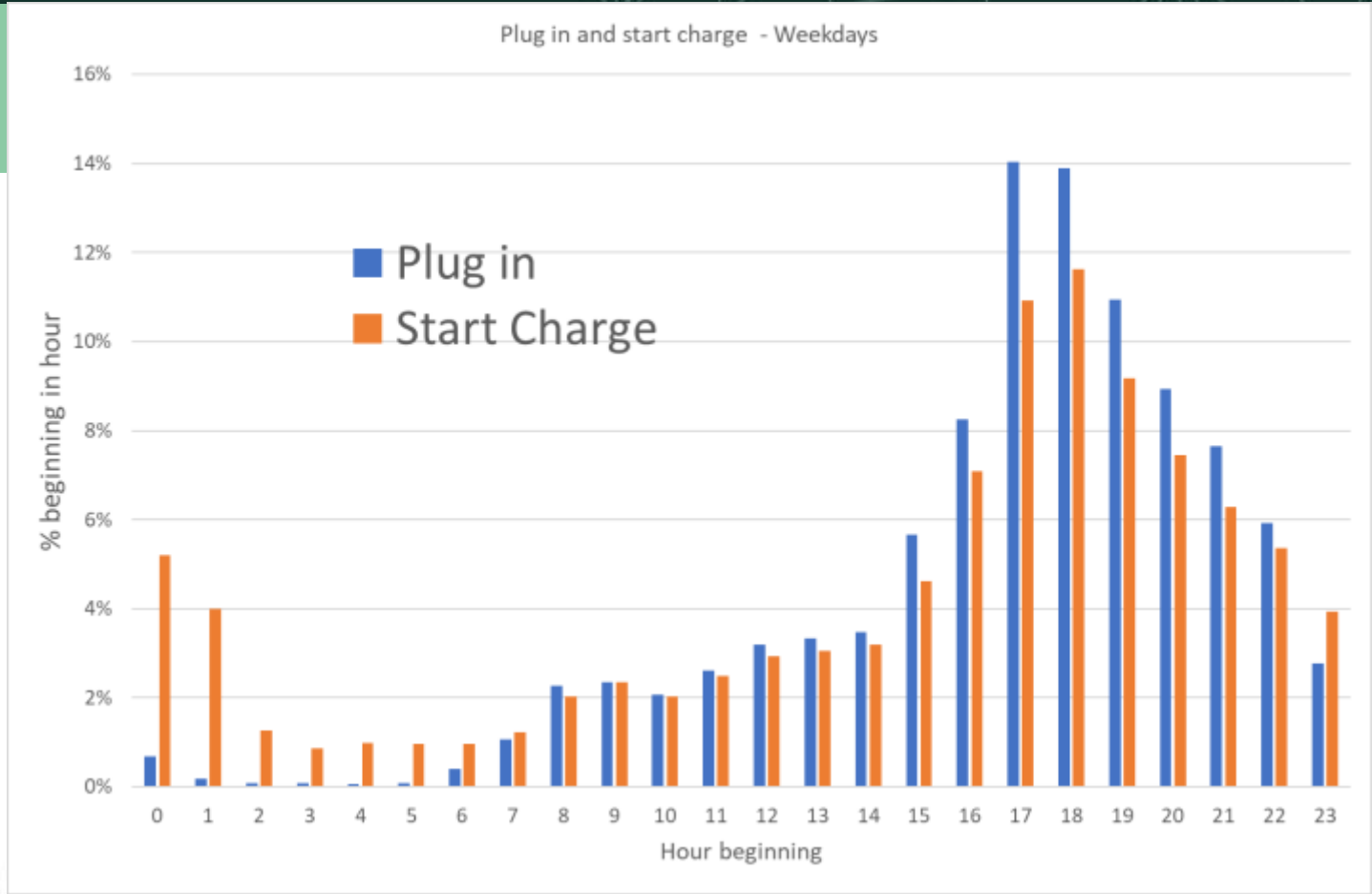
- Plug in – start of transaction
- Weekday vs weekend



Plug-in based on 134,197 events
Start charged based on 94,519 events

When do people charge their EVs?

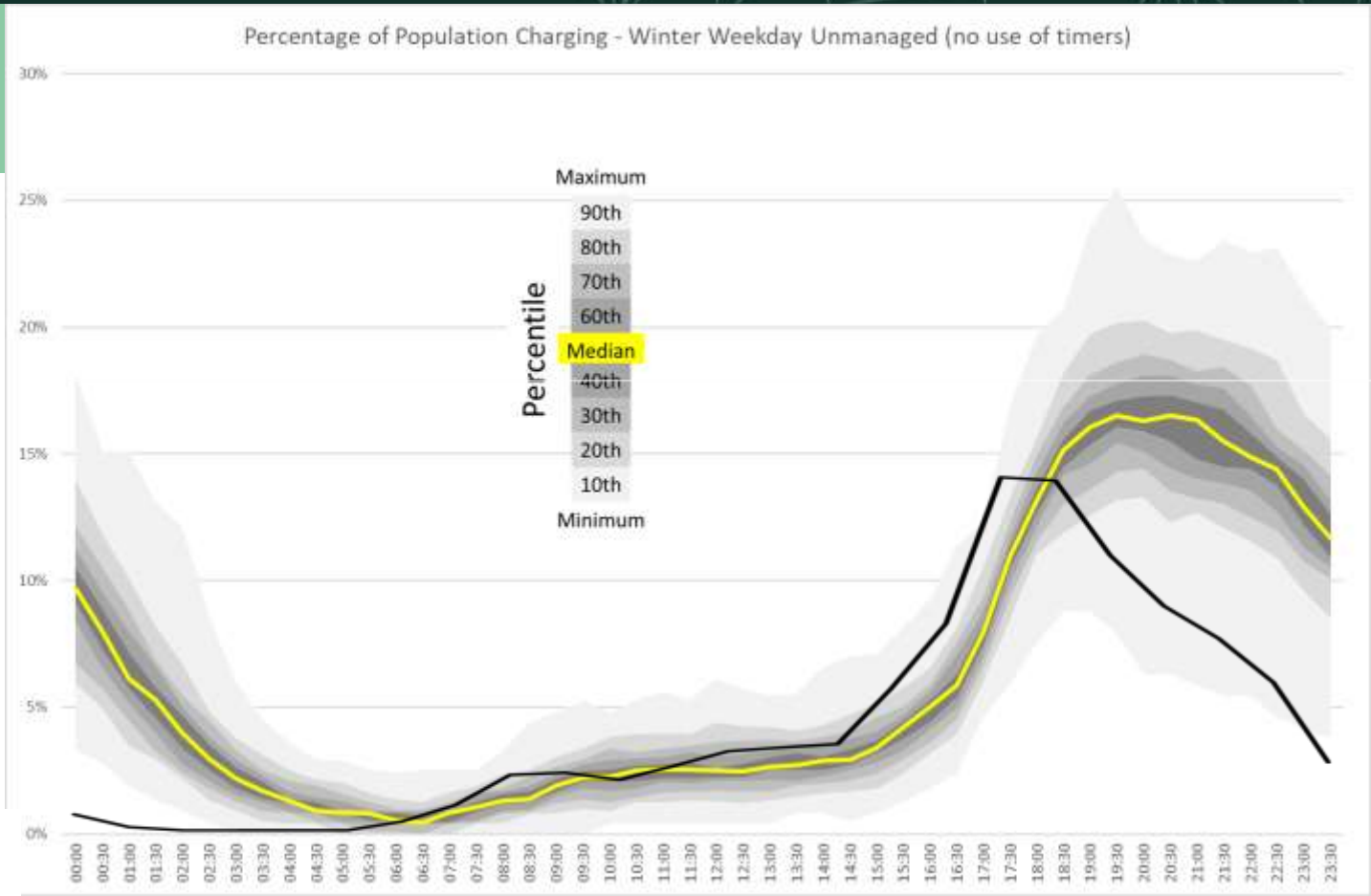
- Plug in – start of transaction
- Weekday vs weekend
- Start charge can be delayed
  - On-board timer
    - Delay start until…
    - Departure time



Plug-in based on 134,197 events
Start charged based on 94,519 events

Charging Diversity Time of Day

- BEV & REX 7kW
- Mean/Median % of population charging varies through day
- Variance varies too
- Highest variance around early evening and overnight



Based on 30,000 Transactions

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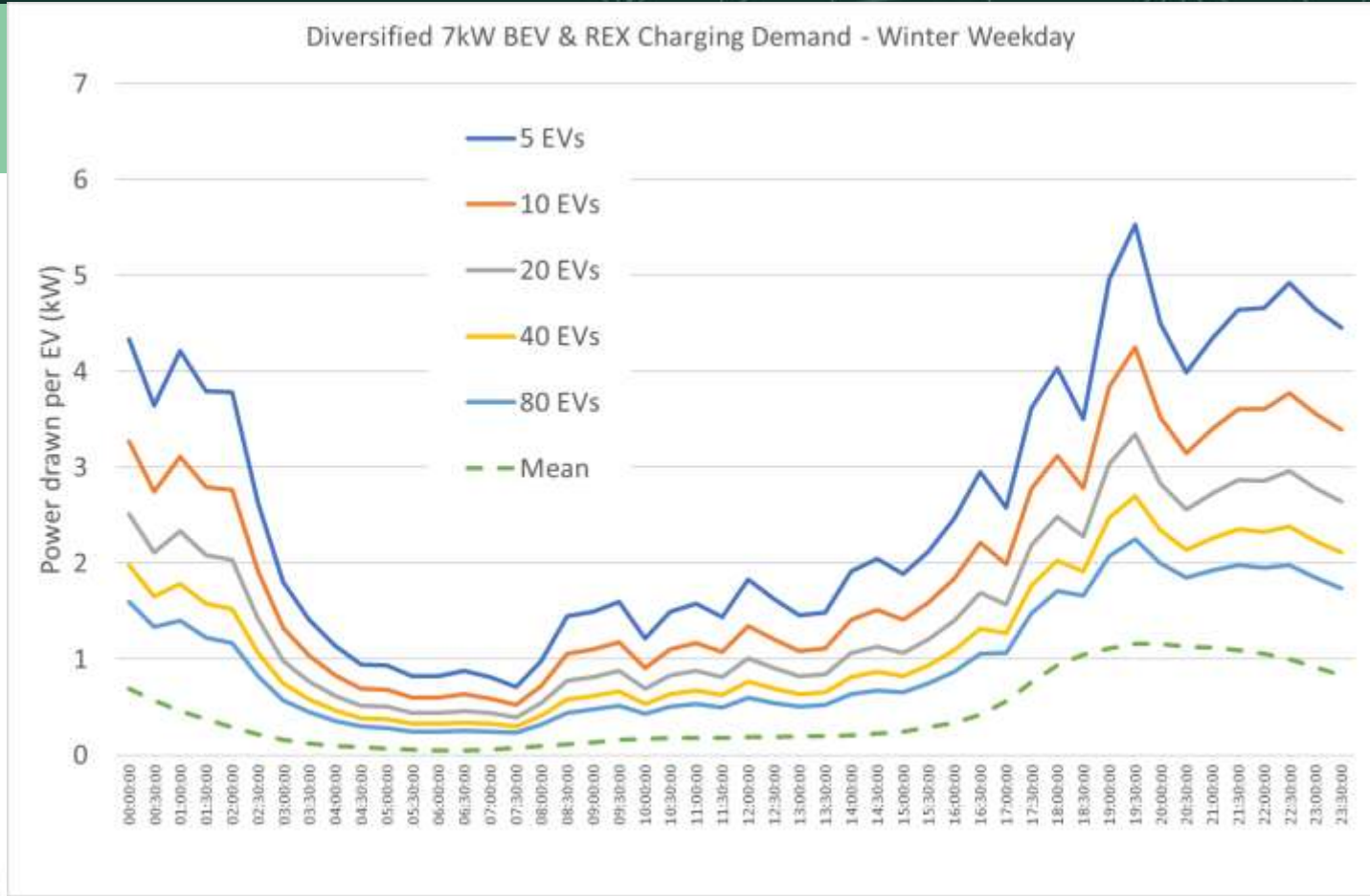
Diversified Demand

$$\text{Demand} = \text{Mean} + \frac{\text{Variance}}{\sqrt{N}}$$

As N increases

Demand per EV tends towards Mean



ELECTRIC NATION

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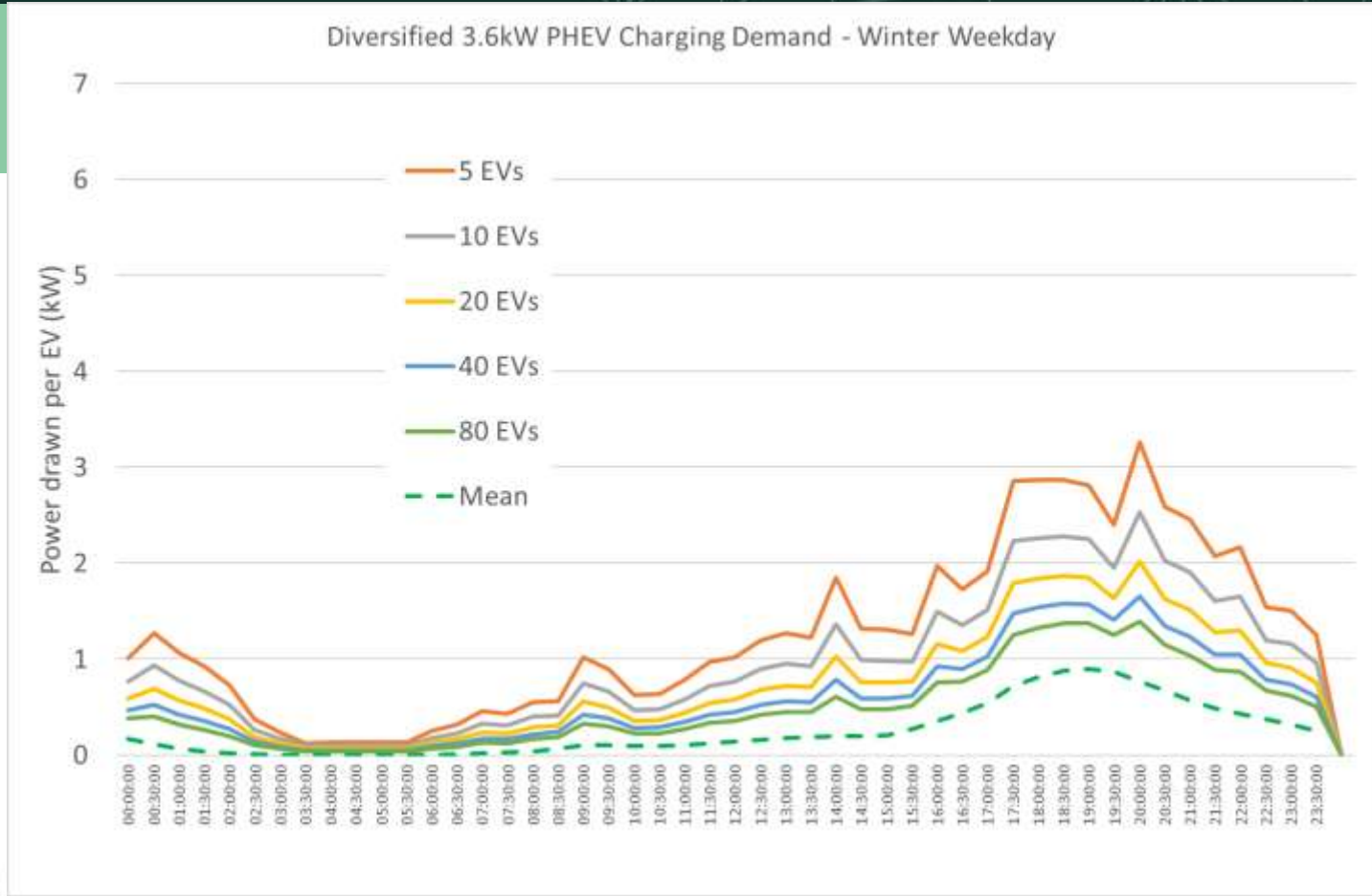

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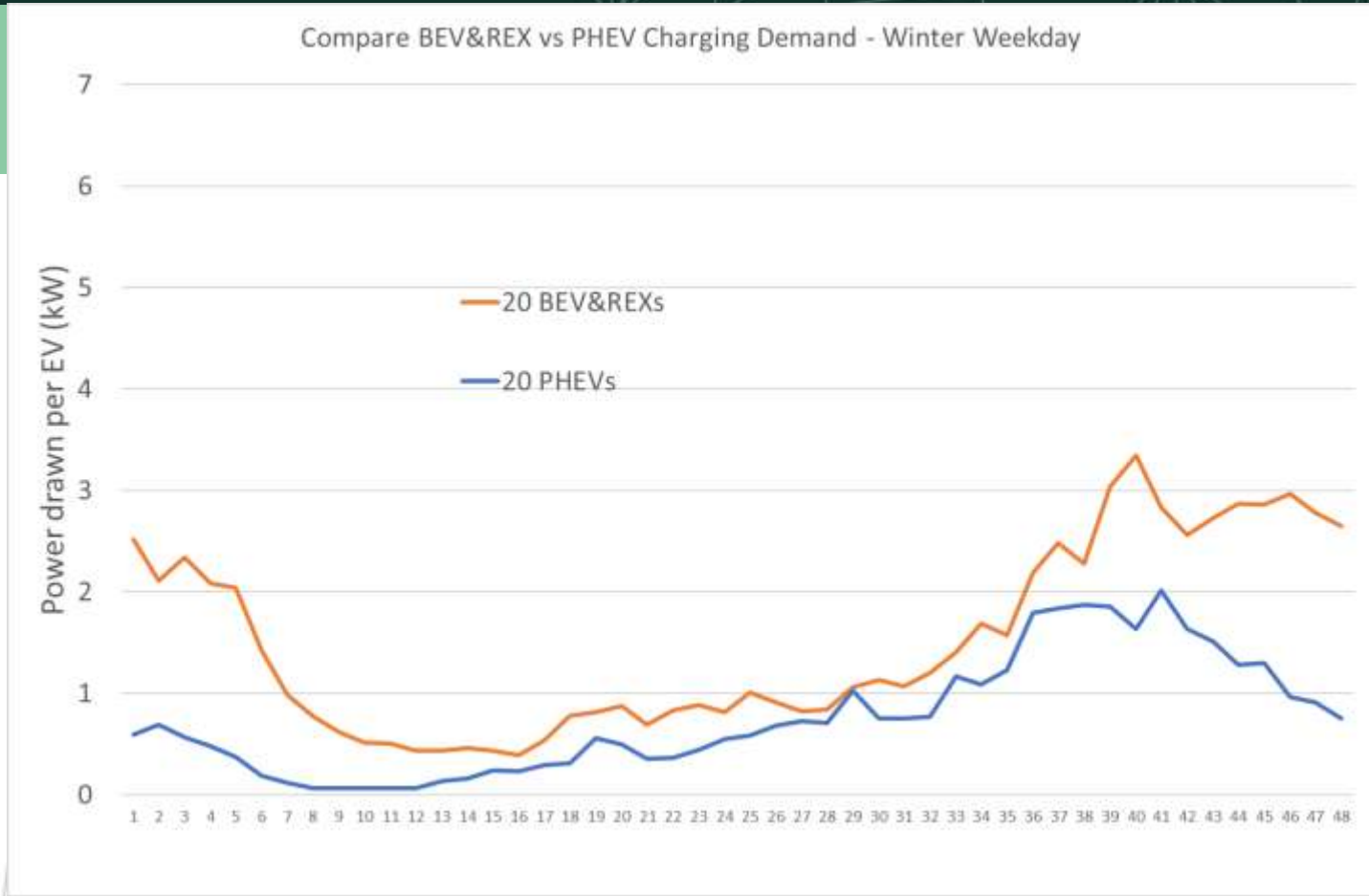
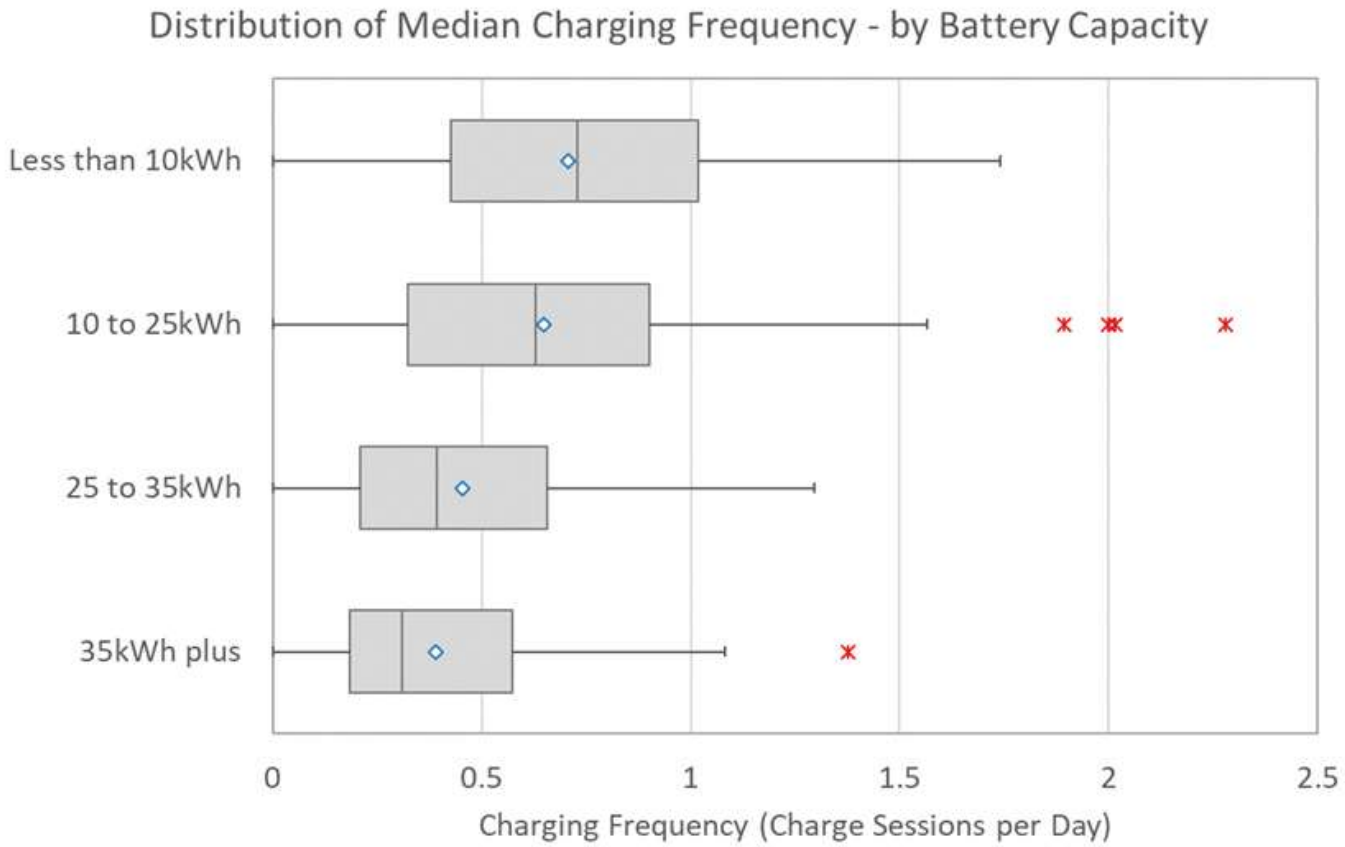


What causes variance?

The bigger the battery the less frequently it is charged



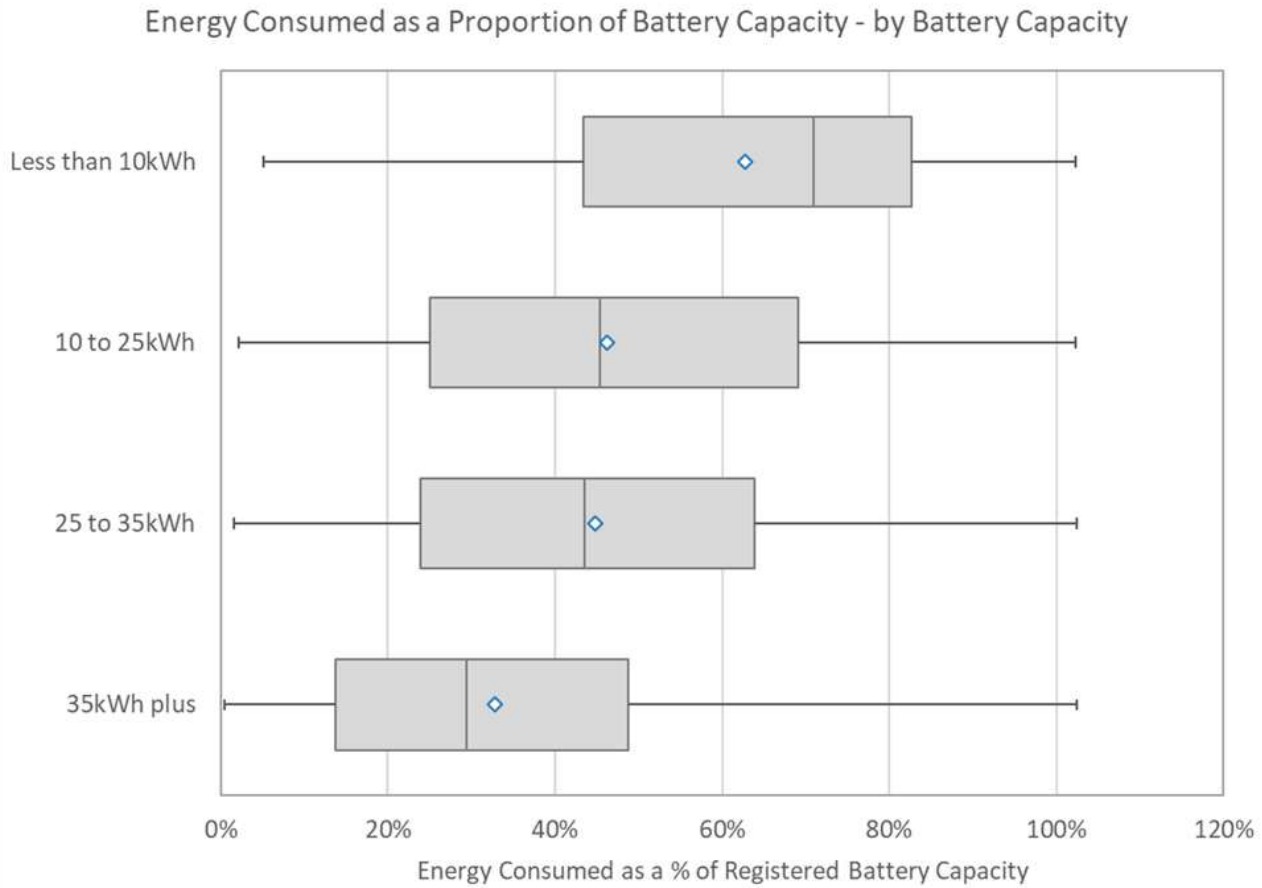
Less than 10kWh = 142 participants, 10 – 25kWh = 126, 25 to 35kWh = 137, 35kWh+ = 90

What causes variance?

Smaller batteries are drained more between charges than bigger batteries

For BEVs & REXs:

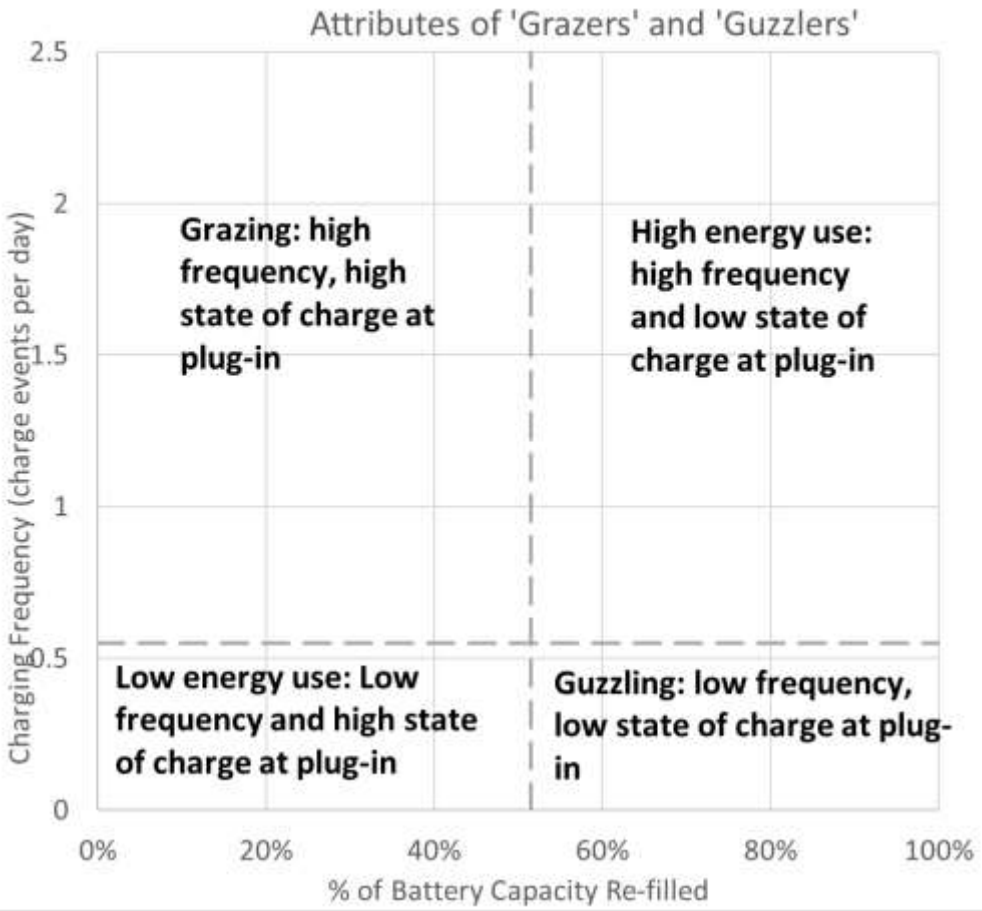
Mean battery SOC at start of charge is >50%



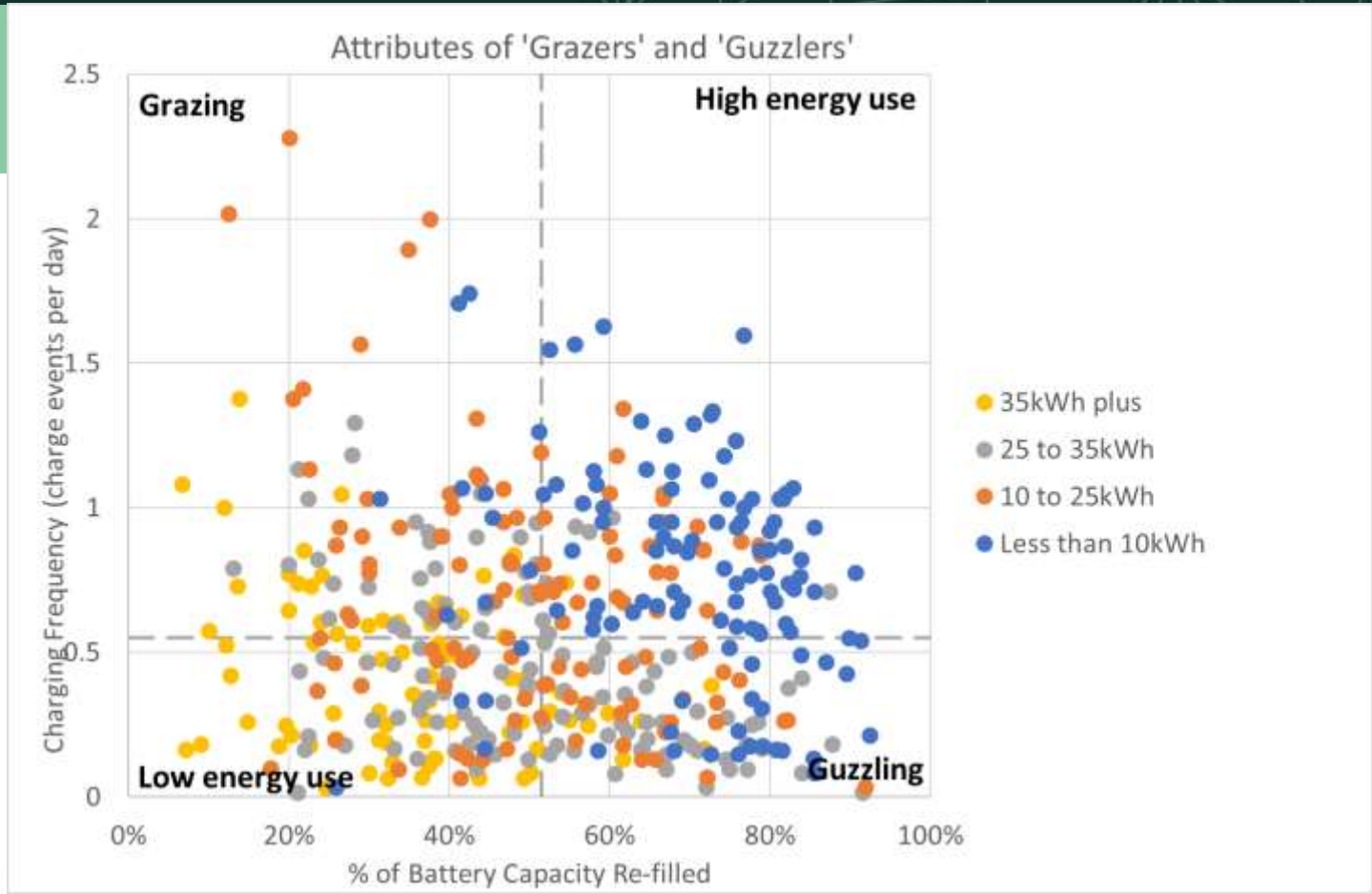
Based on 137,886 charging events

ELECTRIC NATION

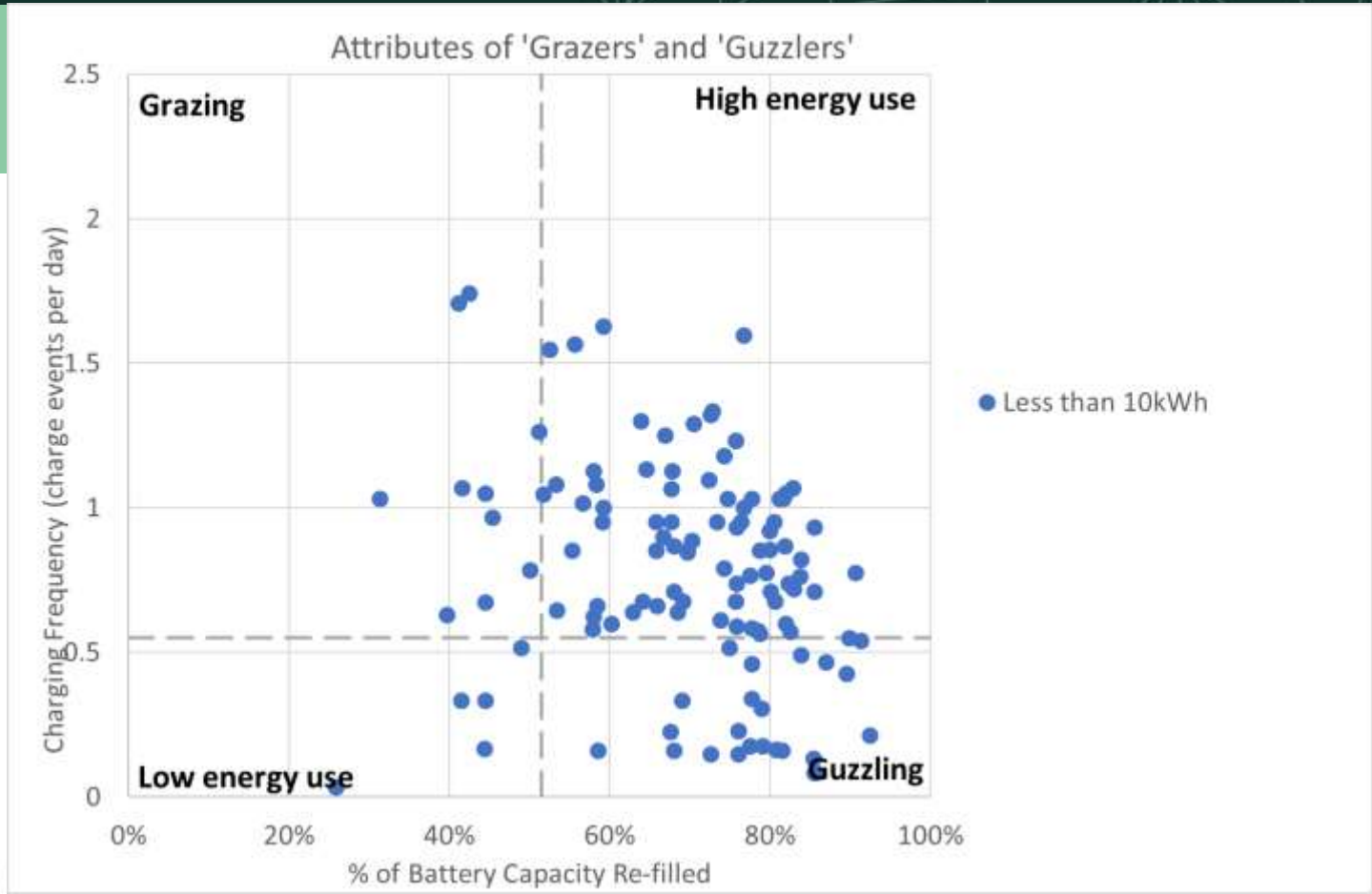
Grazing and Guzzling



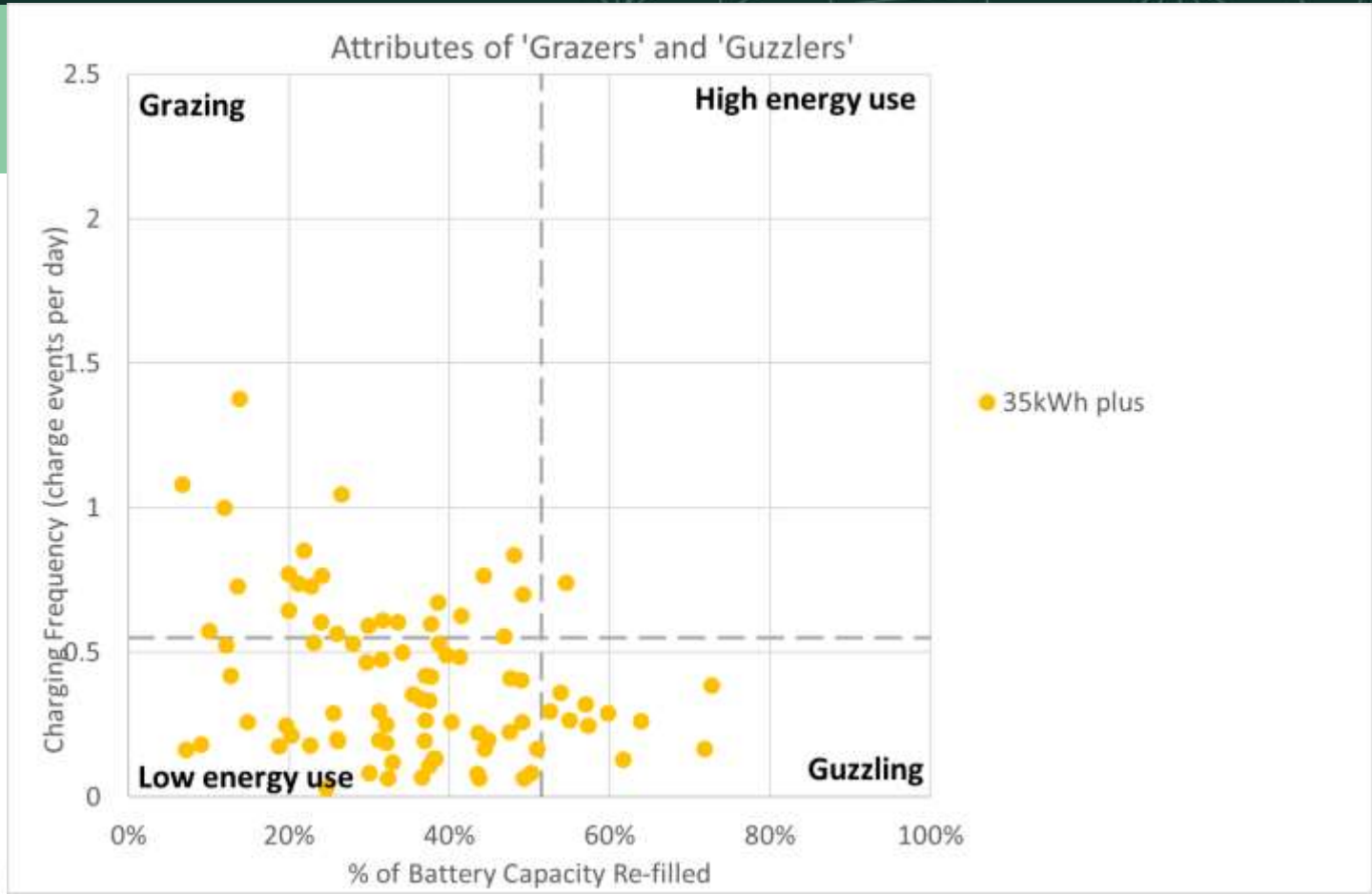
Grazing and Guzzling



Grazing and Guzzling



Grazing and Guzzling



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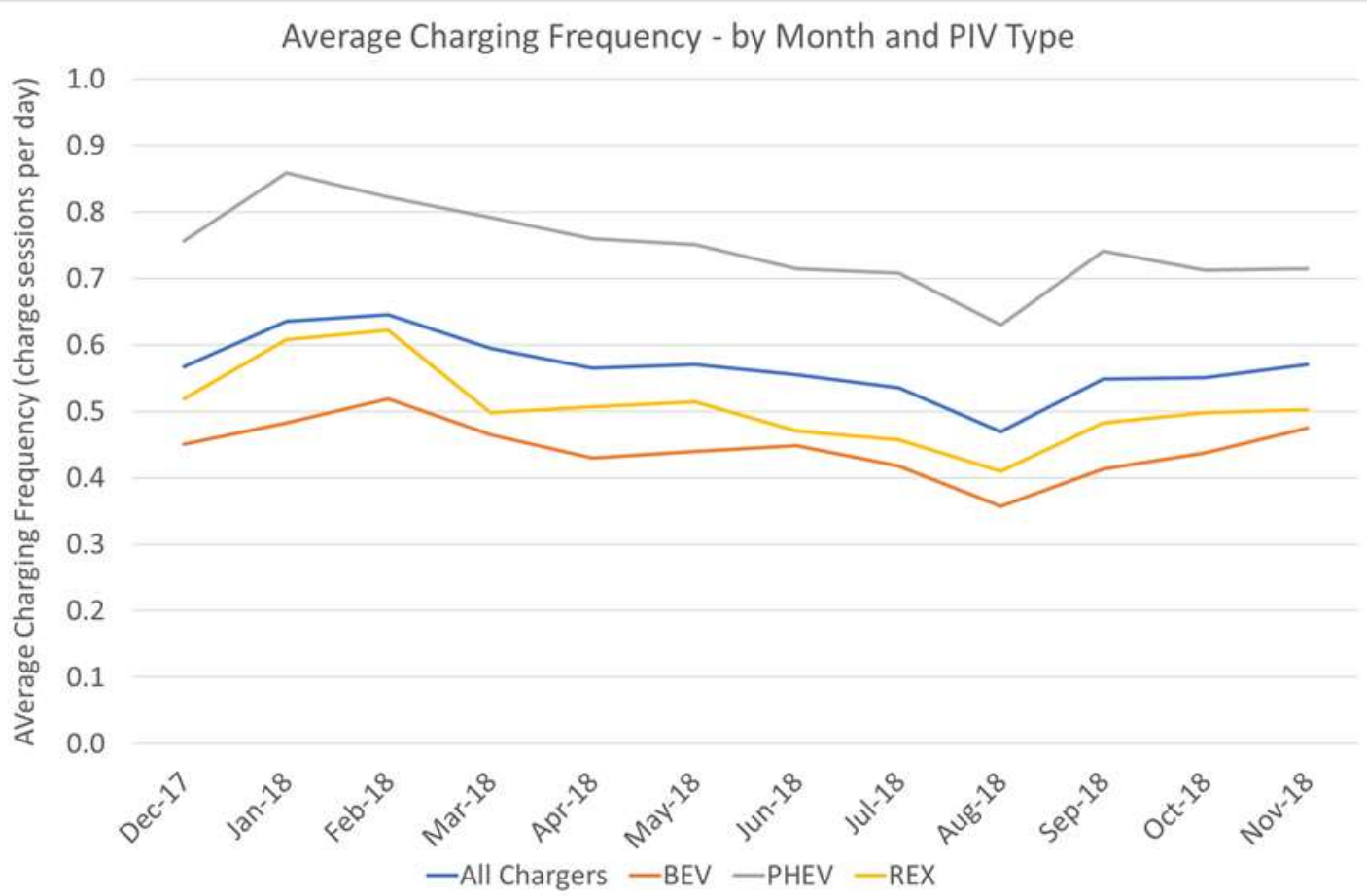
Seasonal Effects

Significant seasonal difference observed

- Probably caused by battery conditioning and passenger compartment heating
  - Aircon more efficient (summer)



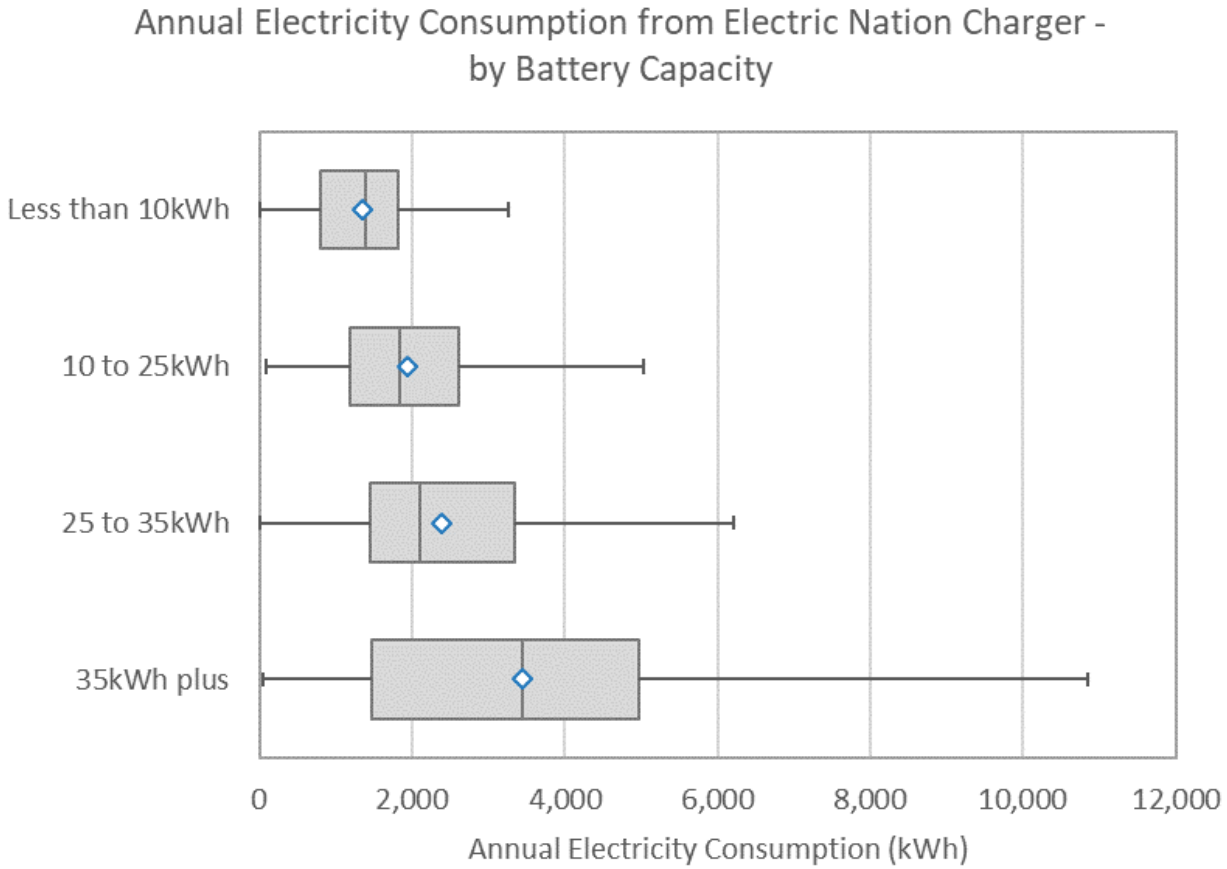
Annual energy Consumption

Overall Mean consumption in trial

2,000 kWh

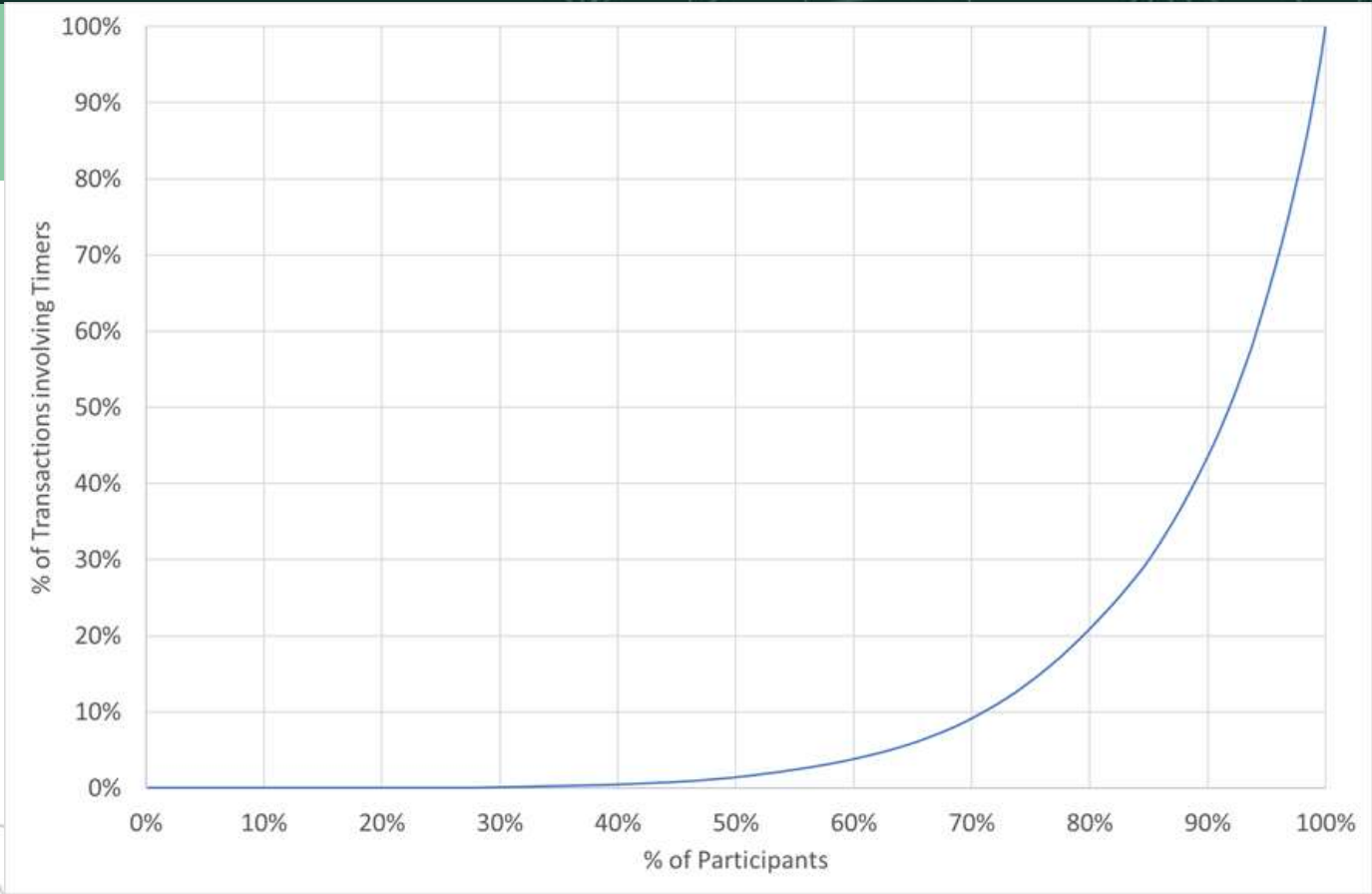
“about a house worth”

Equivalent to 25-35 miles per day



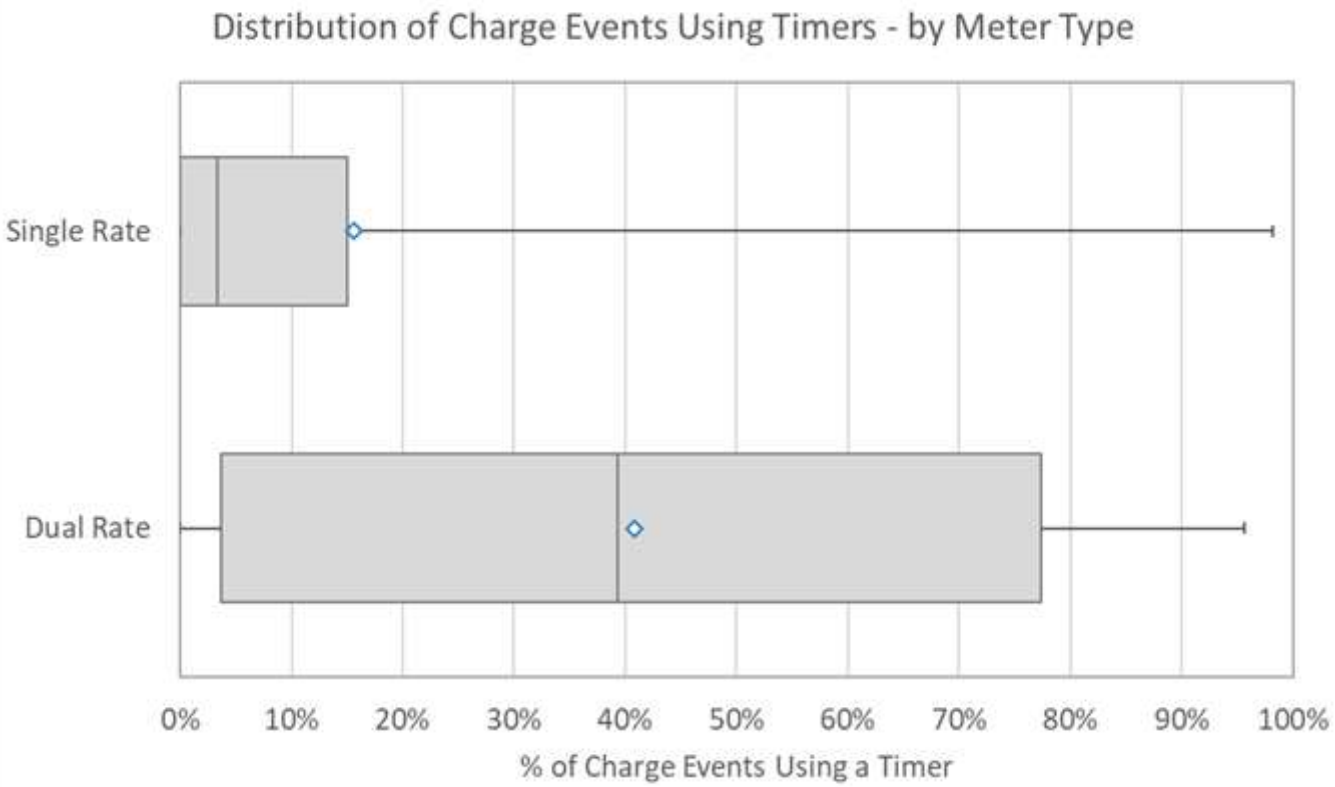
Use of timers

- 20% of participants responsible for 80% of timer use



Use of timers

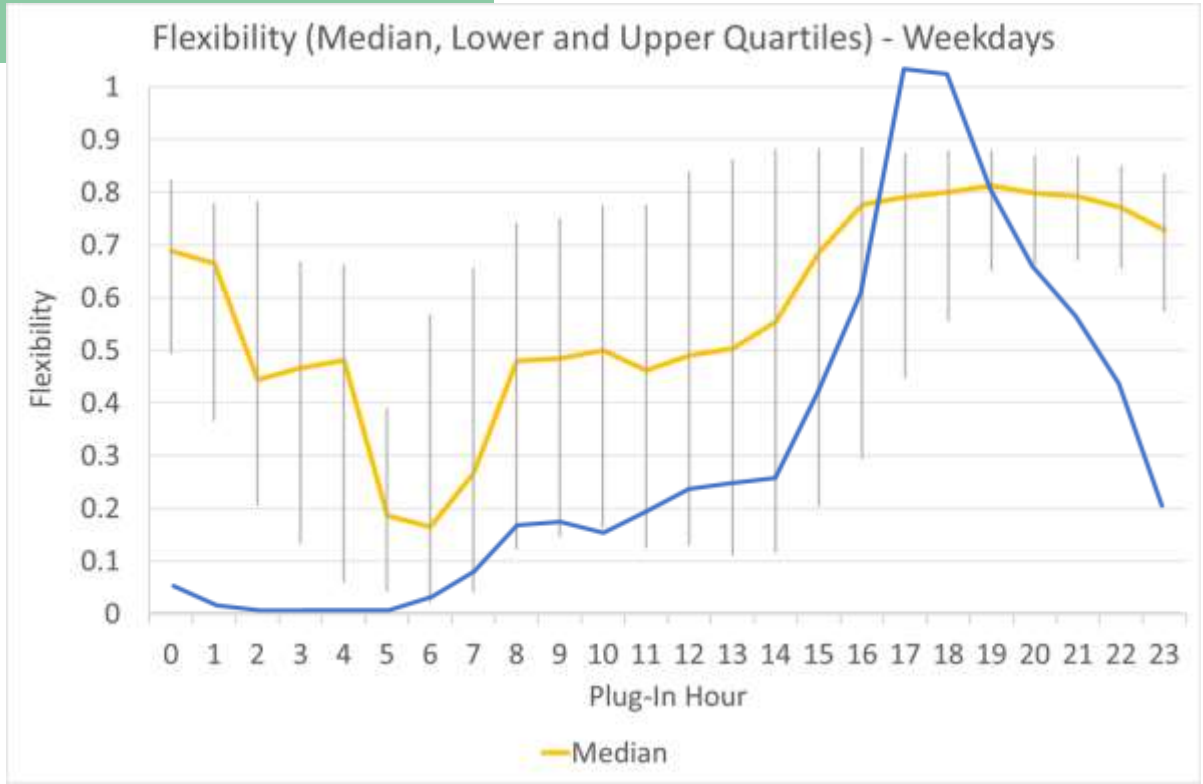
- 20% of participants responsible for 80% of timer use
- Participants with dual rate meters more likely to use timers
- But not necessarily on dual rate tariffs
  - Economy7
  - Single rate meter users won't see financial benefit at all



Flexibility in Charging

$$\text{Flexibility} = 1 - \frac{\text{Charging Duration}}{\text{Plug in Duration}}$$

Flexibility just right at time of highest rate of plug-in



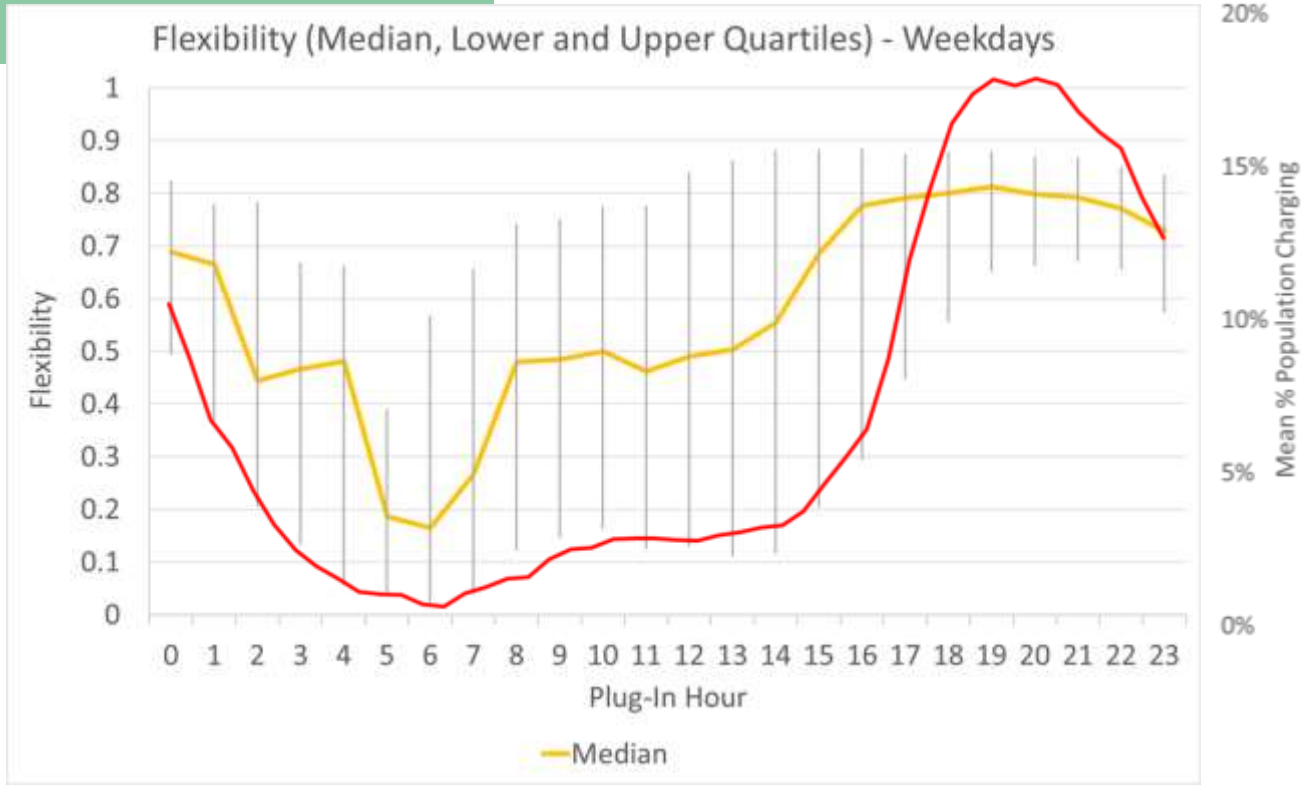
Based on 137,886 charging events

Flexibility in Charging

$$\text{Flexibility} = 1 - \frac{\text{Charging Duration}}{\text{Plug in Duration}}$$

Flexibility just right at time of highest rate of plug-in

And at time of highest rate of charging



Based on 137,886 charging events

Lessons learned

- There is flexibility in charging behaviour
- Especially at peak electricity demand period
- Shows that substantial proportion of EV charging could be shifted to later evening and overnight
- Understanding of what contributes to variance in charging behaviour
  - Charging frequency
  - Day of week & seasonal effects
  - Amount of charge taken
  - Use of timers

Thank you for listening

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Trial 1 Findings and Observations

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Senior Consultant
&
Nicole McNab
Impact
Associate Director

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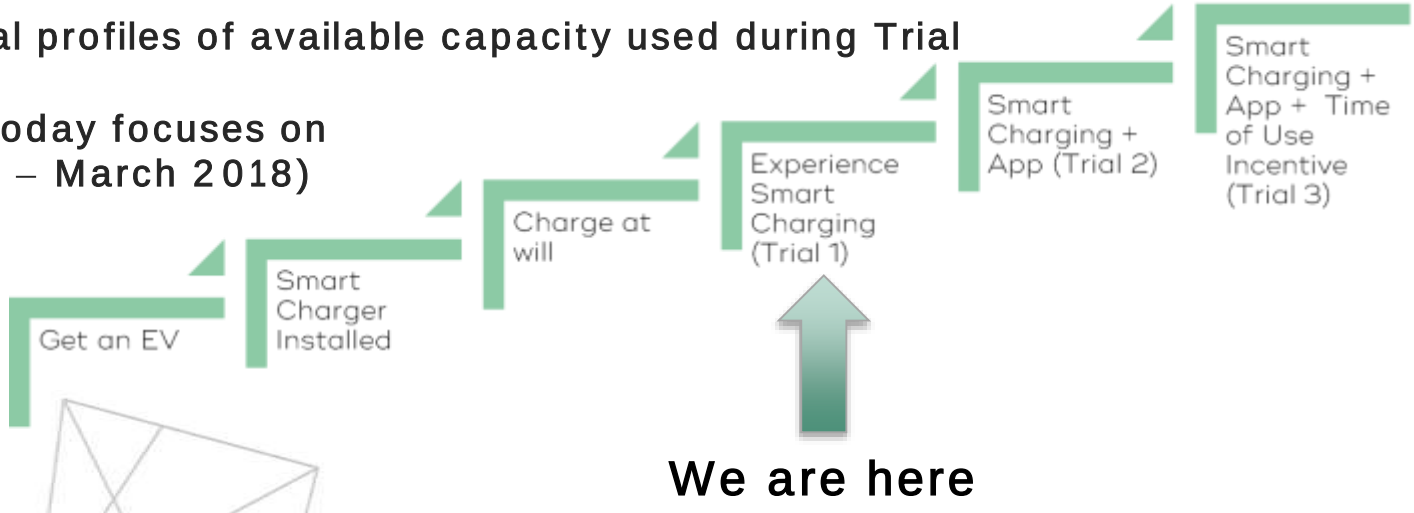
Trial 1 Introduction

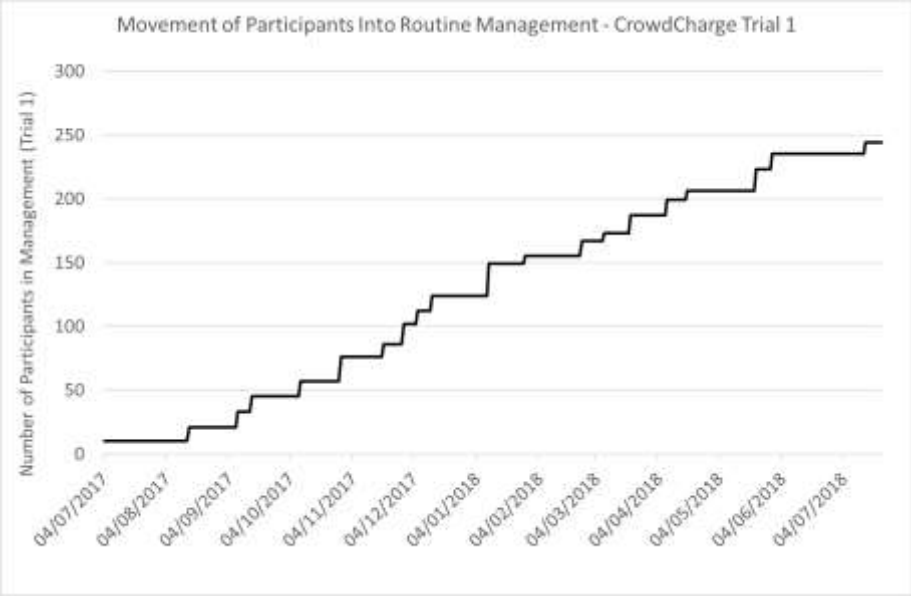
- Demand management active, with no interaction available for participants
- CrowdCharge: July 2017 to July 2018
- GreenFlux: July 2017 to April 2018
- Different seasonal profiles of available capacity used during Trial
- Data presented today focuses on 'Winter' (January – **March 2018**)



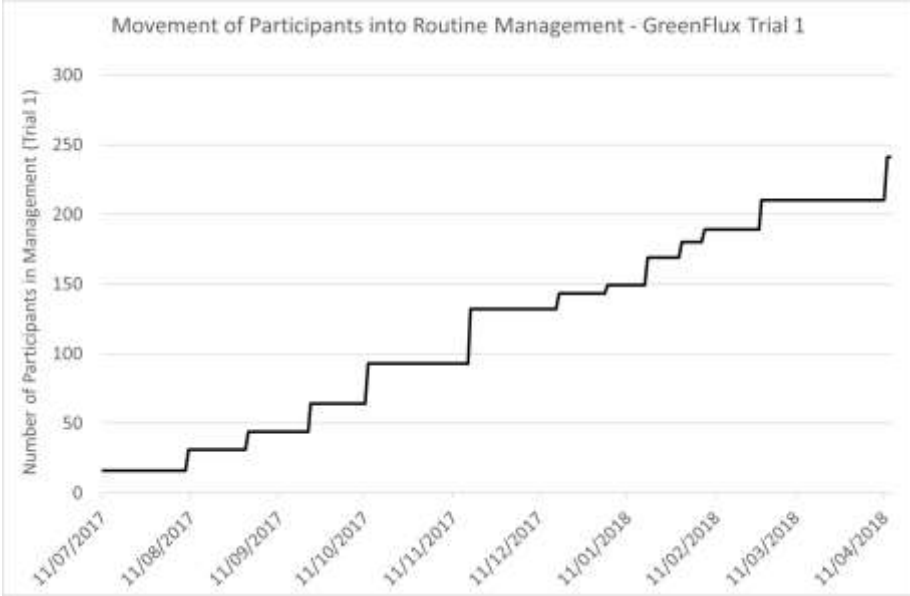
Establishing Groups of Chargers

Chargers were moved into the management groups throughout the trial

CrowdCharge

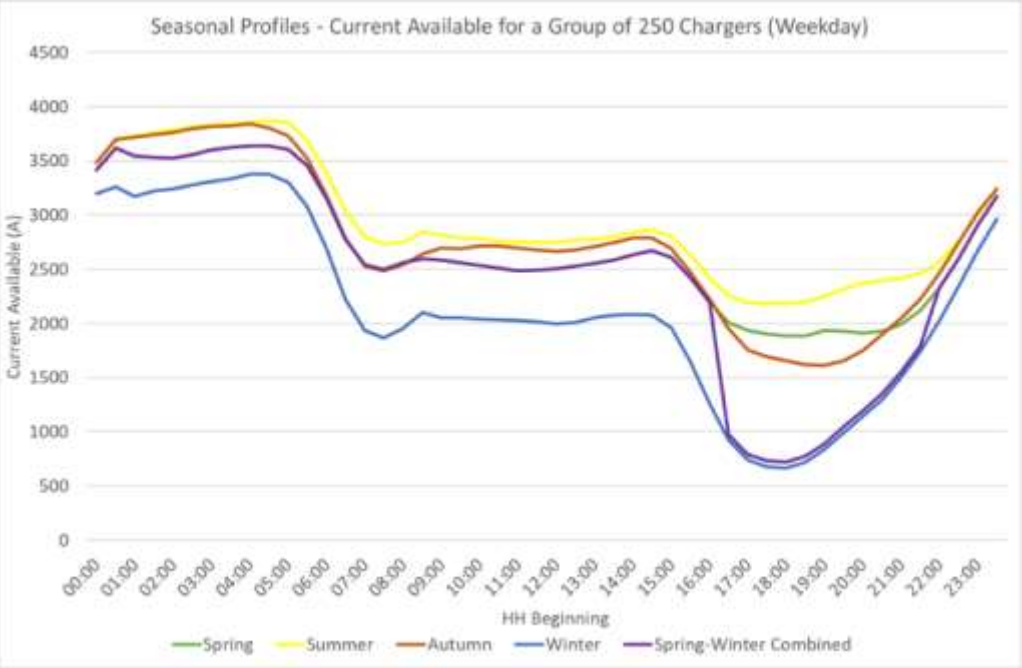


GreenFlux



Management Principles

- Chargers put into groups
- GreenFlux and CrowdCharge given ‘capacity profiles’ – the total amount of current a group of chargers could draw
- Capacity is based on real ‘spare’ capacity for an HV feeder in the East Midlands
- Profiles varied by season
- CrowdCharge and GreenFlux used their systems so Total Demand < Capacity Profile



Management Principles

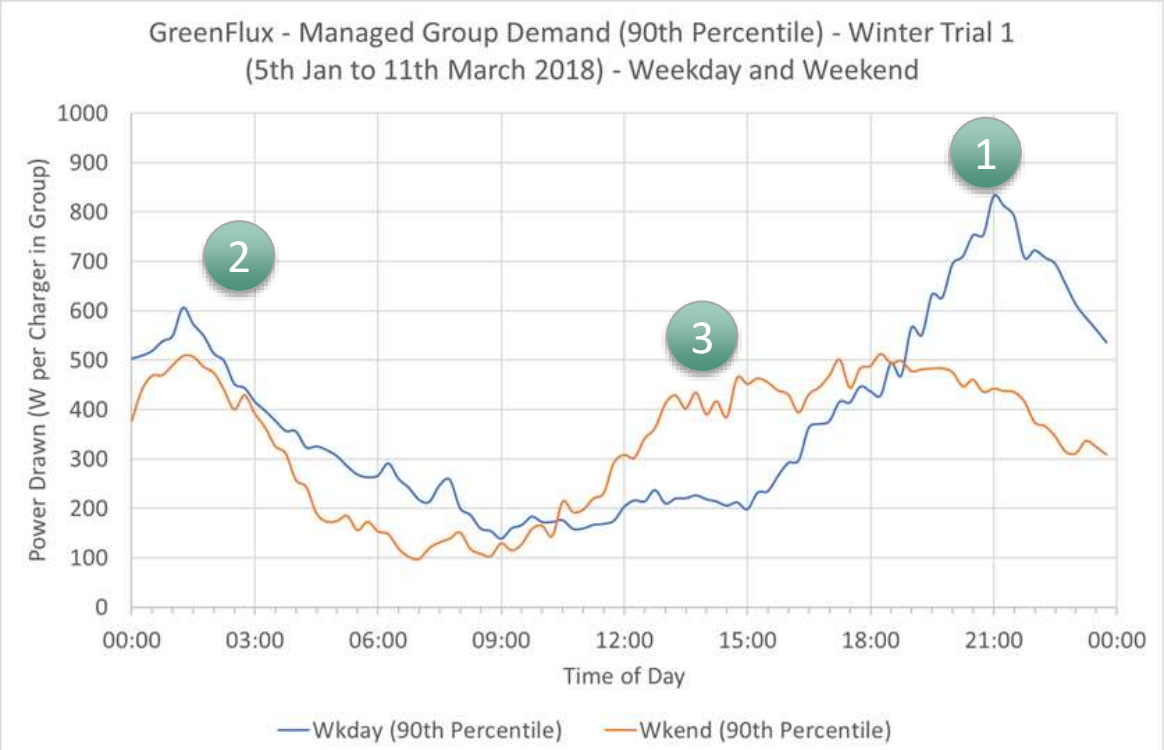
- ‘Group Level Management’: periods of time when chargers were being managed – typically the evening peak
- More restrictive than Business as Usual – particularly if substations were fitted with real-time monitoring
- ‘Individual Level Management’: when individual charging events were constrained
- CrowdCharge and GreenFlux used different algorithms to share out the available current

Winter Demand Profiles

- Total power drawn by groups of chargers – divided by no. of chargers in the group
- 90th Percentile shown
- Profiles are restricted – i.e. the size of the evening peak was constrained by capacity profiles
- CrowdCharge profiles are similar

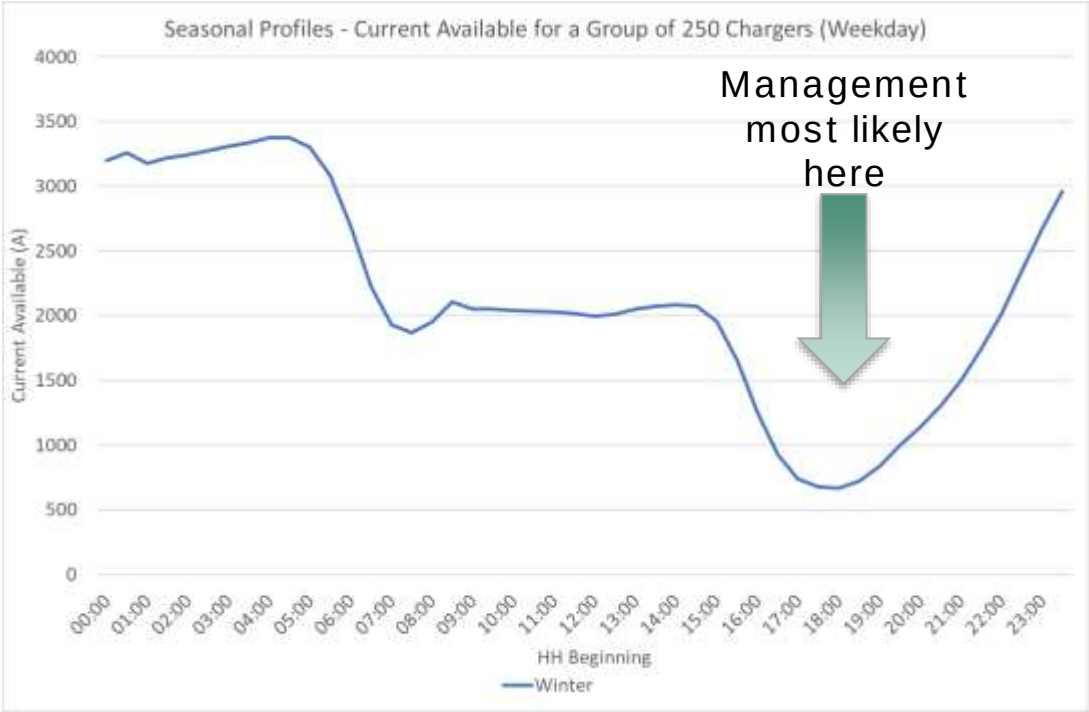
Winter Demand Profiles

1. Peak ≈ 850W per charger. Timing and size of peak is due to management
2. Increase in demand as overnight charging begins (people using timers)
3. Weekend profile: greater daytime demand, no evening peak



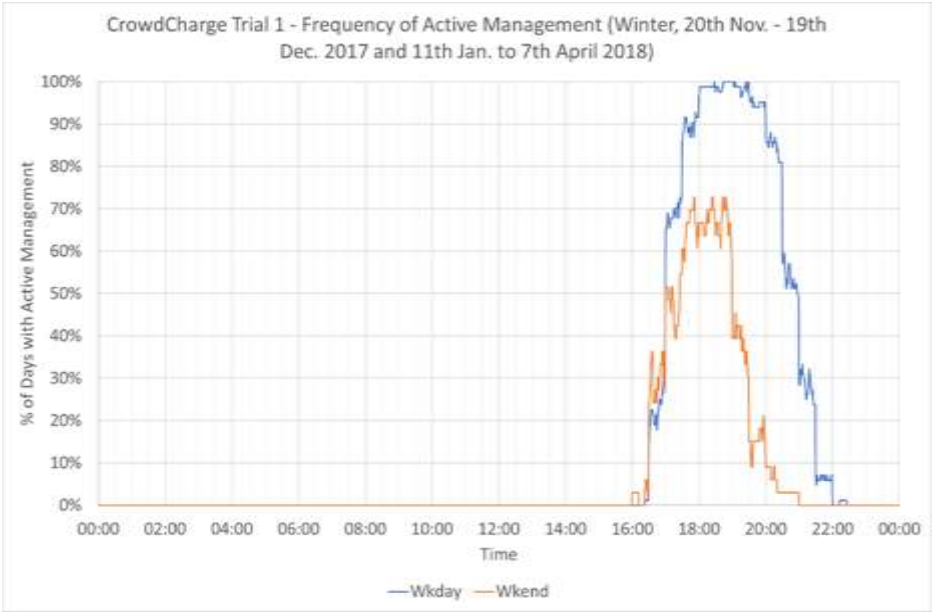
Group Level Management

- **Groups were managed** when there wasn't enough **capacity to give all active chargers their maximum allocation**
- **Most likely to happen when:**
  - **Capacity is lowest**
  - **Demand is highest**
- **= Weekday evening peak**

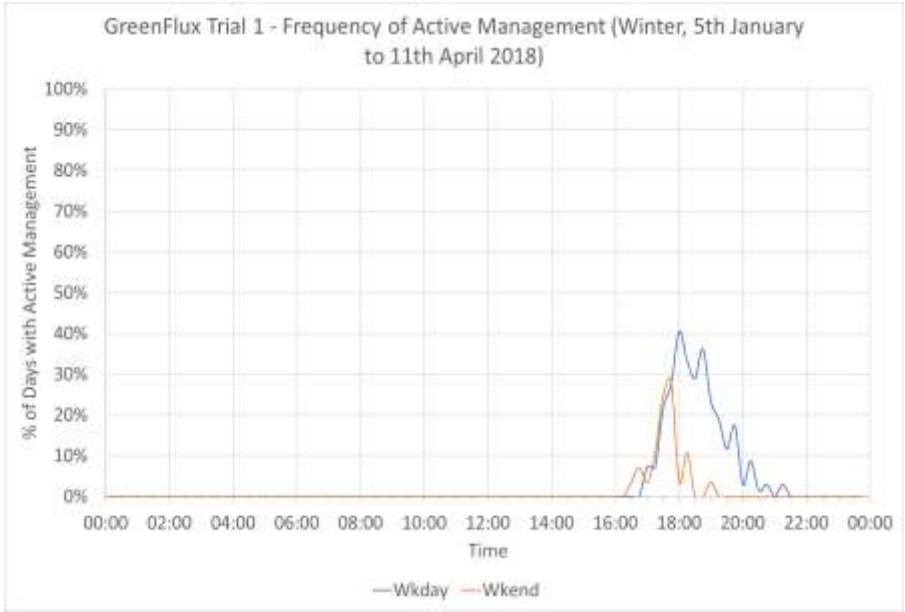


Group Level Management

CrowdCharge



GreenFlux



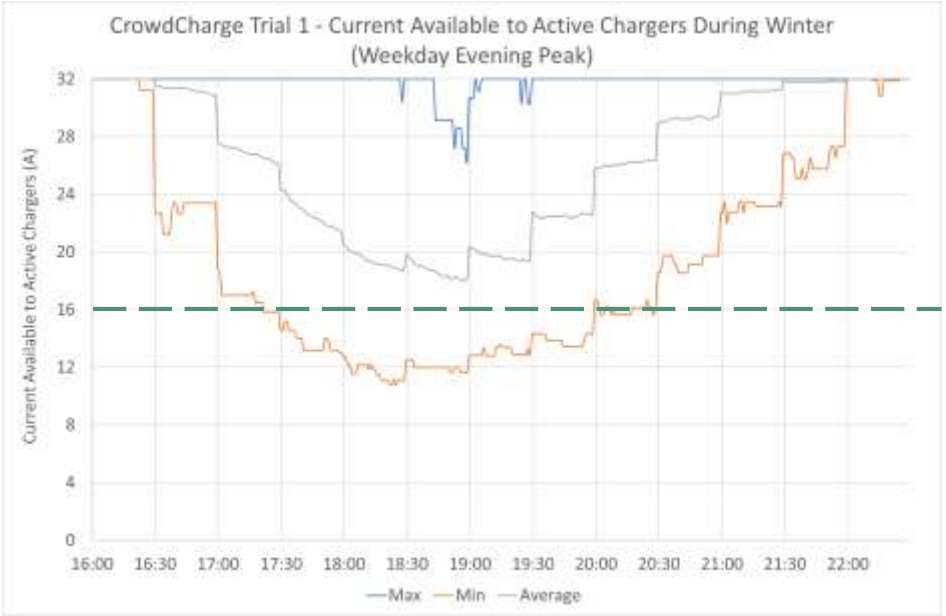
Group Level Management – How Restrictive (CrowdCharge)

- All active chargers were given the same current allocation. Examples when Capacity Limit = 300A
  - 9 active chargers – 9 x 32 = 288A (<300A) – No Management
  - 15 active chargers – each get 20A (300 ÷ 15). 16A cars aren't constrained
  - 20 active chargers – each get 15A (300 ÷ 20). 16A cars are constrained

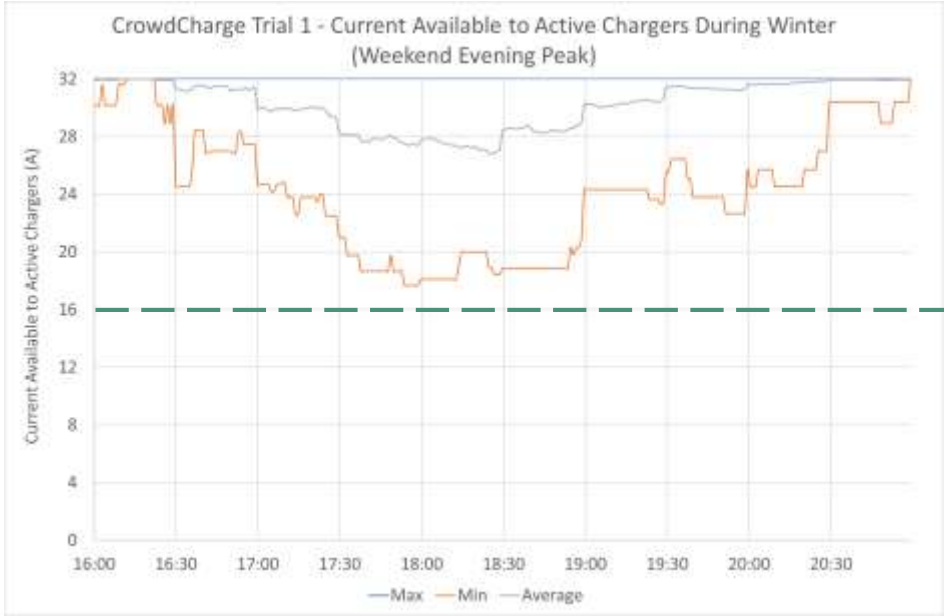
- Winter data analysed to show current available at different times of day for CrowdCharge group

Group Level Management – How Restrictive (CrowdCharge)

Weekday



Weekend



Individual Level Management

- Participants experienced different amounts of management, e.g.:
  - Charge exclusively overnight – no management
  - CrowdCharge 16A vehicle, charging in the peak – managed less than a participant with a 32A car and the same behaviour
  - Charge in the middle of the day – no management

- Need to understand if there is a link between 'management experience' and satisfaction with **charging arrangements** → 'Customer acceptability of smart charging'

- Used the meter value data to show which charge events were constrained, and how much

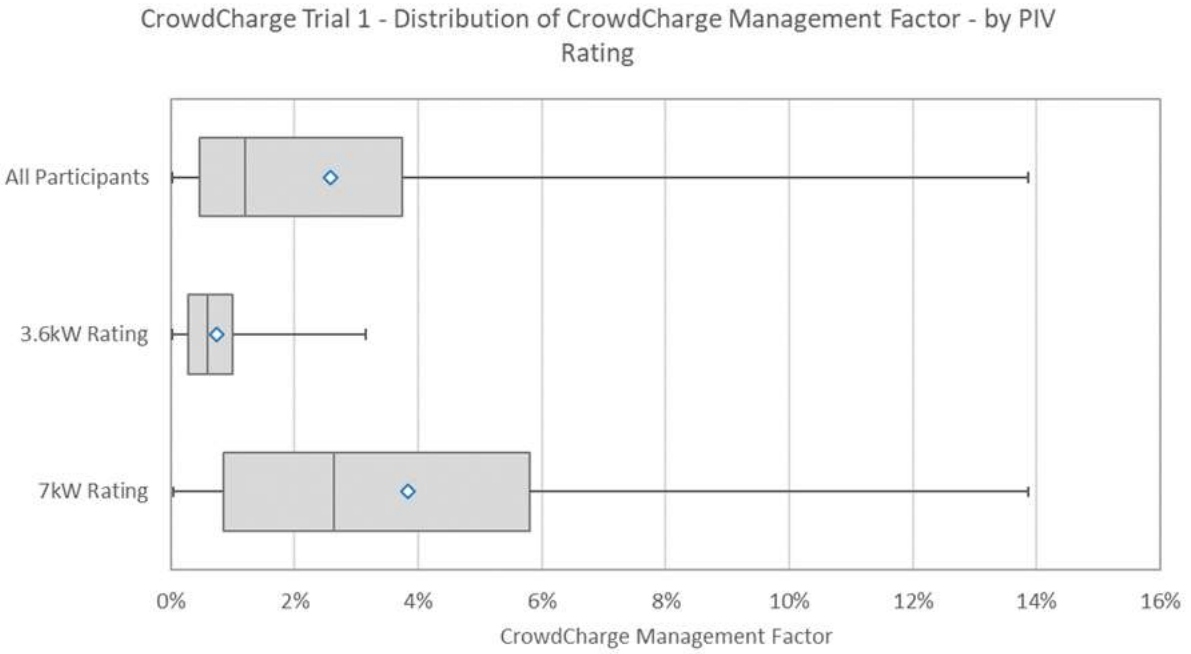
- CrowdCharge – 8% of all Trial 1 charging events were constrained
- GreenFlux – 17% of all Trial 1 charging events were constrained

Individual Level Management – Metrics Used

- For each charging event:
  - 'Managed' (Yes/No): binary flag to show whether the session was constrained. **Used for both CrowdCharge and GreenFlux**
  - **Restriction (only for managed charging events):**
    - **CrowdCharge = compare the minimum possible charging time to the time actually taken**
    - **GreenFlux = % of the time in the charging event which was constrained**
- For each participant:
  - **Calculate % of their charge sessions which were managed**
  - Take the median 'Restriction' value
  - **Management Factor = % of Sessions Managed x Median Restriction**
  - Participants who weren't managed don't have a 'Management Factor'
  - **Value for CrowdCharge and GreenFlux** Management Factor aren't comparable

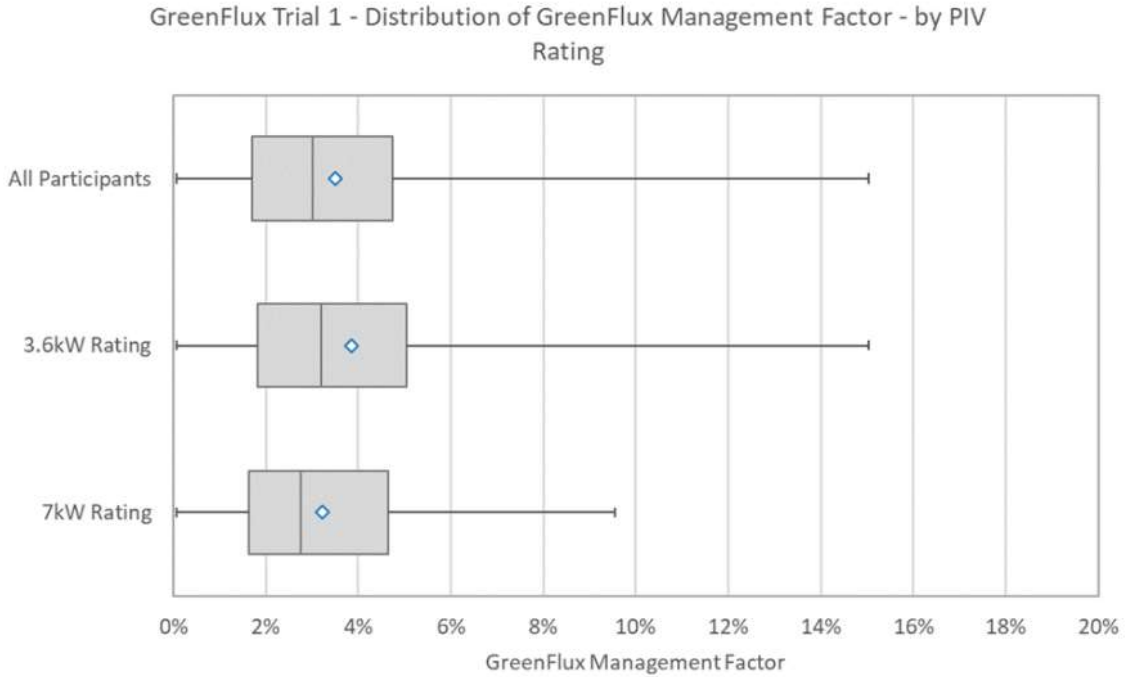
CrowdCharge Management Factor

- 25% of Trial 1 Participants experienced no management
- Participants with 3.6kW (16A) vehicles have lower Management Factor values – they experienced management less often, and for less time
- Considerable variation in both groups – depends on charging behaviour



GreenFlux Management Factor

- 19% of Trial 1 Participants experienced no management
- 3.6kW (16A) and 7kW (32A) vehicles treated equally – so a similar distribution of Management Factor
- Considerable variation in both groups – depends on charging behaviour



Trial 1 Customer Research Results – based on two engagement pieces

Survey results

Focus group results

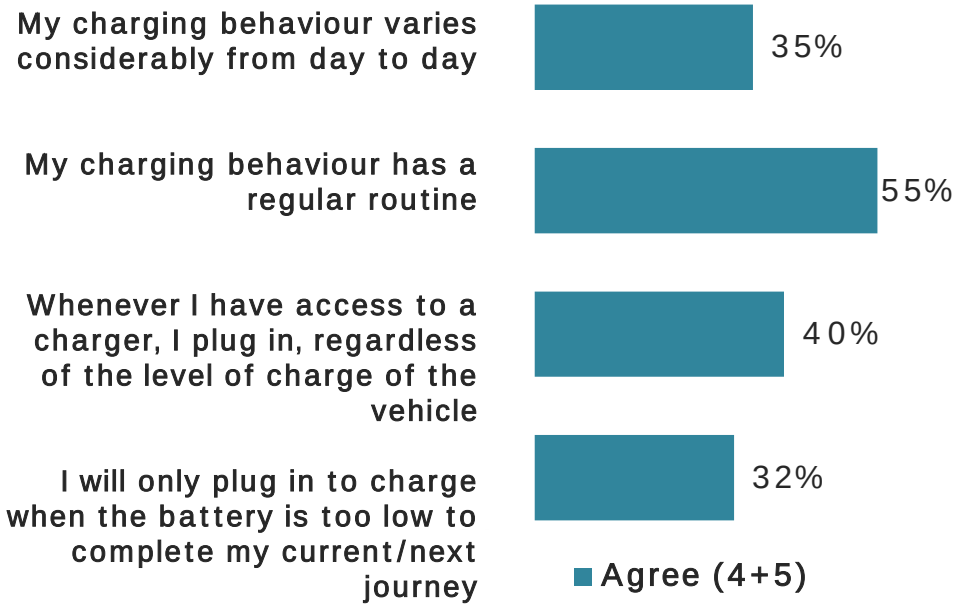
Trial 1 – Many Didn't Notice/ Were Not Impacted

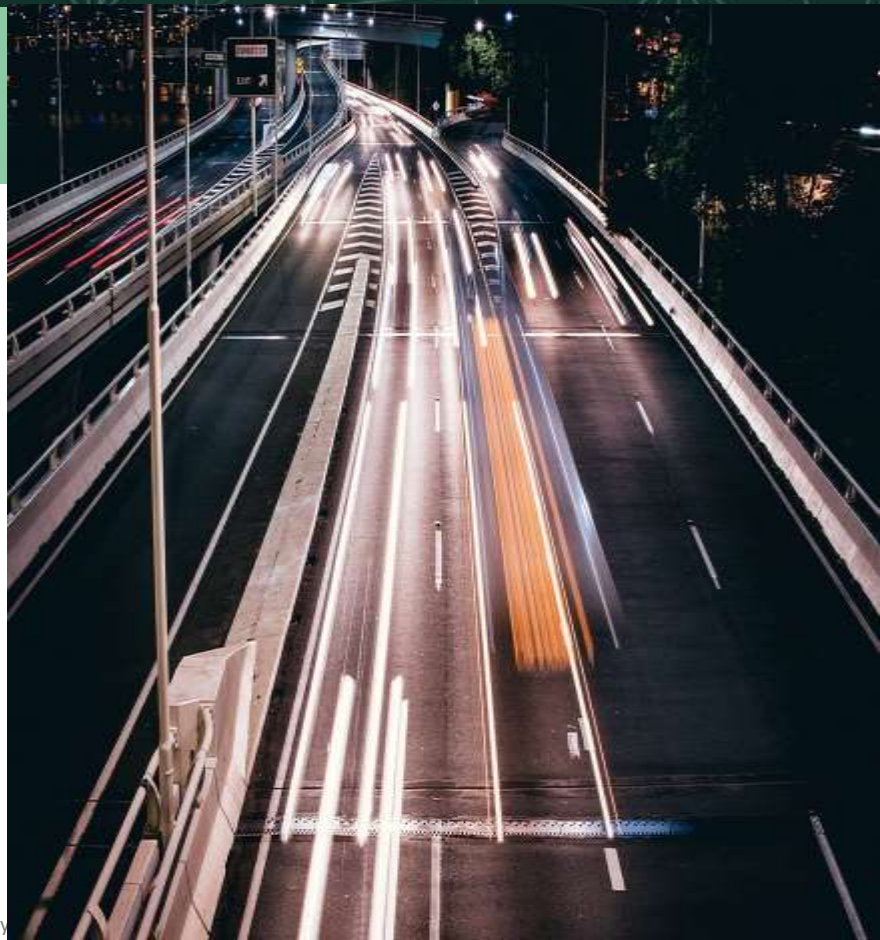
I never actually had reduced charging. Or if I did, I didn't know when it was happening. I never noticed it.

I either didn't have it or didn't notice. But I think I generally put the car on to charge and left it on for several hours. So, I suppose it would have evened itself out in the period anyway.

Trial 1 Vs. Baseline Charging Behaviour

- Charging behaviour has stayed relatively similar to the baseline





B1 To what extent do you agree or disagree with the following statement, where 1 is strongly disagree and 5 is strongly

Participant Acceptability With Trial 1

- Acceptability with charging arrangement
  - Scoring 8, 9 or 10 out of 10

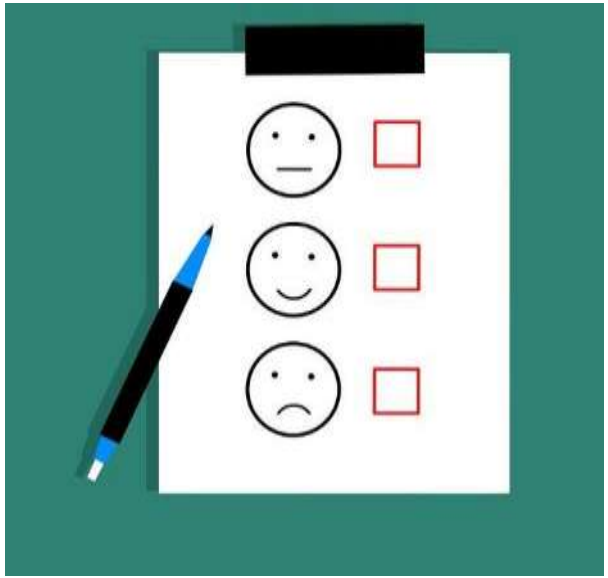
	Baseline	Trial 1
CROWD charge	75%	78%
GreenFlux Smart charging	75%	77%

I get home seven, eight o'clock in **the evening, I plug my car in, I** don't really mind when my car gets charged up. I don't need it invariably until seven o'clock the **next morning.**

I think possibly for the first couple of weeks I was thinking, 'what's going to happen?' But after that, no. **It just became normal.**

B8 On a scale of 1 – 10, where 1 is completely unacceptable and 10 is completely acceptable, how acceptable are your current charging arrangements? Base: All Trial (279), Baseline (498)

Participant Satisfaction With Trial 1

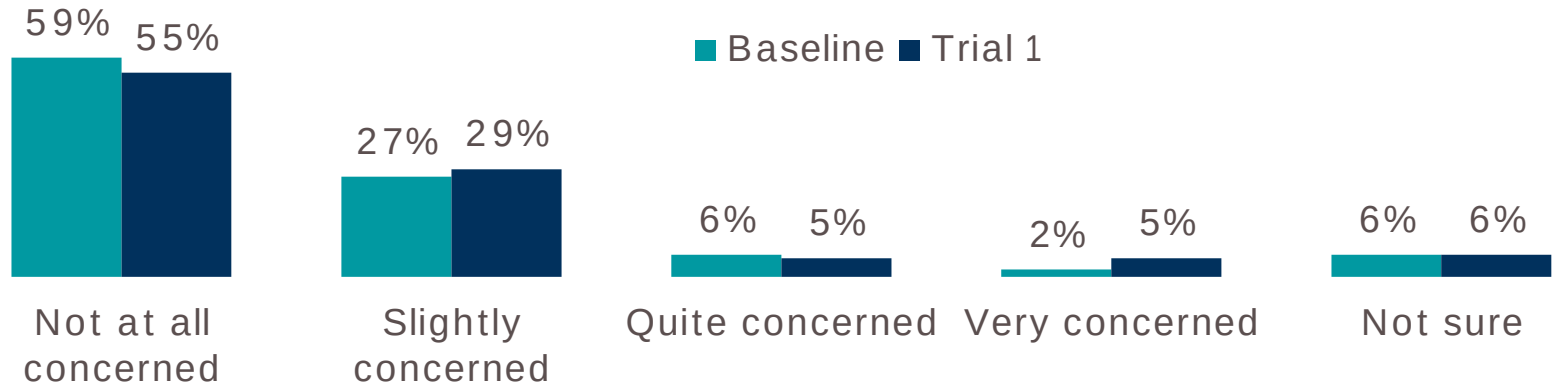


- Satisfaction with charging arrangement
  - Scoring 8, 9 or 10 out of 10

	Baseline	Trial 1
CROWD charge	77%	75%
GreenFlux Smart charging	77%	74%

B8 On a scale of 1 – 10, where 1 is completely unacceptable and 10 is completely acceptable, how acceptable are your current charging arrangements? Base: All Trial (279), Baseline (498)

Concerns About Managed Charging



- **Participants are slightly more concerned about being part of the trial in comparison to the baseline, but the majority have few concerns**
- 60% of Crowd Charge participants were 'not at all concerned' vs. 50% of **GreenFlux**

B12 How do you feel about having your charging arrangements managed as part of the trial? Base: All Trial (279), Baseline (498)

I guess it's always that concern that the one moment where you do need to quickly charge the car and you perhaps can't, that it would be frustrating. But I don't know, perhaps that moment never actually occurs.

I think it would be a concern if I desperately needed to charge and the charger was giving me twenty, thirty, forty percent charge rates. But, as I say, that's not an issue I've had through the trial. So, perhaps it's just like that range anxiety, I guess. It's just that anxiety that there's a tiny chance something like that might happen.

There's a vague possibility of something where you can see you're being demand-managed. I never knew. But that's not really vital. Just a little pretty picture somewhere.

Trial 1 Customer Research Results – Linking Management Factor and Satisfaction

- Participants divided into 'Never Managed' group, and four quartiles for Management Factor
- Can compare satisfaction levels in each group

Experienced more management

Group	% of Survey Responses (% of Satisfaction Scores)		
	Dissatisfied (1 – 4)	Neutral (5 -7)	Satisfied (8 – 10)
Never Managed	0%	14%	86%
Management Factor 1st Quartile	7%	7%	86%
Management Factor 2nd Quartile	5%	24%	71%
Management Factor 3rd Quartile	3%	25%	72%
Management Factor 4th Quartile	0%	27%	73%

Trial 1 Customer Research Results – Linking Management Factor and Satisfaction

Experienced more management

Group	% of Survey Responses (% of Satisfaction Scores)		
	Dissatisfied (1 – 4)	Neutral (5 - 7)	Satisfied (8 – 10)
Never Managed	0%	18%	82%
Management Factor 1st Quartile	4%	19%	77%
Management Factor 2nd Quartile	0%	29%	71%
Management Factor 3rd Quartile	6%	18%	76%
Management Factor 4th Quartile	4%	11%	86%

Trial 1 Customer Research Results – Linking Management Factor and Acceptability

Experienced more management

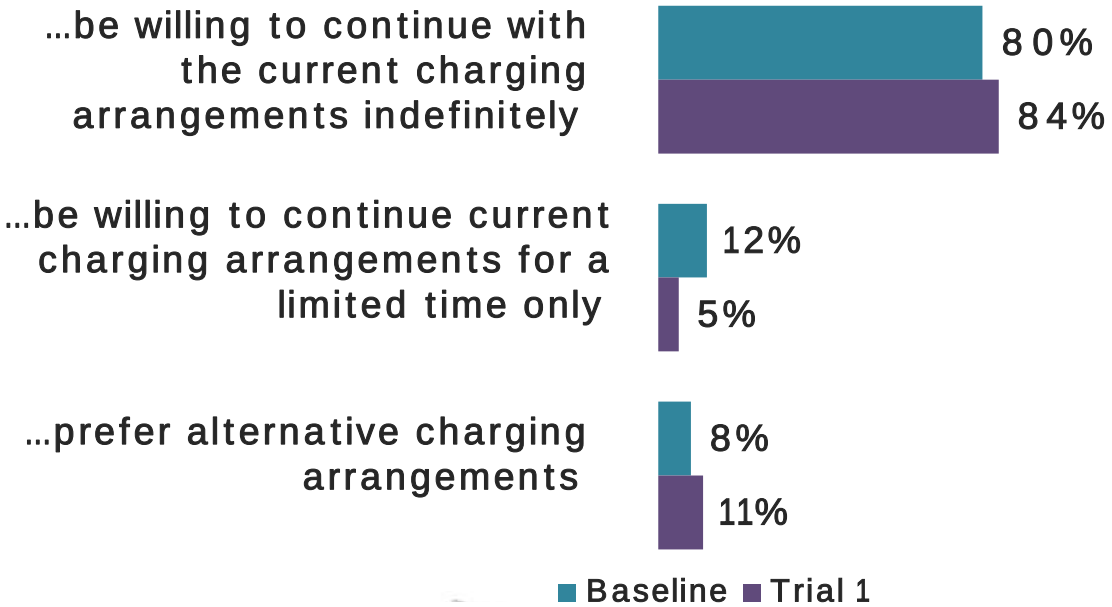
Group	% of Survey Responses (% of Acceptability Scores)		
	1 - 4	5 - 7	8 – 10
Never Managed	0%	9%	91%
Management Factor 1st Quartile	0%	14%	86%
Management Factor 2nd Quartile	5%	19%	76%
Management Factor 3rd Quartile	9%	25%	66%
Management Factor 4th Quartile	0%	19%	81%

Trial 1 Customer Research Results – Linking Management Factor and Acceptability

Experienced more management

Group	% of Survey Responses (% of Acceptability Scores)		
	1 - 4	5 - 7	8 - 10
Never Managed	0%	9%	91%
Management Factor 1st Quartile	8%	19%	73%
Management Factor 2nd Quartile	3%	23%	74%
Management Factor 3rd Quartile	3%	18%	79%
Management Factor 4th Quartile	0%	11%	89%

Would Consumers Continue With Their Charging Arrangements?



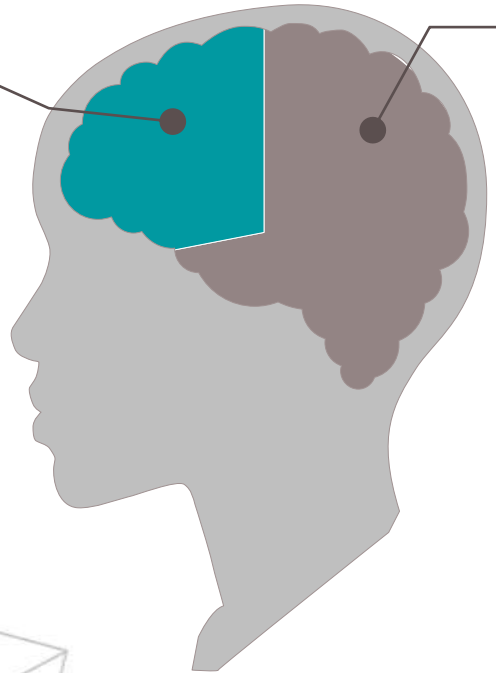
Charger Type	
Green Flux	Crowd Charge
87%	81%
5%	6%
8%	13%

B10 Which statement best describes your attitude to changing your charging behaviour.. Base: All Trial (279), Baseline (498)

Logic Vs. Emotive Responses

System 1

System 2



Quick, short, sharp decisions and impressions which only engage the subconscious brain. This is done using ‘heuristics’ which are mental shortcuts to decision making

More engaged conscious decision making process, used when your customers have more information in front of them and use the conscious part of their brain.

Thank you for listening

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COLLABORATION PARTNERS

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WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Electric Nation & V2G

Mike Potter
CrowdCharge
Chief Executive

COLLABORATION PARTNERS

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Electric Nation V2G – Purpose of trial

- To test the effect of exporting on the LV network on neighbouring phases and substations
- Test and prove control function of the chargers using the Crowd Charge system
- Testing phase of trial running from June-September 2019
- Findings reported to be published during Autumn 2019

Crowd Charge Bi-directional V2G charger

- UK's first mass production market ready single phase V2G charger
- 3000 units installed in Japan; converted for the UK market
  - Will operate with V2G capable versions of Nissan Leaf, eNV200 (new models) and Outlander PHEV
- 230v, 50Hz AC – single phase; 6.0kW bi-directional; CHAdeMO connection; CE certified and ENA G99 connection compliant
- Crowd Charge controller required per charger for OCPP

Electric Nation V2G – Installations

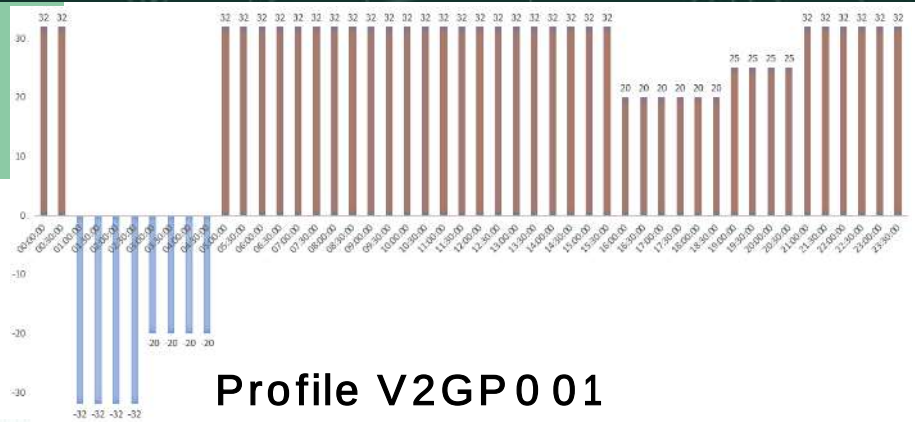
- 3 units installed for this mini-project
  - installed within WPD network area

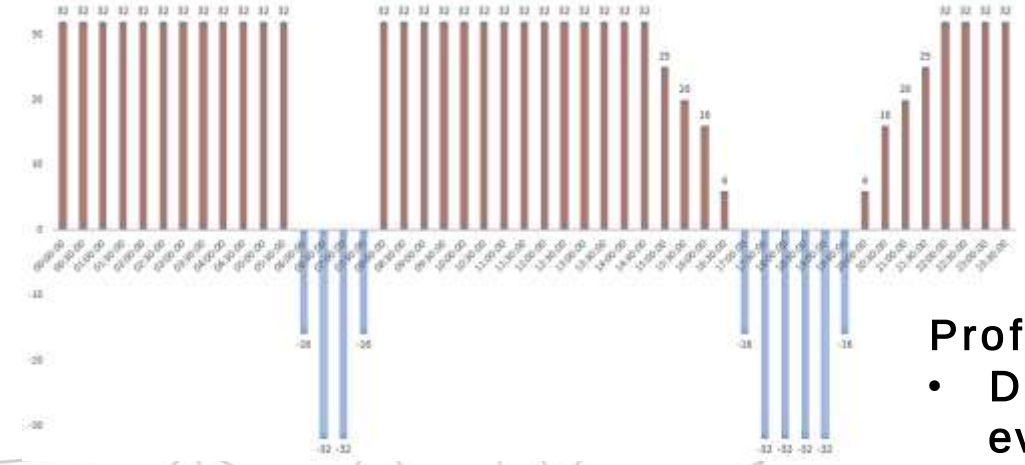
- Comms issue in establishing a reliable WIFI connection on site
  - Roaming SIM cards installed

- Monitoring equipment installations
  - 2x Lucy Electric Gridkeys installed in substations to monitor low voltage grid data/status
  - Single phase power quality/harmonics in neighbouring phases

Electric Nation V2G – Testing profiles

4 testing profiles to be implemented during June/July 2019, additional profiles during August/September





Profile V2GP001

- Reduced charging rate during evening peak
- Discharge during off peak hours (early AM)

Profile V2GP003

- Discharge during morning/ evening charging peaks

Electric Nation V2G – Testing profiles

- Profile V2GP001

Thank you for listening

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Lucy Electric
TRL

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Trials 2 & 3 Findings and Observations

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&
Nicole McNab
Impact
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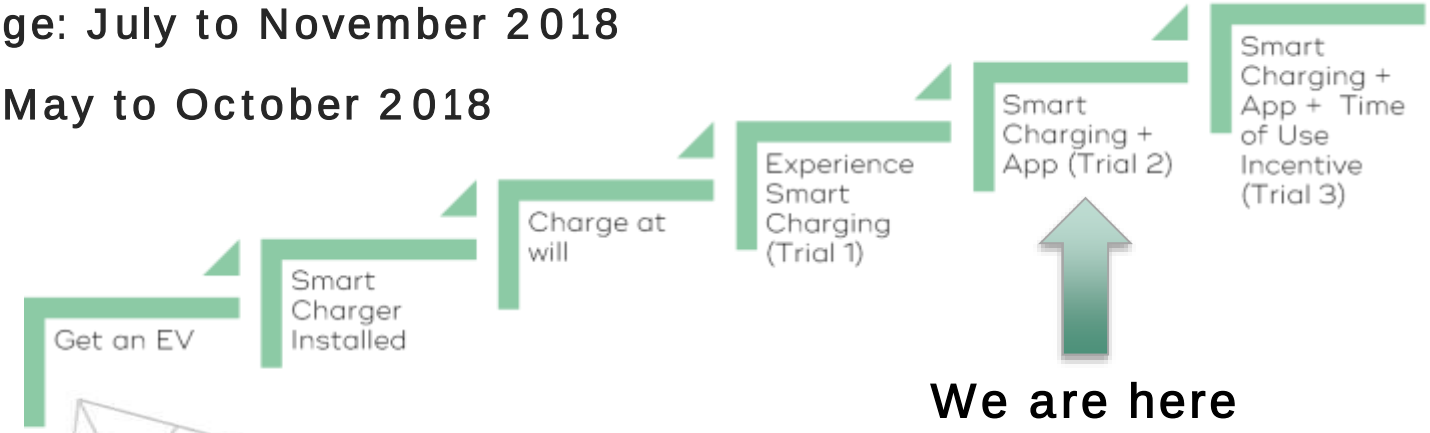
YOUR ELECTRIC VEHICLE YOUR SMART CHARGE

TRIAL 2

Trial 2 Introduction

- Introduced apps so participants could interact with smart charging systems
- Demand management still active
- CrowdCharge: July to November 2018
- GreenFlux: May to October 2018



Comparing Winter and Summer Demand

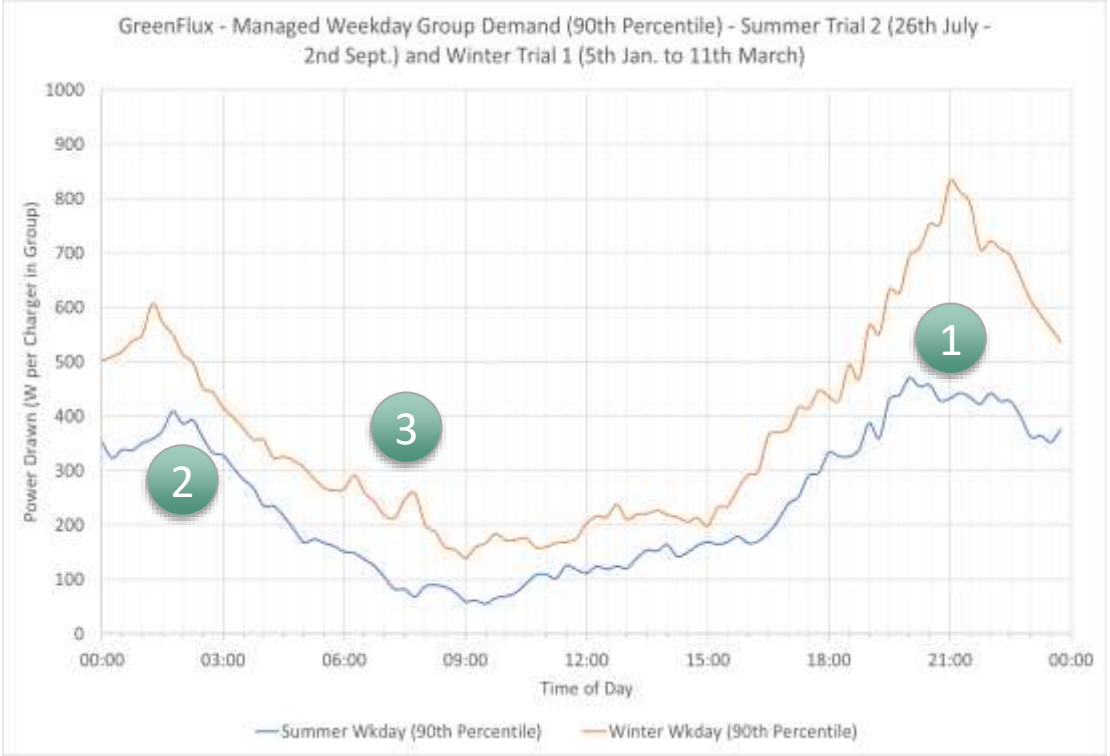
- Same approach as Trial 1 profiles
- Total power drawn by groups of chargers – divided by no. of chargers in the group
- 90th Percentile shown
- Profiles are restricted – i.e. the size of the evening peak was constrained by capacity profiles – for both winter and summer
- CrowdCharge profiles are similar
- Winter = 5th January – 11th March 2018
- Summer = 26th July - 2nd September 2018

Comparing Winter and Summer Demand - Weekdays

1. Peak demand much lower (≈480W per charger, compared to 850W per charger)

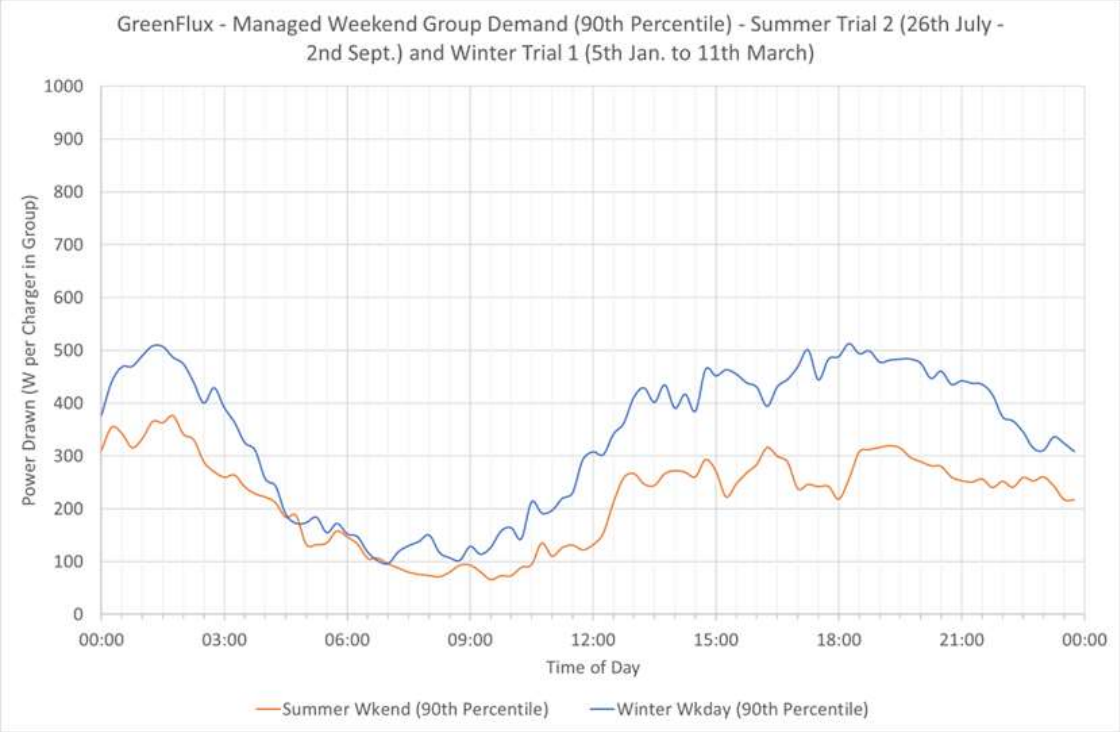
2. Timer use continues in summer – small increase in demand at 02:00

3. Less evidence of pre-conditioning of vehicles in the morning



Comparing Winter and Summer Demand - Weekend

- Weekend demand is similar shape to the winter:
  - Less pronounced evening peak
  - Higher daytime demand
- Demand is lower throughout



Management during Trial 2

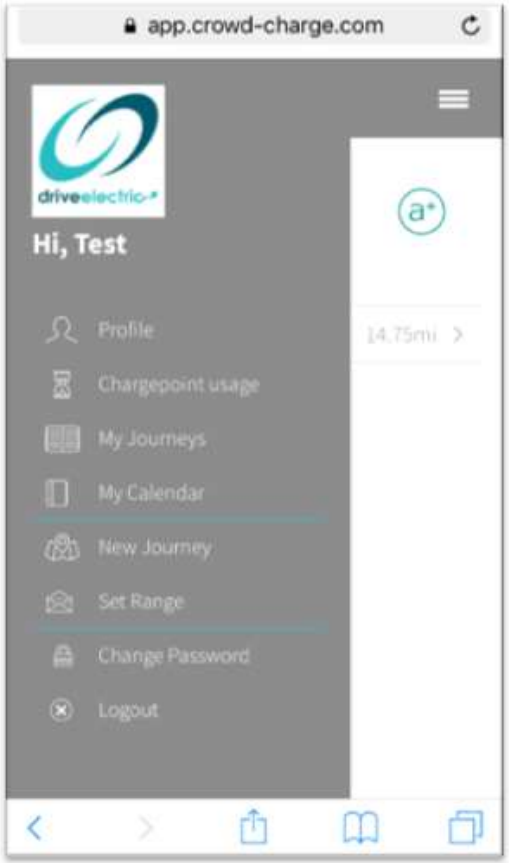
- Management principles remained the same as Trial 1 – i.e. chargers constrained when there wasn't enough capacity to give all active chargers their maximum allocation
- Profile selected to ensure management still occurred
- Apps made very little difference to amount of management
- Profiles meant management experience tended to be less restrictive in Trial 2, with more participants experiencing no management at all
- Details in the final report

Apps - Introduction

- Introduced in Trial 2
- Allowed participants to interact with the smart charging system – entering information to influence the likelihood that their charging sessions would be managed
- CrowdCharge and GreenFlux systems were very different

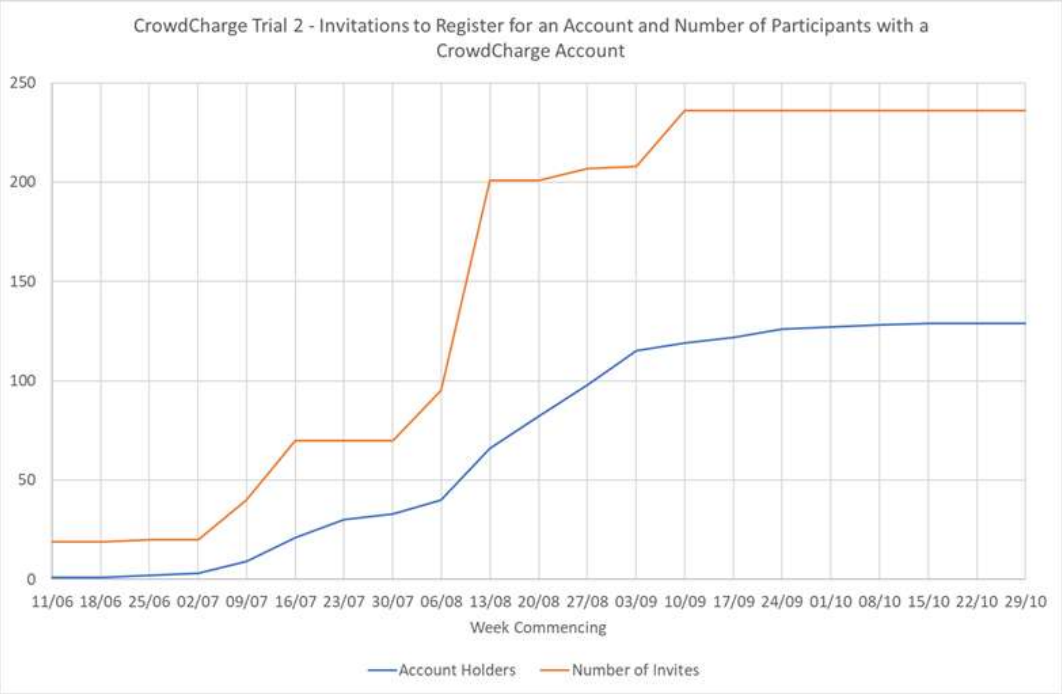
CrowdCharge App

- Web based
- Participants asked to register for an account
- Could enter three types of information:
  - Regular journeys (e.g. commute)
  - One off journeys
  - State of Charge (SoC)
- Algorithm used journeys and SoC to prioritise chargers when management was active



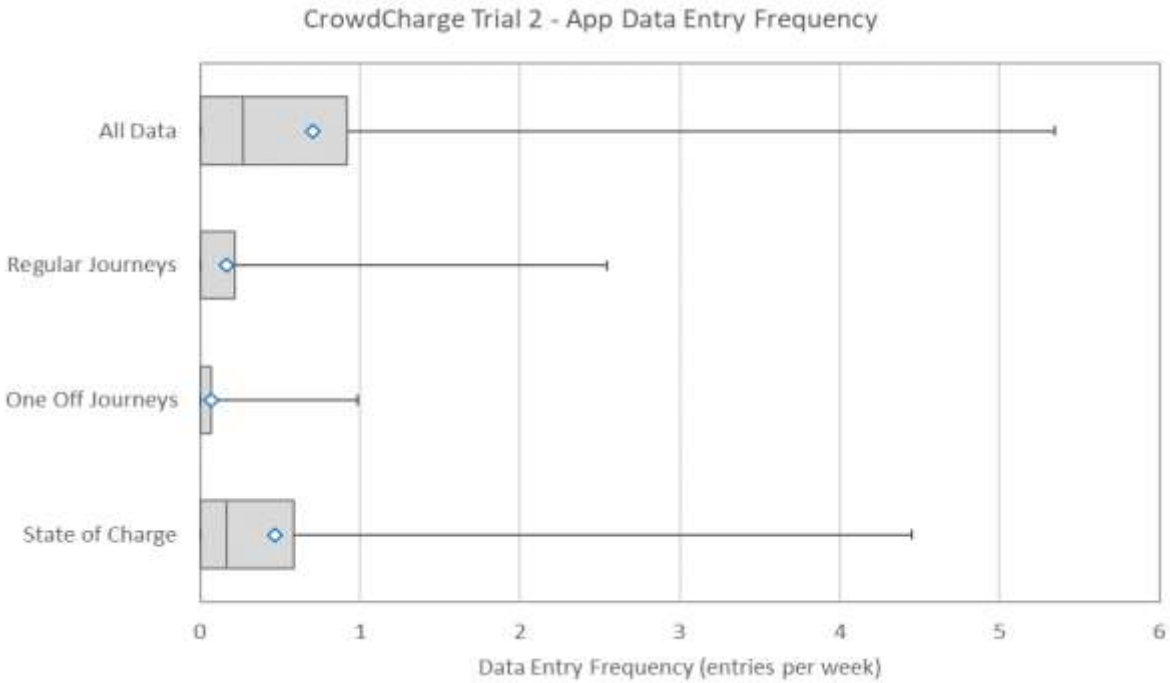
CrowdCharge App – Account Registrations

- Sign-up was optional
- 55% of participants signed up for an account (129 registrations from 236 invites)
- No clear correlation between sign-up rate and:
  - Battery Capacity
  - Concern about demand management
  - Charging Frequency
  - Trial 1 Management Experience



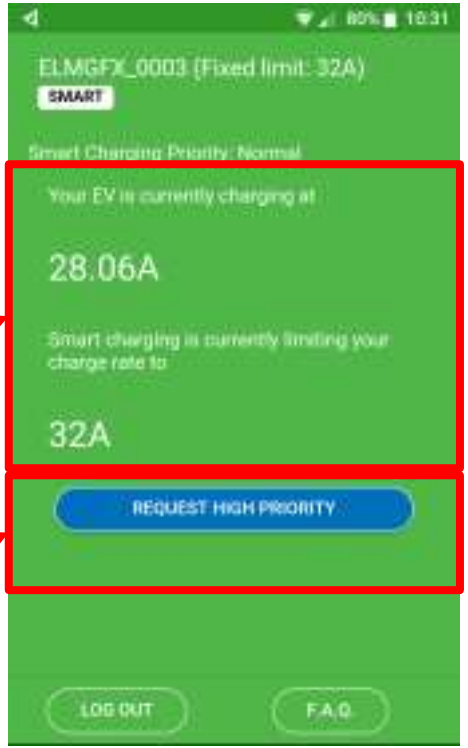
CrowdCharge App – Data Entry

- Of 128 participants:
  - 65% entered at least one piece of data (of any type)
  - 41% entered at least one regular journey
  - 25% entered at least one 'one-off' journey
  - 57% entered State of Charge



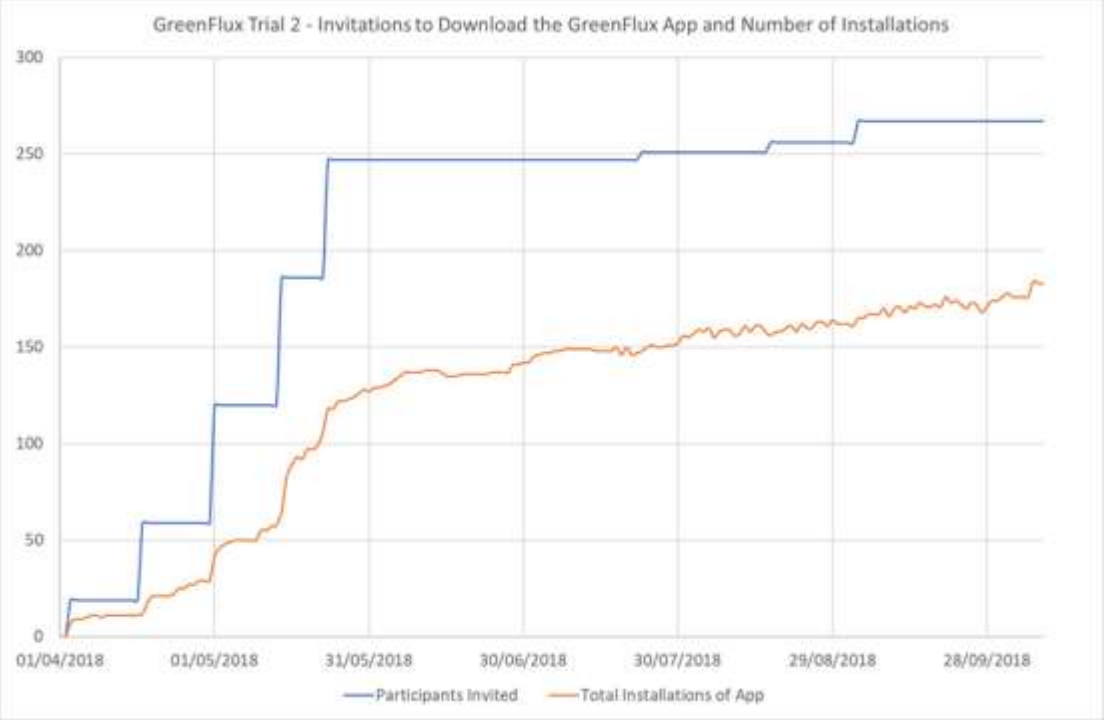
GreenFlux App

- Native iOS and Android app
- Participants sent instructions for how to download the app, and login details
- App interface:
  - Showed current being drawn and amount allocated
  - Allowed participant to select ‘high priority’ for their current charging session
- High priority effectively prevented them from being managed



GreenFlux App - Downloads

- Downloading the app was optional
- App was downloaded 183 times from 267 invites = 69%
- Customer research looked at reasons why participants didn't download or use the app

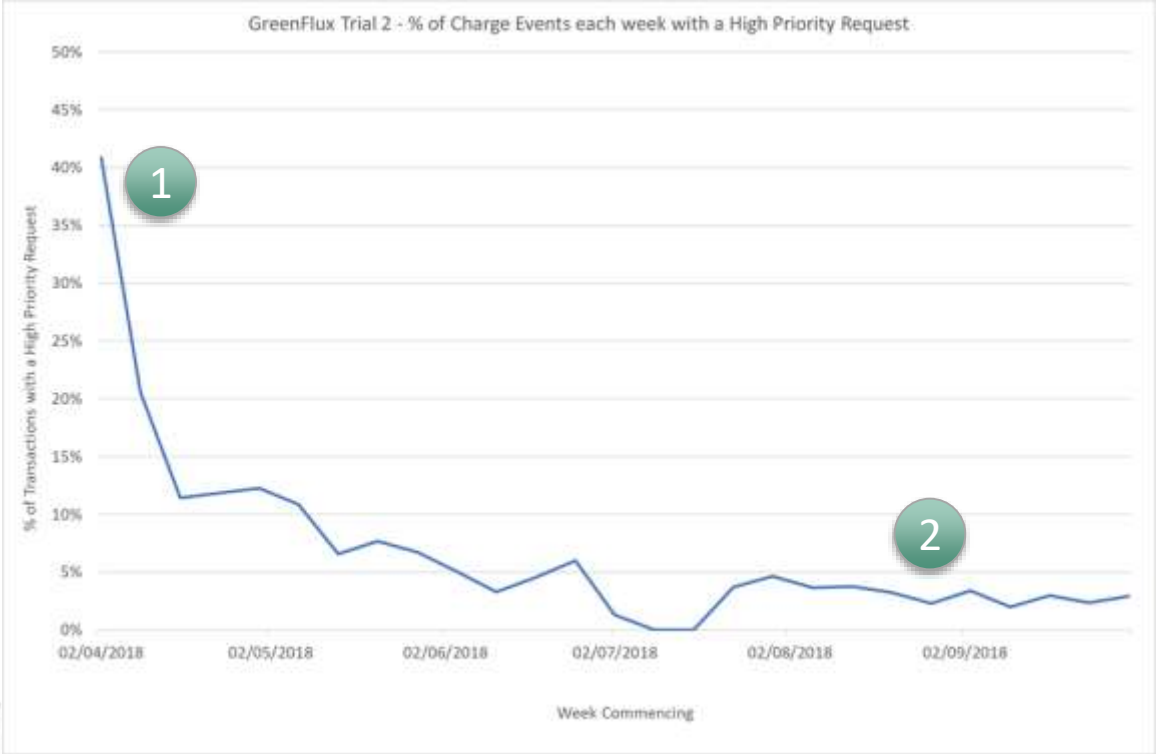


GreenFlux App – High Priority Requests during Trial 2

- Analysed proportion of charging sessions where high priority was requested over the duration of Trial 2

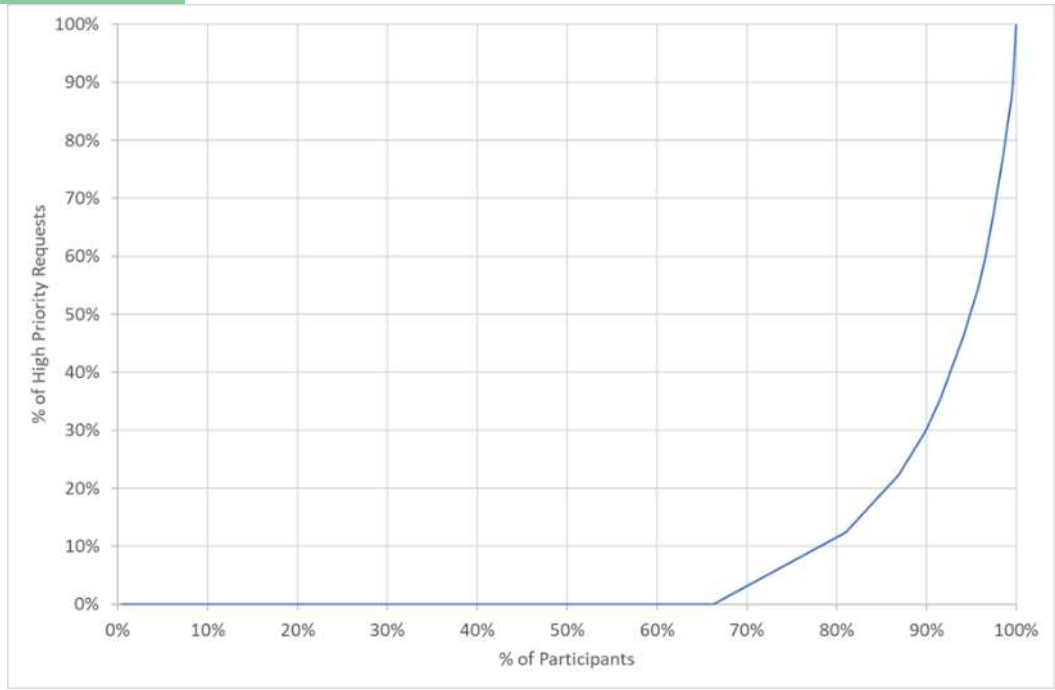
1. 1st group of participants were asked to try using the app and give feedback – much higher rate

2. Usage settled to approximately 3% of transactions each week



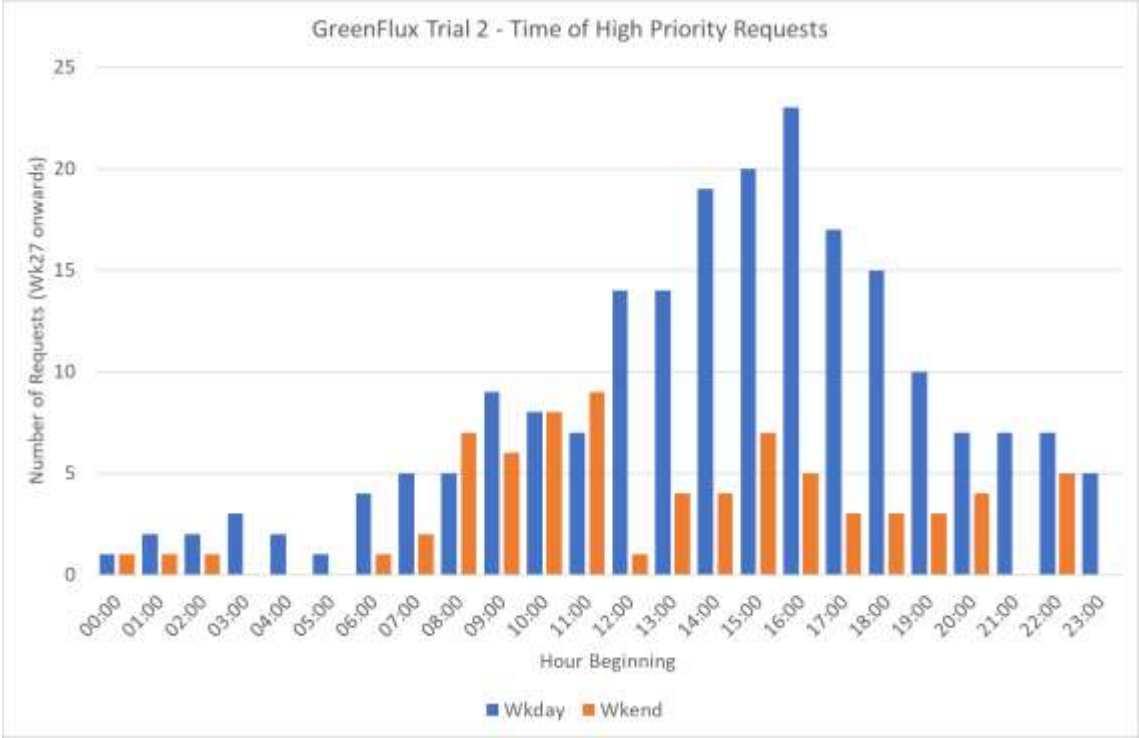
GreenFlux App – High Priority Requests during Trial 2

- Once app use had stabilised:
  - 67% of participants made no high priority requests
  - 20% of participants responsible for 90% of requests
- Participants with vehicles with 35kWh+ batteries were more likely to use high priority
- No link between concern about management, or Trial 1 GreenFlux Management Factor and tendency to use high priority



GreenFlux App – High Priority Requests during Trial 2

- Participants could request high priority in response to observing management, or “just in case”
- Requests more frequent on weekdays
- Clustered in the evening peak
- But requests still occurred when management was very unlikely



Why Did Participants Press The Button?

30%

Pressed the button to 'test it was working'

I wanted to make sure I had the juice for the next day.

Came home and need to leave again in an hour

Other reasons were often due to:

- Doing an extra trip on that particular day
- Felt their car wasn't charging fast enough

Coming home from work and needing to 'top up' to make an unscheduled trip out

Wanting to charge vehicle at full rate whilst it was being restricted as I had another journey soon

B17b What were your reasons for requesting high priority charging? Base: 132

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Reassurance Came With GreenFlux's Trial 2 App

Once they'd introduced the high priority demand thing, that was fine. I could just switch it to that, and the problem went away.

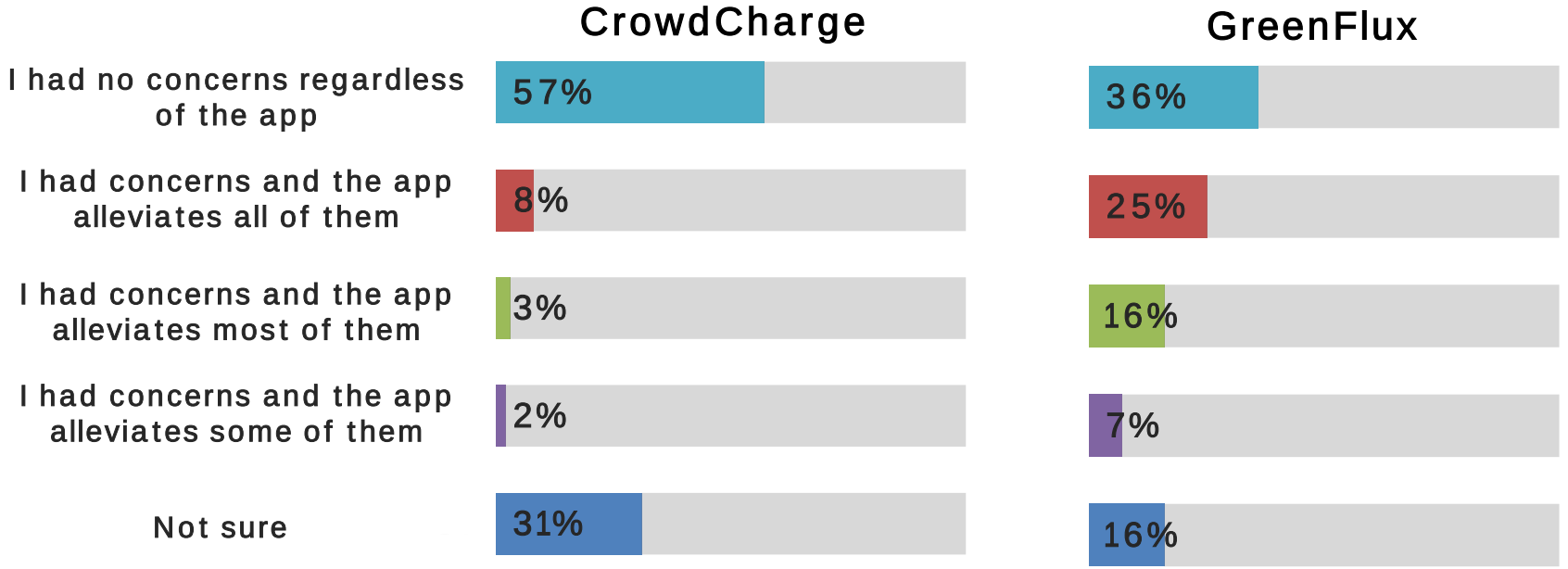
Being able to go for high priority was useful a couple of times when I was going to make a longer trip and wanted to be sure that the car was ready to go when I needed it.

Then the app came out, I could request a high priority charge. That was perfect because on the odd occasion when I do have to go straight out to work, I'd charge up for an hour and then go straight off.

I could cope with the fifteen minutes or so that it stopped immediately you plugged in because I knew the car was going to get a full charge [due to the high priority button].

App Helps Smooth Out Concerns

- At least 48% of GreenFlux drivers had concerns after trial 1…
- For the majority with concerns, the app solved all or most of the issues with anxiety of managing demand



B22 To what extent does the app alleviate your concerns about managed charging? Base: All aware of the app: 119
B22 To what extent does the app alleviate your concerns about managed charging? Base: 210

B15 Have you used the app? Base:209

The Majority Were Aware Of The Apps

CrowdCharge

71%

GreenFlux

91%

- Awareness high, although could have been higher for CrowdCharge
- 55% registered for CrowdCharge
- 69% downloaded the app for GreenFlux
- Why didn't some participants use the app?

B14 Are you aware that you can access an app to interact with your smart charging system? Base:230 GreenFlux
B14 Are you aware that you can access an app to interact with your smart charging system? Base:168 CrowdCharge

Reasons For Not Using The App – General Reasons

ELECTRIC NATION

Reasons For Not Using GreenFlux App

GreenFlux Smart charging

Happy with their charging without it

"Cannot see what difference it would make to my charging routine."

"Downloaded it but there is no **reason to use it, I plug in when I get home I unplug when I go to** work."

"I've not needed to request a high **priority charge and happy for it to be on normal priority for all my charges** so far."

Haven't felt the need/ had the time to download it

"I do not use apps and do not have a smartphone."

"I haven't downloaded it and I **can control my charging through the car using the** BMW app."

"Just haven't had the time to **sort it out... I have an 11** month old son!!"

Technical issues

"It doesn't work, have never **seen an 'active' charge** session."

"I have not been sent the access details."

"I found the app by chance on the App Store and downloaded it but I've never been sent the code?"

ELECTRIC NATION

Reasons for not using CrowdCharge app

CROWD charge

High effort without the return

"It looked very complicated and I cant see any benefits."

"It takes to long to tap all the **information in and monitor what is going on with the car** etc. time is too precious."

"Too time consuming to set up and **input all the required information. I have an app for my car so I can set** charging plans remotely."

Planning to use it but haven't had time yet

"Not got around to **completing the set up of** the App."

"Not got round to it yet. Will **download it now as it** sounds useful."

"I signed up to it and that's **as far as I got and it all got** bit hectic"

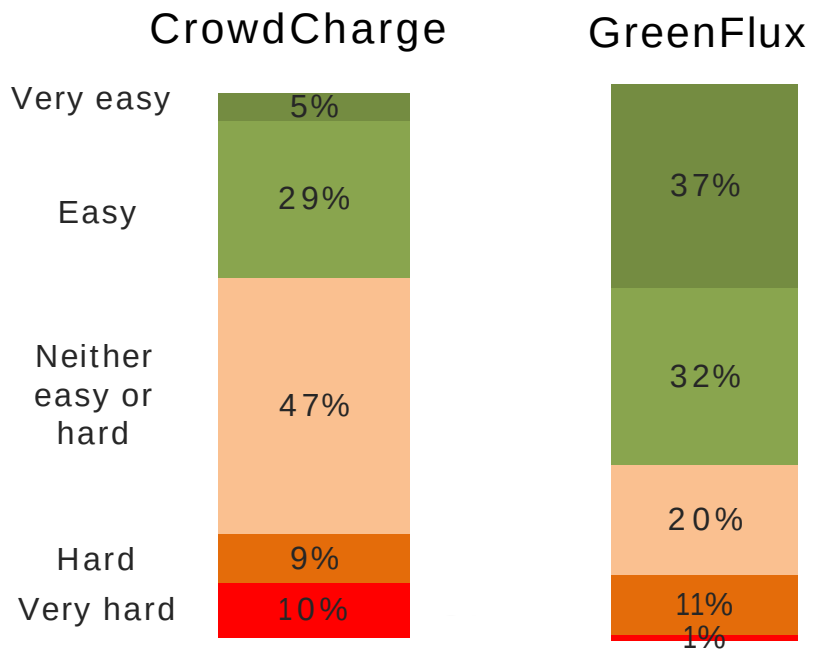
Technical issues

"I can't get logged on despite **several attempts. I have contacted the right sources and mentioned this but not** had feedback."

"Can't work out how to use it."

"Not an app as I would describe, **need to go on to web browser rather than an actual app, not** very convenient."

Ease Of Using The Apps



B23 How easy do you find using the app? Base: All app users: 58
B23 How easy do you find using the app? Base: 150

Thoughts On CrowdCharge Overall – Effort High For Users

[Registration] Pretty easy, no problem at all.

I don't use apps at all. I have a very old model of iPhone so, I don't bother with any apps whatsoever.

I didn't download the app because I wasn't aware it had actually ever become available.

Easy to register but high effort to use

The only way I could setup journeys was on an ad-hoc basis and I just didn't see a huge amount of necessity really it was often knowing I needed to head out with five, ten, twenty minutes' notice so, it didn't really serve any purpose.

It was a bit fiddly to have to load in one-off journeys and I just stopped bothering, to be honest.

Additional Features Participants Would Have Liked Included On The App

See previous charging history/patterns

Access the app when car not charging

Current state (%) of charge while charging

Cost of current and past charging

Proper / better designed app (not website) - CrowdCharge

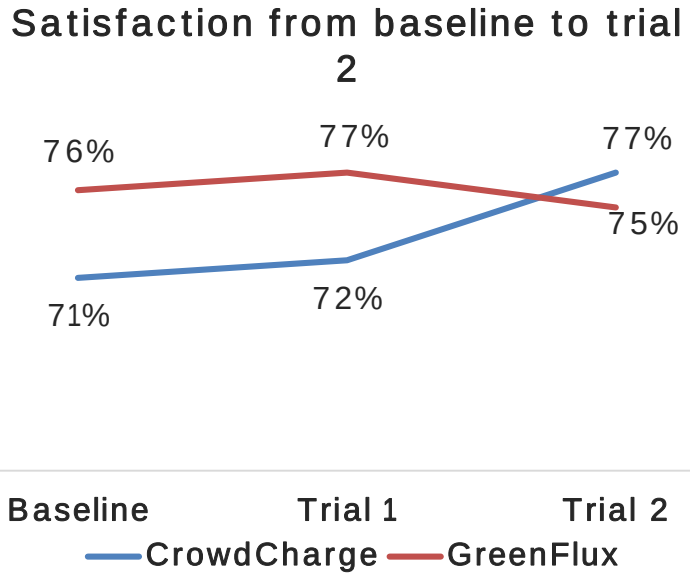
Less information needed each time app is opened

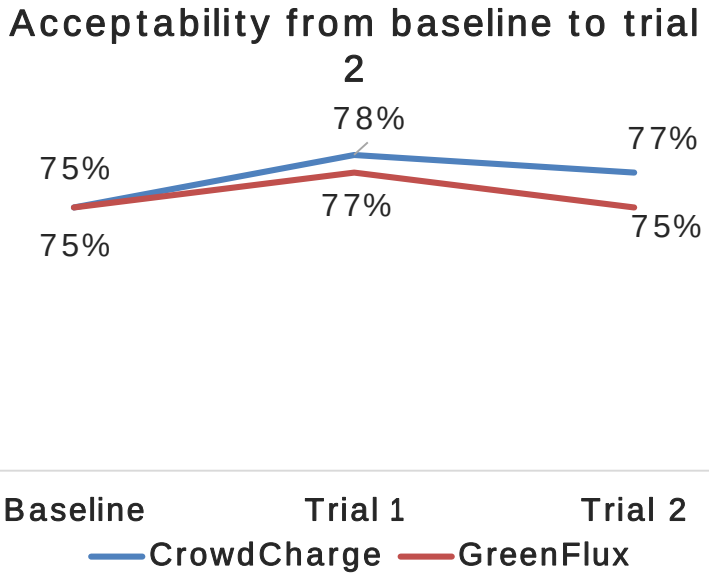
Compatible with car/ telematics

B20 Are there any other functions that you expected to see on the app? Base: 230

B20 Are there any other functions that you expected to see on the app? Base: All aware of app: 119

Trial 2: Satisfaction And Acceptability

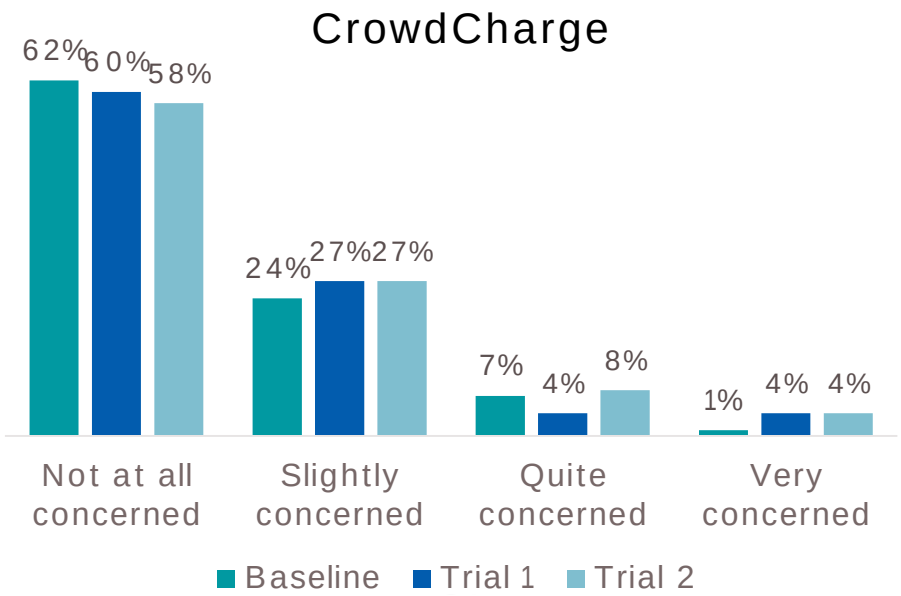


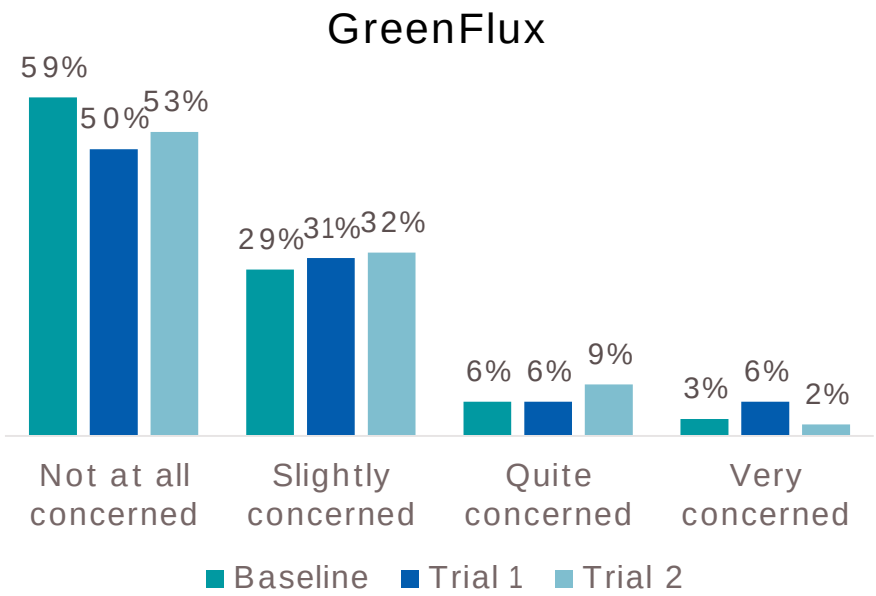


B9 On a scale of 1 – 10, where 10 is very satisfied and 1 is very dissatisfied, how satisfied are you with your current charging arrangements? Base: GF Baseline (290) CC Baseline (205) GF T1 (144) CC T1 (133) GF T2 (229) CC T2 (168) GF T3 (208) CC T3 (194) B8 On a scale of 1 – 10, where 1 is completely unacceptable and 10 is completely acceptable, how acceptable are your current charging arrangements? B9 On a scale of 1 – 10, where 10 is very satisfied and 1 is very dissatisfied, how satisfied are you with your current charging arrangements? Base: GF Baseline (290) CC Baseline (205) GF T1 (144) CC T1 (133) GF T2 (229) CC T2 (168) GF T3 (208) CC T3 (194)

Most Remain Unconcerned About Having Their Charging Arrangements Managed

85% of participants had **no or only slight** concerns





B12 How do you feel about having your charging arrangements managed as part of the trial? Base: Crowd Charge Baseline (206) Trial 1 (134) Trial 2 (168)
B12 How do you feel about having your charging arrangements managed as part of the trial? Base: GreenFlux Baseline (290) Trial 1 (144) Trail 2 (230)

Trial 2 Customer Research Results – App Usage and Satisfaction (GreenFlux)

Participants divided based on their usage of the high priority feature during Trial 2

Group	% of Survey Responses (% of Satisfaction Scores)		
	Dissatisfied (1 – 4)	Neutral (5 -7)	Satisfied (8 – 10)
No high priority requests made	7%	16%	77%
High Priority used for less than 5.8% of charging events	0%	22%	78%
High Priority used for more than 5.8% of charging events	10%	26%	64%

Trial 2 Customer Research Results – App Usage and Acceptability (GreenFlux)

Participants divided based on their usage of the high priority feature during Trial 2

Group	% of Survey Responses (% of Acceptability Scores)		
	1 – 4	5 – 7	8 – 10
No high priority requests made	9%	14%	77%
High Priority used for less than 5.8% of charging events	3%	22%	75%
High Priority used for more than 5.8% of charging events	10%	21%	69%

Trial 2 Customer Research Results – App Usage and Acceptability (CrowdCharge)

Participants divided based on their usage of the CrowdCharge app during Trial 2

Group	% of Survey Responses (% of Acceptability Scores)		
	1 - 4	5 -7	8 – 10
No app account	3%	13%	84%
Had an account, didn't enter data	0%	13%	88%
Had an account, did enter data	1%	22%	77%

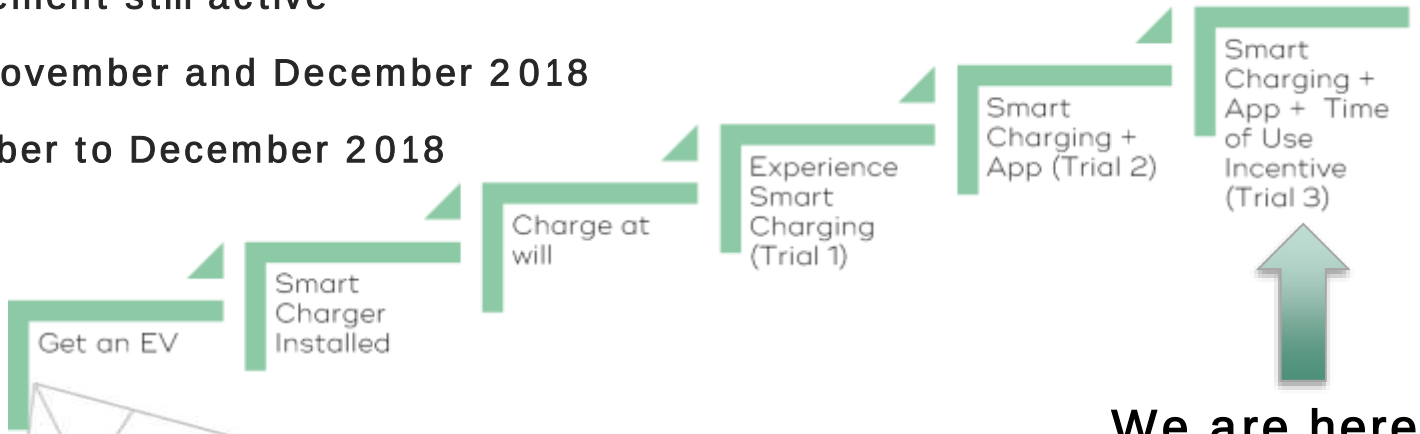
ELECTRIC NATION

YOUR ELECTRIC VEHICLE YOUR SMART CHARGE

TRIAL 3

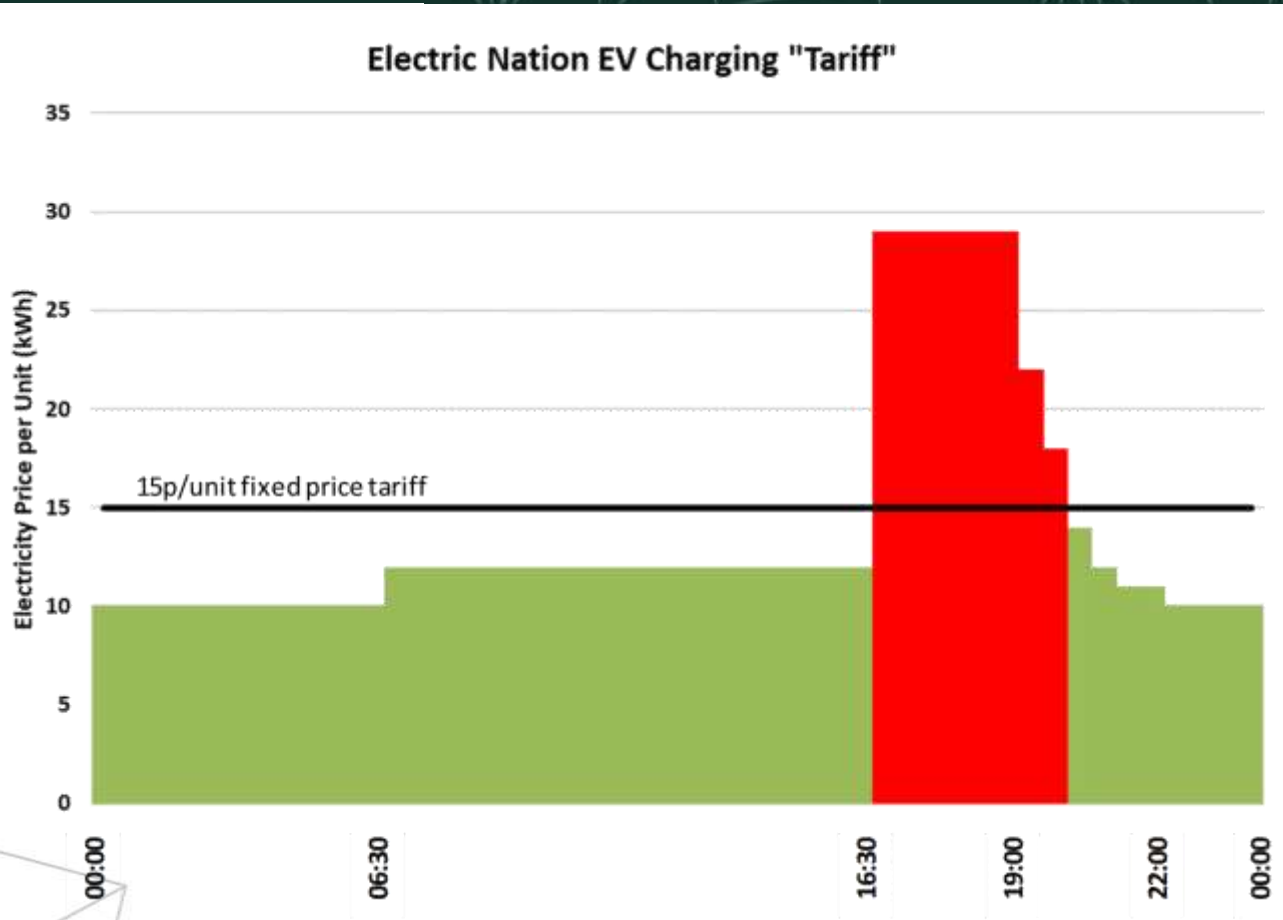
Trial 3 Introduction

- Introduced a time of use tariff understand how this might change charging behaviour – ToU tariffs are becoming more common (and more complex)
- Apps updated – designed to support users to change their behaviour
- Demand management still active
- CrowdCharge: November and December 2018
- GreenFlux: October to December 2018



Time of Use Tariff

- Tariff based on historical prices from Octopus Agile
- Used by both CrowdCharge and GreenFlux
- Applied to EV charging only
- “Savings” passed onto participants as an Amazon Voucher at the end of the trial



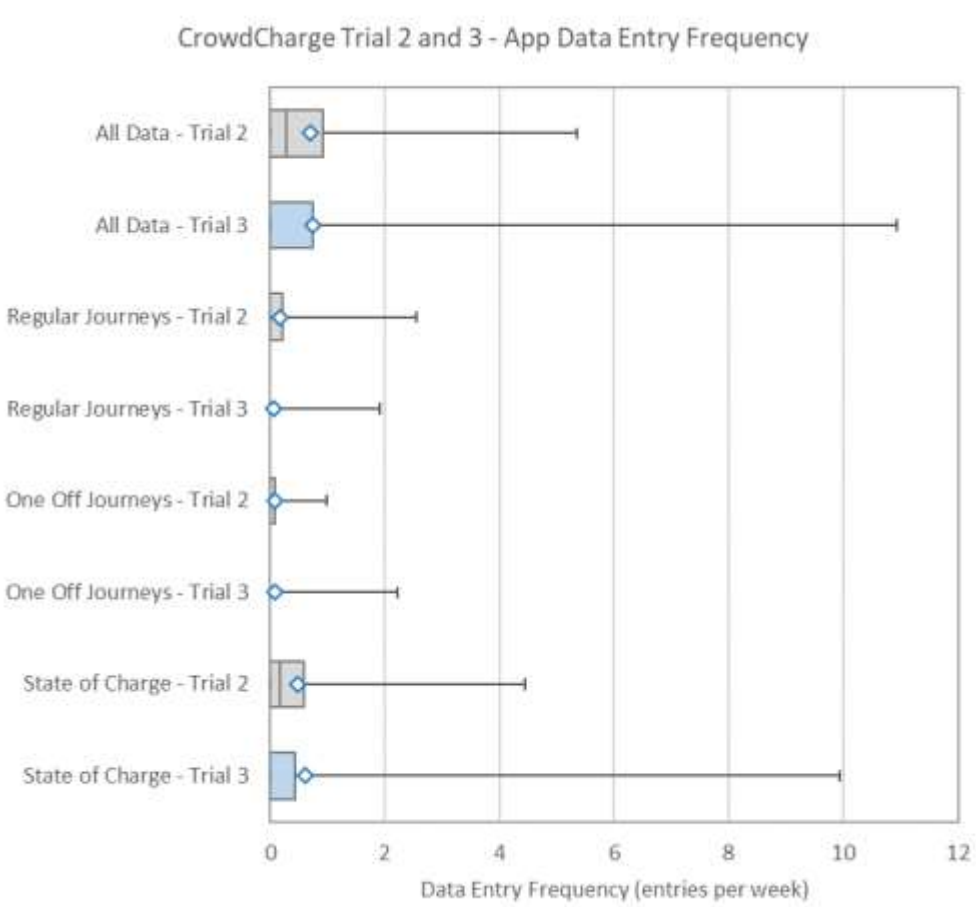
Trial 3 Approach

- Algorithm updated to take account of tariff and charge at lowest price possible
- Example: plug in at 18:00, enter state of charge and have a planned journey departing 8:30 the next morning – charging is shifted to overnight (cheap rate)

- App updated to give customers a "set and forget" charging preference:
  - 'Optimise Time' (default) – charge at all times, regardless of price
  - 'Minimise Cost' – charging paused between 16:30 and 22:00
  - 'Optimise Time and Cost' – charging paused between 16:30 and 19:00
- Example: plug in at 18:00, with app set to "minimise cost". Charger pauses charging until 22:00

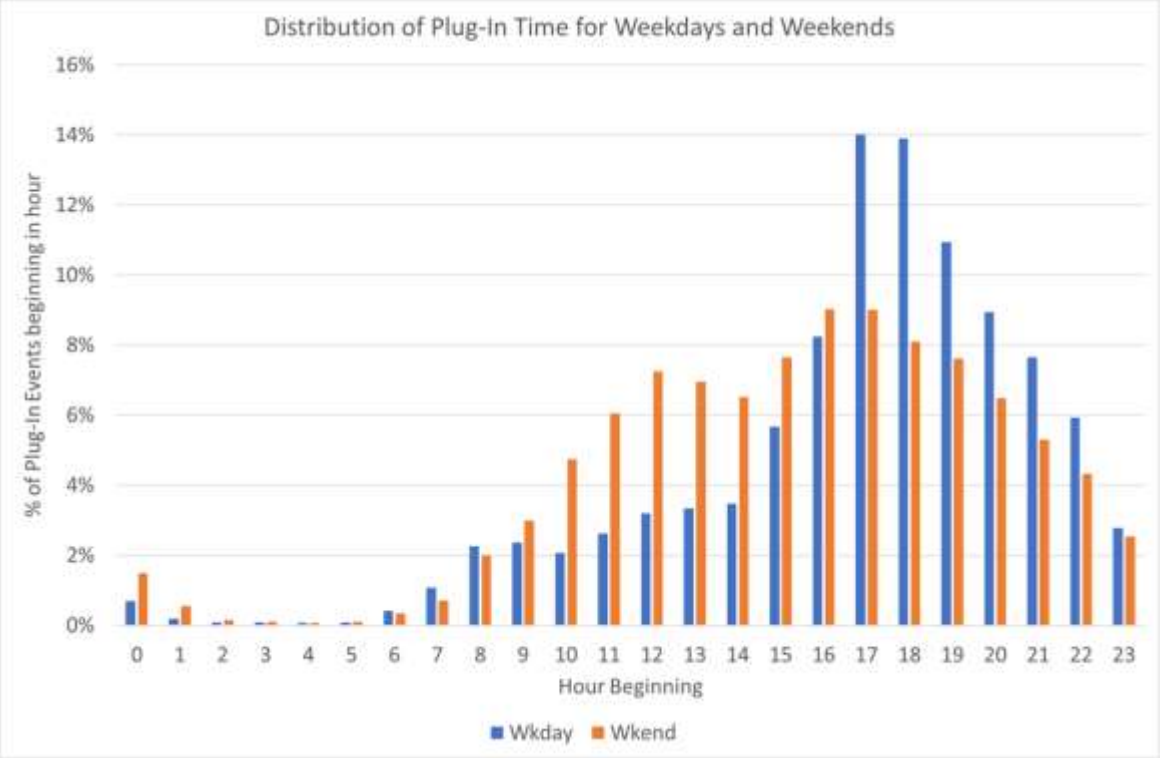
CrowdCharge Trial 3 – Data Entry

- Participants needed to be registered for an app account to be eligible for a Trial 3 reward
- Reward incentivised 17 extra people to sign-up:
  - Trial 2 sign-up rate = 55%
  - Trial 3 sign-up rate = 64%
- Participants were encouraged to enter data to maximise their reward value
- Frequency of data entry declined for most participants between Trial 2 and Trial 3



CrowdCharge Trial 3

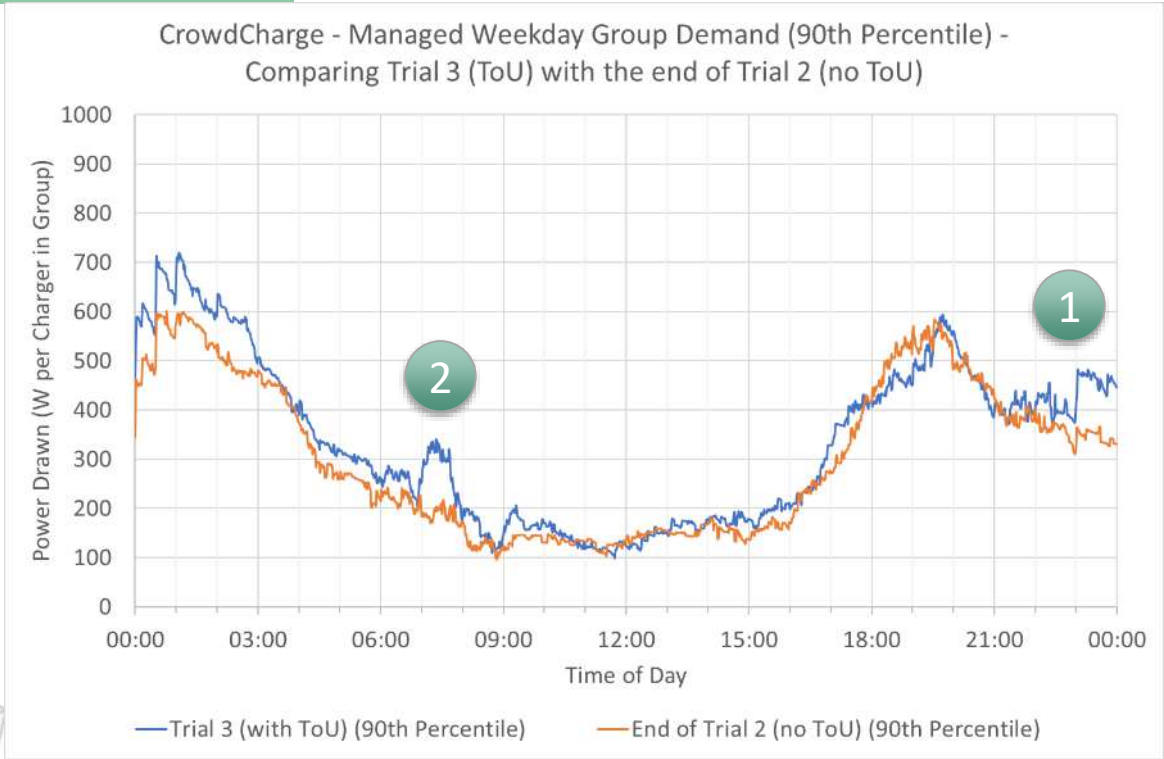
- For the algorithm to schedule charging a journey plans was needed
- Without a planned journey, system assumed next journey was 50 miles, leaving 4 hours after plug-in
- Low data entry frequency led to assumption being made too regularly
- Early evening plug-ins without a planned journey led to peak time charging



CrowdCharge Trial 3 – Results

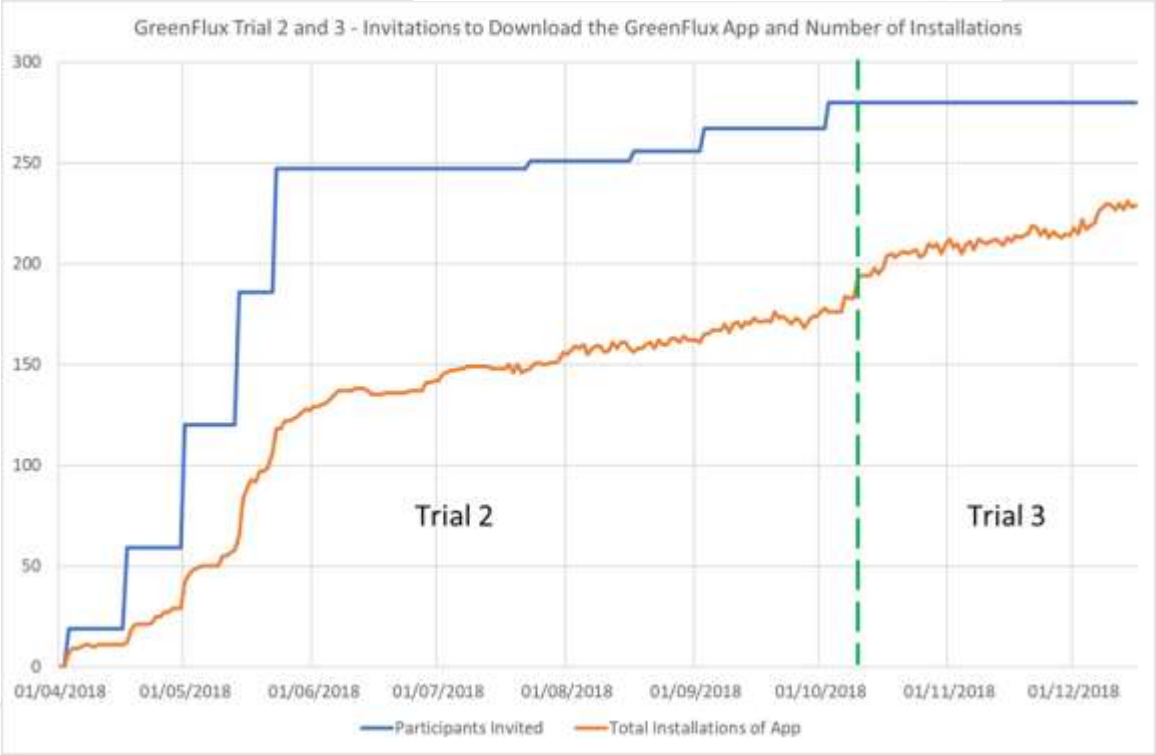
- Minimal change in the demand profile between the last month of Trial 2 (October/November) and Trial 3 (November/December)
- Demand management continued in Trial 3

1. Evidence of some charge sessions starting once off-peak rate had begun
2. Morning pre-heating has re-appeared (seasonal effect)



GreenFlux Trial 3

- App was updated to make it easy for participants to move their charging away from the peak
- 82% of participants downloaded the app by the end of Trial 3 (69% at end of Trial 2)
- High Priority requests continued at ≈ 3% of charge events throughout Trial 3 (despite no management occurring)

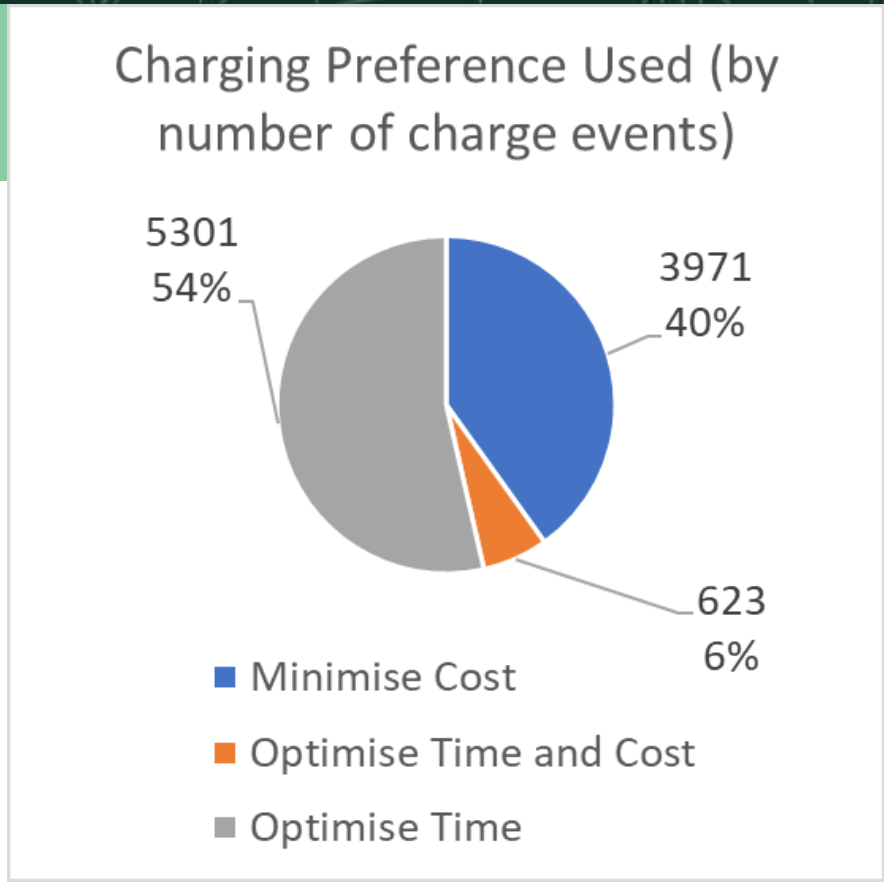


GreenFlux Trial 3 – Impact on Demand Profile

1. Evening peak around half of previous value – no demand management necessary
2. Large increase in demand at the start of off-peak price
3. Overnight demand slightly higher until about 3:30

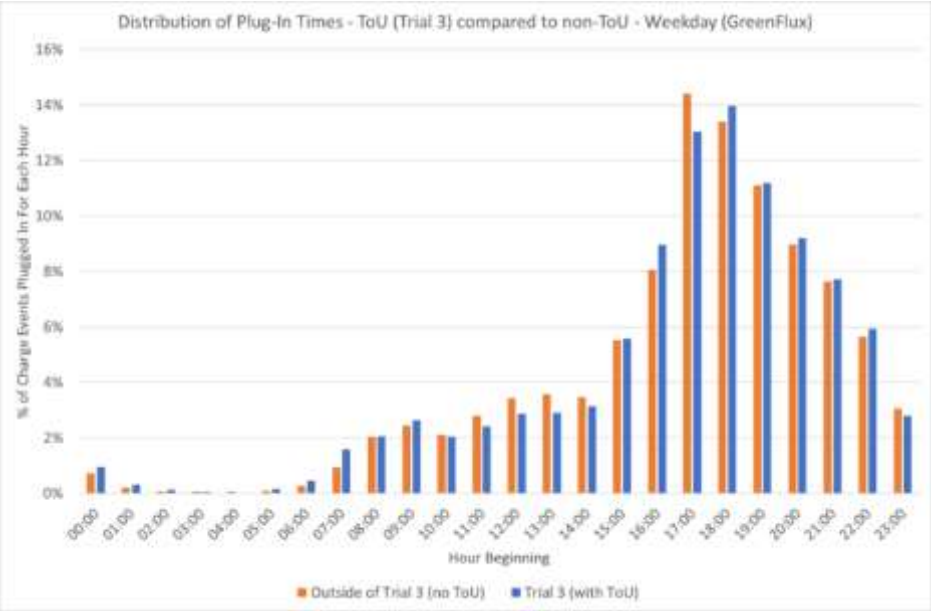
GreenFlux Trial 3 – Headline Stats

- 9,985 charging events
- 246 participants charged during Trial 3:
  - 53% used Minimise Cost at least once
  - 14% used Optimise Time and Cost at least once
  - 86% used Optimise Time at least once
- Average reward value = £21
  - 77% of participants got a reward of more than £10 (the starting value)
  - 12% got £10
  - 11% got a reward of less than £10
  - 2 participants got nothing

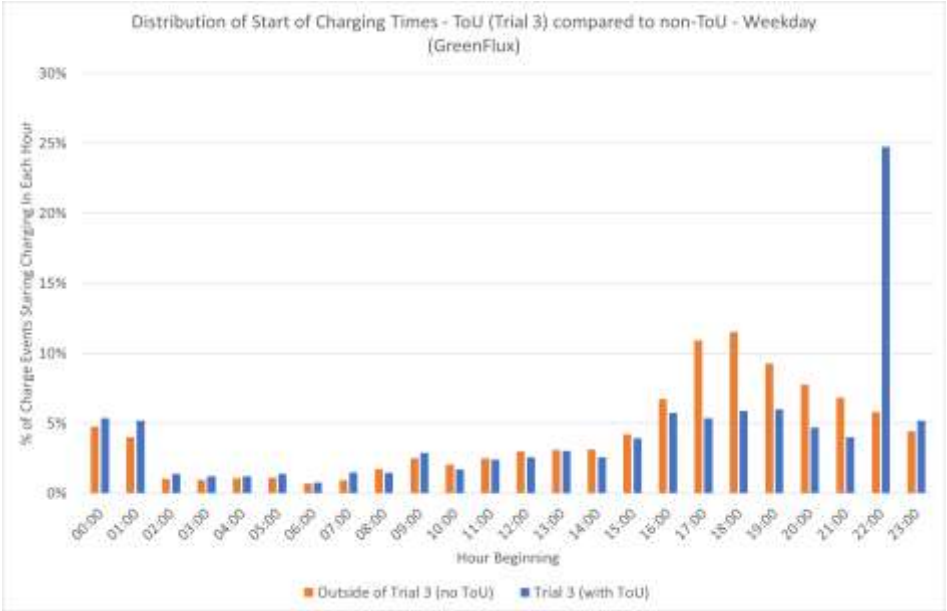


GreenFlux Trial 3 – How was the change achieved?

Plug in Time



Start of Charging Time



GreenFlux Trial 3 – How was the change achieved?

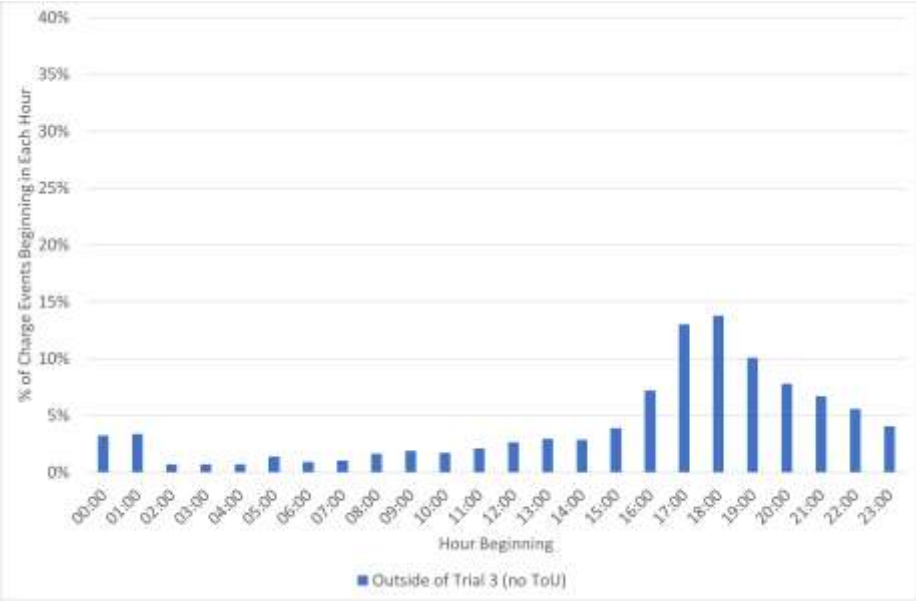
- **App Users** – participants who used a 'non-default' profile at least once = 61% of Trial 3 Participants
- **Non App Users** – all their charging sessions were on 'Optimise Time' (the default) = 39% of Trial 3 Participants
- **For each participant, compare % of their charge events starting in the Weekday Evening Peak during Trial 3, and for the rest of the trial**

Group	Trial 3 vs. Outside Trial 3 - % of Events Starting in Wkday Evening Peak		
	Lower %	Equal %	Higher %
All Participants	77%	1%	22%
'App Users'	89%	0%	11%
'Non-App Users'	57%	3%	39%

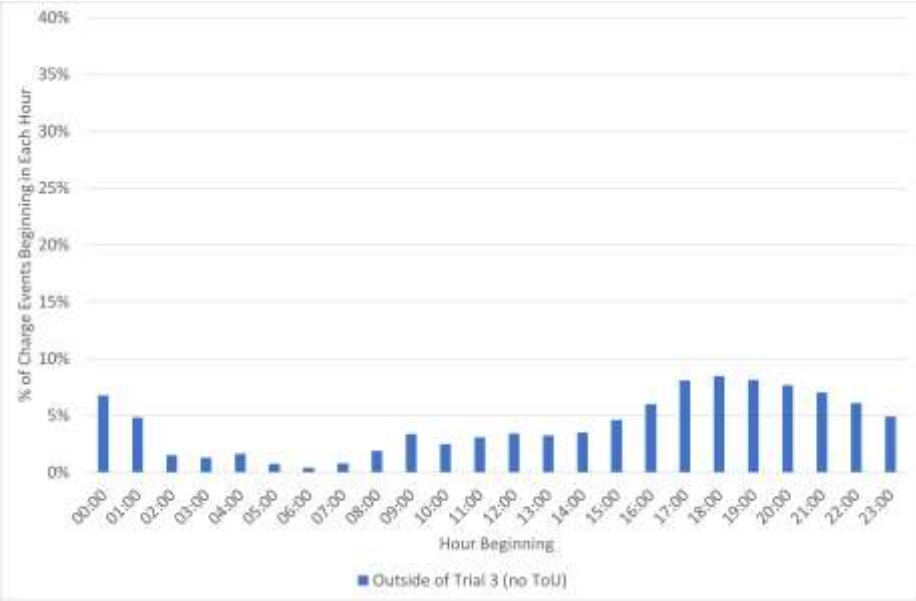
GreenFlux Trial 3 – How was the change achieved?

% of Charge Events Beginning in Each Hour – Before Trial 3

App Users



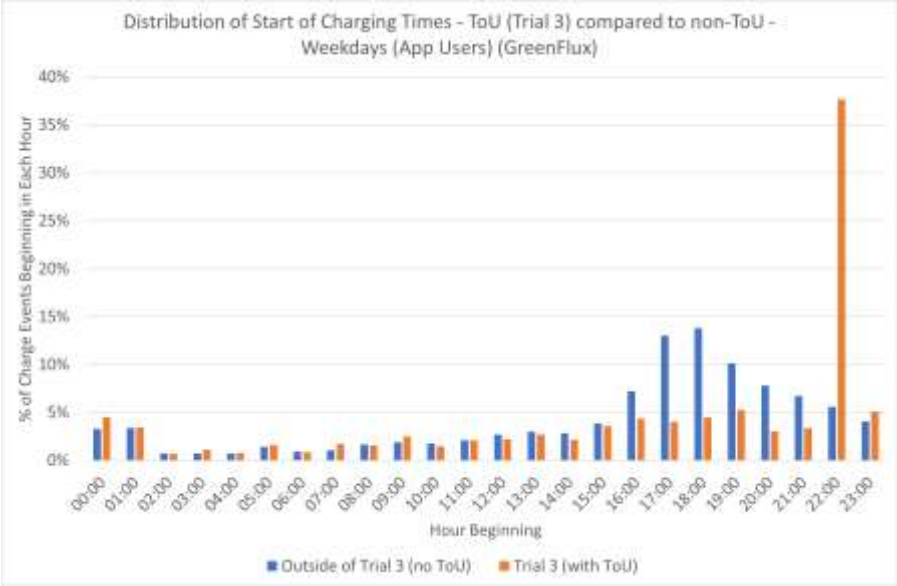
Non-App Users



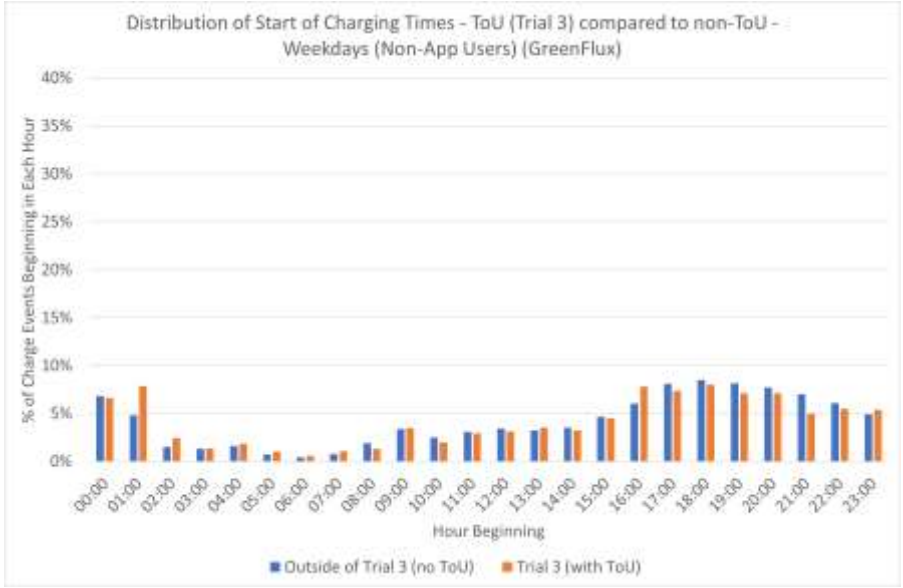
GreenFlux Trial 3 – How was the change achieved?

Now compare the change in Trial 3

App Users

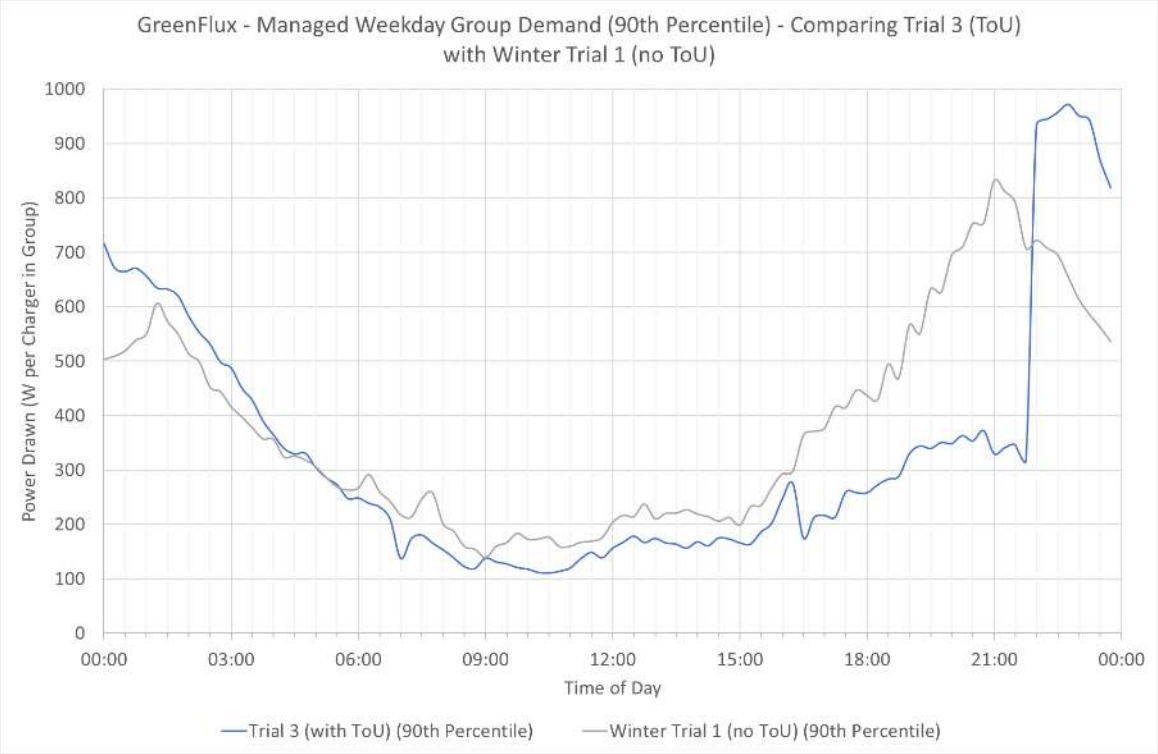


Non-App Users



GreenFlux Trial 3 Results

- Smart charging and apps can make it easy for drivers to change their behaviour
- Extra detail in the report – including what influences whether people use the app, and what preference they chose



Ease Of Understanding The Reward Structure

43% found the charging preference reward structure easy to understand

88% found the charging preference reward structure easy to understand

B28. How easy to understand is the charging preference reward structure? Base for those that used the app to change or review their charging preferences : 106
B28. How easy to understand is the reward structure based on the app time of use tariff? Base: those that are aware that the app was recently updated 47

CrowdCharge Registrations Up From Trial 2, But Not By A Significant Amount

64%

Registered for the Crowd Charge app

- Reasons for not registering are mainly due to technical issues and lack of understanding surrounding the relevance of the app

Why didn't you register for the app?

"I couldn't understand it, It's too much trouble and I don't have data on my phone."

"Issues with **registering my make of** vehicle."

"I was worried that it **would interfere with my Nissan app which also schedules charging times and pre-heating for the** car."

"I believed I **would have to enter all my journeys into it** manually."

B14b. During 2018, did you register for the Crowd Charge app? Base: 152
B14c. Why didn't you register for the app? Base: those that didn't register for the app 55

ELECTRIC NATION

Trial 3 appealed to different users for different reasons

I think I probably had a little burst [of inputting data] after the reward mechanism was announced, but that's about it. Nothing continuous or special.

I think there were a couple of occasions when I held off plugging in the car at six p.m. and plugged it in at maybe nine p.m. instead, and then it would start charging straightaway.

I wanted a new mandolin and so, I set the car, in the car, to only charge between midnight and six a.m. And it seemed to work quite well and didn't cause me any problems. And I bought a new mandolin.

It wasn't really the driver for doing it. So, it was like, 'that's nice' rather than anything special.

CrowdCharge – Trial 3 Did Encourage Some To Change Their Behaviour, But Not The Majority

23%

Have changed charging behaviour because of ToU

How have you changed charging behaviour?

"I have plugged it in later rather than as soon as I get in from work."

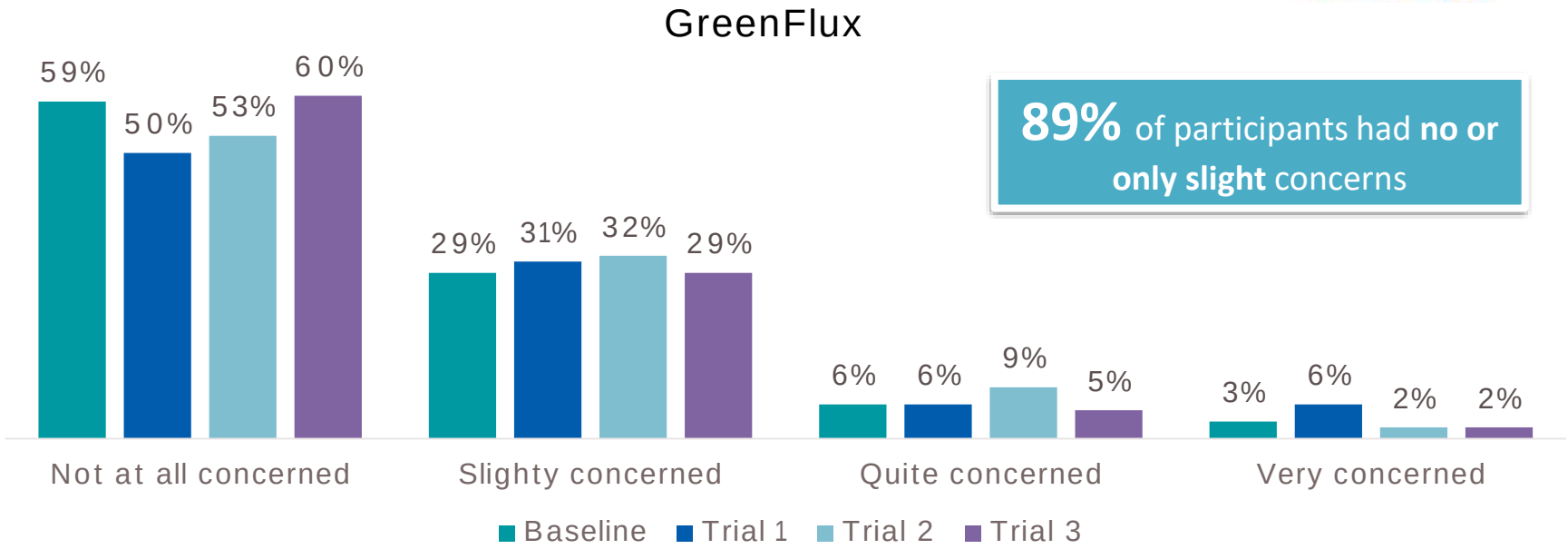
"Generally waiting until off peak hours to plug car in when at home."

"I stopped charging during the day if I didn't need to."

"I'm on a single rate tariff for our electricity supply, but this incentive has made me switch on the 'off peak only' charging setting for the car."

B34. Have you changed your charging behaviour because of the Time of Use tariff offered through the app? Base – all that have used new version of the app: 43
B34b. How have you changed your charging behaviour? Base: All that changed behaviour: 10

GreenFlux – Any Concerns With Managed Charging

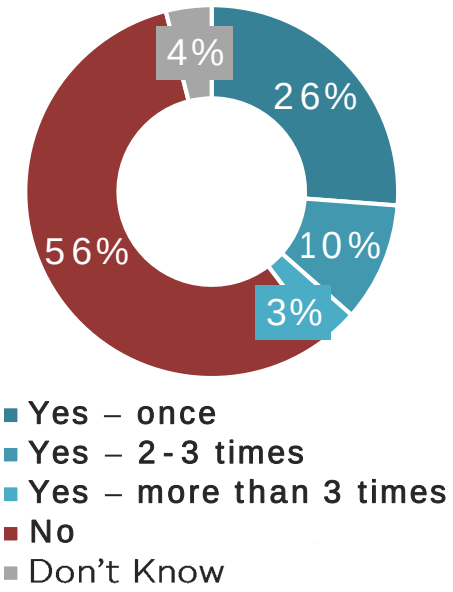


89% of participants had **no or only slight** concerns

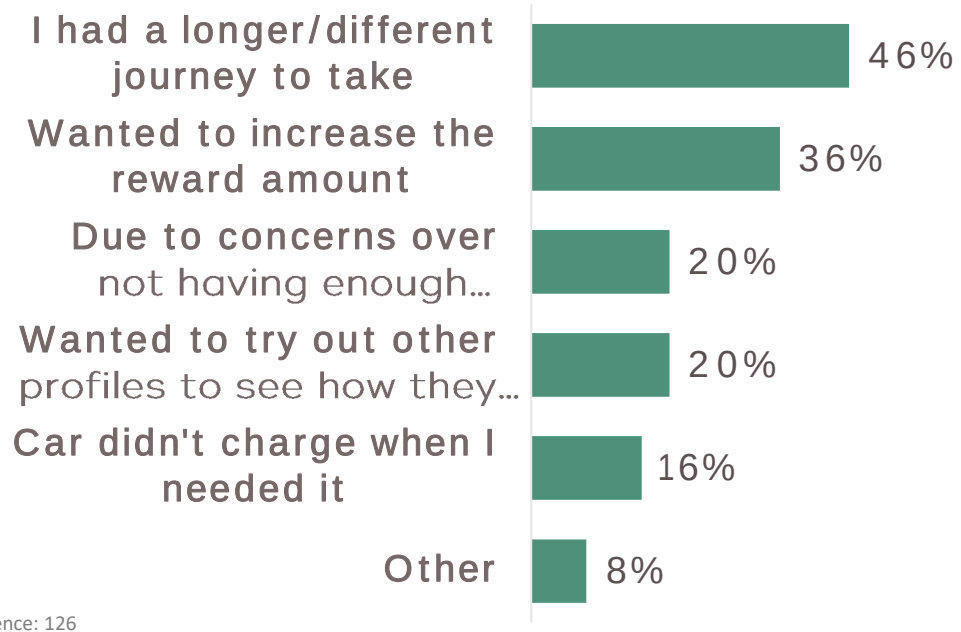
B12 How do you feel about having your charging arrangements managed as part of the trial? Base all: GreenFlux Baseline (290) Trial 1 (144) Trial 2 (230) Trial 3 (207)

Changing Charging Preference - GreenFlux

Did you change the charge profile?



Why?



B27. Have you changed charging preference? Base those that know their charging preference: 126
B27A. Why did you change tariff profiles? Base those that changed their charging preference: 50

GreenFlux – Some Don't Mind Paying More

62%

Of non-app users know this put them on the default, non-reward, charging profile

- Of those that didn't use **the GreenFlux app, most knew they were automatically put on the default profile**
- **Around a third said they were unaware of the rewards system**

B16A Did you know that by not accessing the app, you are on the default 'optimise time' profile (i.e. charging at any time of the day regardless of the price) which means you are not able to accrue additional time of use charging rewards? Base those that knew there is an app but choose not the use it: 37

More Popular Charging Profile

Minimise Cost – restricting the charging to between 10pm and 4.30pm

75%

We set both cars to, like, ten-thirty at night knowing full well they would charge by the morning. We made about thirty-eight pounds, I think, altogether, generally. It did change my behaviour because I still have the timer on the car.

Optimise Time & Cost – avoiding charge at peak times but charging can occur between 7pm…

19%

The few times I had to use the high priority, but I was prepared for that to effectively cost me as opposed to the rewards because I wanted the functionality. I wanted the car charged.

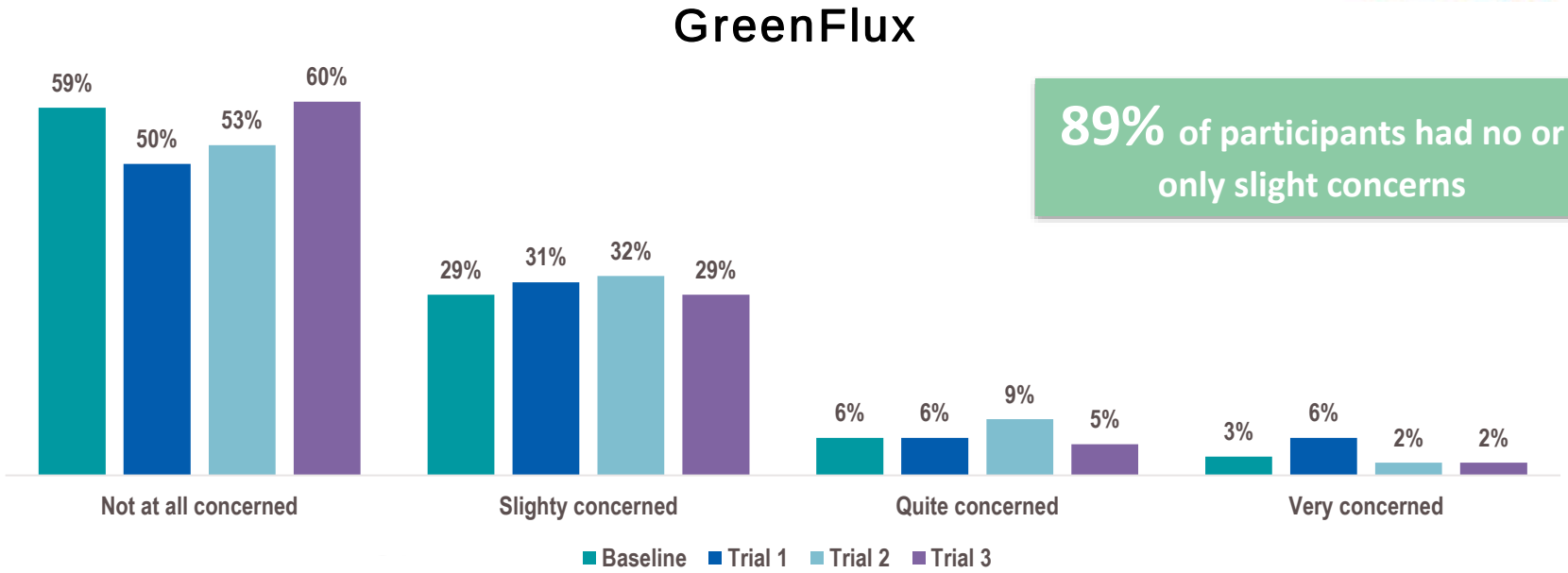
Optimise Time – charging all times of the day regardless of the price

19%

I only tend to charge at home when I actually really do need some extra charge. So, I think I would always be pressing the high priority button.

B25 Which charging preference have you used so far? Base those that have used the app to review charging preferences or reward balance: 135

GreenFlux – Any Concerns With Managed Charging



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ELECTRIC NATION

Potential Improvements To The Rewards System

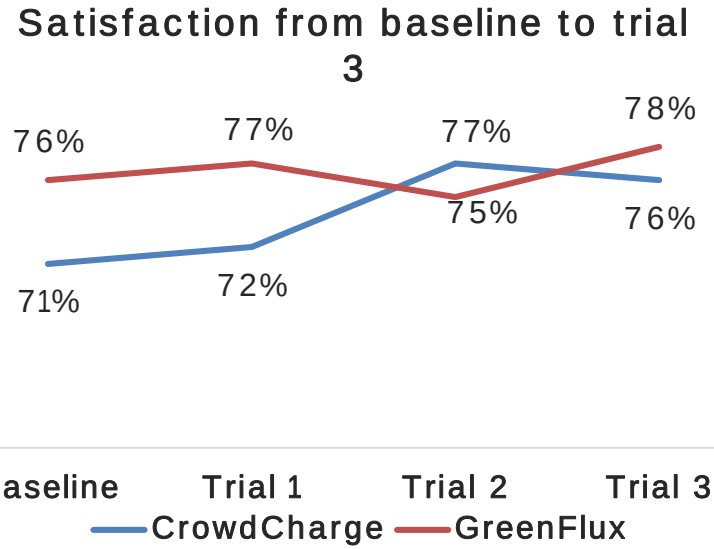
There's more incentive to do something if you're **giving them money than actually giving a discount. Because I think having that discount,** it's taken away in your bill and at the end of the bill, you don't see it. But if there was an app that **showed you how much discount you were going to get as you went along, that would be great.** *GreenFlux*

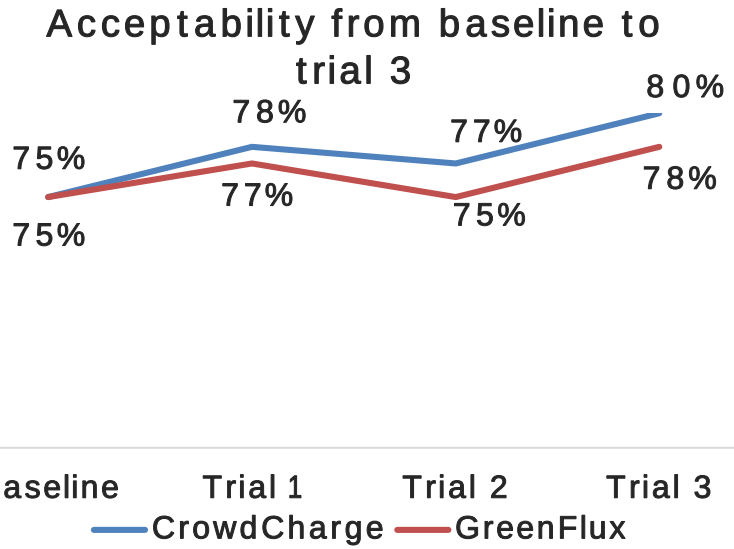
I would look at it the other way around. I think there ought to be penalties for peak-time charging or for habitual peak-time charging if it's not necessary. *GreenFlux*

I think just an occasional Amazon discount voucher, or something is nice but it's not a general motivator and it's just an extra complication really. Whereas if you're looking at the electricity bill and you can see you paid this much and we got this much discount because it's demand-managed, that's where I'd notice it. *CrowdCharge*

Every single charging network seems to want something on your phone, when really you could just do a contactless payment or, in the case of this app, it ought to be a button on the charger. Because it is a one-button app. So, I'd rather see it built in to the charger than have to install yet another thing on my phone. *GreenFlux*

Satisfaction And Acceptability Throughout The Project





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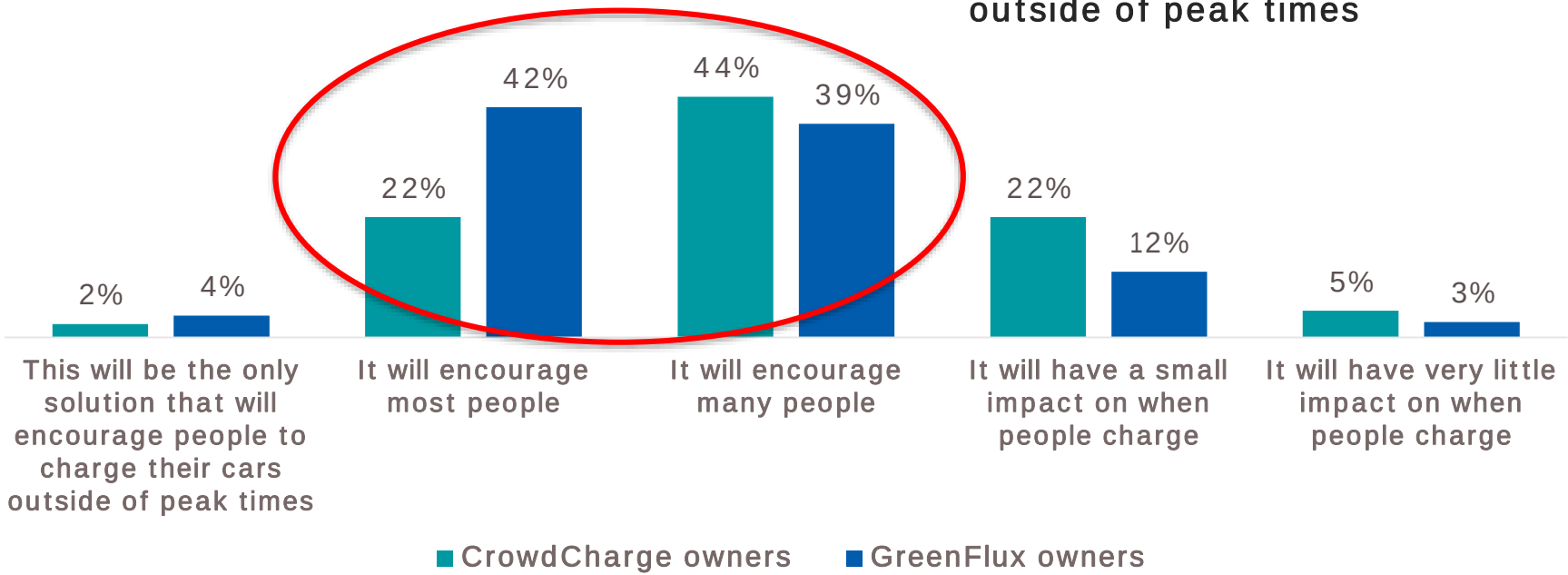
If A Similar App/ Scheme Was Available, Would It Encourage Others To Change At Different Times?

- The vast majority believe that charging preferences will help encourage drivers to charge outside of peak times



B30. To what extent do you think the charging preference will encourage EV drivers to charge their cars outside of peak times? Base for those that used the app to change or review their charging preferences : 106
B30. To what extent do you think the charging preference will encourage EV drivers to charge their cars outside of peak times? Base: those that have used the app to either enter journeys, review journeys, review charge point usage or entered state of charge 41.

Thank you for listening

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Conclusions from the trial

Nick Storer
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Data from the trial shows flexibility in charging

But without another incentive the demand in the evening peak requires management

Demand management is technically feasible, and acceptable to the majority of participants

Trial data shows that Time of Use incentives appear to be highly effective at moving demand away from the evening peak

Particularly when supported by smart charging (with an app), which makes it simple

Smart charging can:

- Support the introduction and management of ToU based charging
- Provide a means to manage any negative consequences of mass uptake of ToU incentives

Data from smart chargers can provide a strong data source for building an evidence base for future developments

Thank you for listening

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WPD's EV Strategy and what comes next

Paul Jewell
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DSO Development Manager

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Forecasts and the changing horizon

- Our forecasts for Electric Vehicle adoption predict around 37,000 across our region now rising to 3,064,000 in 2030.
- In simple terms, each Electric Vehicle uses the same kWhs of energy per year as a standard domestic home.
- The What Car "Car of the Year" for 2019 being the Kia e-Niro and it being described as "sensibly priced" and will "fit into most people's lives".
- We also predict price parity in 2021 or 2022 and a step change in car ownership.

Electric Vehicle Strategy Document

- Our first Electric Vehicle strategy document was issued in March 2019. It covers areas including;
  - Our forecasts and assumptions
  - Technical considerations
  - Stakeholder Engagement
  - Our plans to support connections
  - Innovation Projects
  - Transitioning to Business as Usual

- Throughout 2019 we will create shorter customer-specific documents for the different stakeholders involved with Electric Vehicles.

Making use of existing capacity

- We predict that many of our local transformers would support one 35kWh charge every five days for each connected customer
- 35kWh equates to around 150 miles range in many EVs
- The DoT National Transport Survey 2017 sets average annual mileage for all cars at 7,800 miles (and dropping).
- We will continue to identify heavily loaded assets and hotspots, and uprate them through the normal reinforcement process.
- We will publish a heat map showing our ability to support charging at a local transformer level

Flexibility in Charging

- Electric Nation framed our plans for managed charging and flexibility. These were developed further at our stakeholder events
- We expect to see four levels of flexibility
  - Time of use tariffs
  - “Network Sympathetic” EV Tariffs
  - DSO procured flexibility services (Flexible Power)L
  - LV Active Network Management (ANM) solutions
  - as a backstop
- Where appropriate reinforce the network

Stakeholder Engagement

- Local Authority events held in 2018 with 130 participants
- OLEV work following the EU changes to the Building Performance Regulations.
- Our “Superfast Electricity” projects have been developed with Welsh Government support
- The Renewable Energy Association have featured our plans to increase house service cable designs
- We have developed our plans for fuel stations based on advice from the Petrol Retailers Association

Accommodating EV demands

- At a domestic level we will use Electric Nation results and plan to install three phase services as a minimum standard
- On our low voltage network we expect to connect streetside chargers and also offer single high capacity charger connections at fuel stations.
- Using bespoke transformers we will connect Hub charging for cark parks, and also connect multiple high capacity chargers. We will also connect some depot charging installations
- Using HV connections we will connect larger charger installations and high capacity depot chargers, such as bus depots

Future Innovation Projects

- Electric Vehicle filling stations will look at options to provide capacity at concentrated charging locations
- On street charging will work with local authorities to provide solutions on existing streets. This may include the provision of a dedicated EV charging mains cable in the street and triggers for reinforcement
- Smart Homes (Electric Vehicle and storage) will use data from homes in the Superfast Electricity trial and establish how overall grid use could be reduced by the combined effect of LCTs
- Hub Charging will develop a transformer solution that can be deployed in areas where multiple chargers are planned, such as car parks.

Publications and Advice

- Our Strategy and all related documents
  - hhtps://www.westernpower.co.uk/electric-vehicles
- Guide on electric vehicle charging and DNO engagement for local authorities
  - https://www.westernpower.co.uk/downloads/15766
- Getting electric vehicles moving guide
  - https://www.westernpower.co.uk/downloads/3220
- Electric Vehicle Emissions Testing report
  - https://www.westernpower.co.uk/downloads/1957

Thank you for listening

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