WESTERN POWER DISTRIBUTION

INNOVATION

NEXT GENERATION NETWORKS

Balancing Act Conference

21st November 2018
The Bristol

Nigel Turvey
Network Strategy & Innovation Manager

Housekeeping

Agenda

09.30 – Registration & Refreshments
10.00 – Welcome & Introductions
10.10 – Adapting the electricity network for EV uptake
10.30 – The latest learnings from the Electric Nation project
11.20 – Refreshments
11.40 – Panel Session – Making owning an EV simple and easy
12.15 – Lunch
13.00 – LV Connect and Manage project – Optimising the grid, homes and EV's
13.45 – Afternoon break
14.00 – Future WPD projects and plans – EV data, filling stations and on-street charging
14.30 – WPD Panel of experts – Q&A from the day
15.00 – Close

Innovation Objectives

The objectives of WPD's innovation programme are to:

- Develop new *smart* techniques that will accommodate increased load, storage and generation (Distributed Energy Resources – DER) at lower costs/quicker connections than conventional reinforcement.
- Facilitate regional and local energy markets; including local flexibility services.
- Improve business performance against one or more of our core goals of safety, customer service, reliability, the environment or cost effectiveness.
- Ensure solutions are compatible with the existing network.
- Deliver solutions so that they become business as usual.
- Provide long term, whole system outcomes and value for money for consumers.
- Assist the UK to reduce carbon emissions and combat climate change.

WESTERN POWER DISTRIBUTION

INNOVATION

NEXT GENERATION NETWORKS

Adapting the electricity network for EV uptake

Balancing Act Conference
21st November 2018

Roger Hey
Future Networks Manager

WESTERN POWER DISTRIBUTION
INNOVATION

Agenda

1 – Future Networks Programme

2 – Research, Development and Demonstration of e-Mobility Solutions

3 – Distribution Future Energy Scenarios (D-FES)

4 – Tipping points and exponential change

5 – Questions / Discussion

NEW

WESTERN POWER DISTRIBUTION REVISE

WESTERN POWER DISTRIBUTION EFFS

WESTERN POWER DISTRIBUTION NETWORK EQUILIBRIUM

WESTERN POWER DISTRIBUTION OPEN LV

WESTERN POWER DISTRIBUTION SMART ENERGY ISLES

WESTERN POWER DISTRIBUTION PLUGS AND SOCKETS

Future Networks Programme

Assets

- Management of distribution assets
- Exploitation of asset & network information
- Developing Smart Grid Technology

Customers

- Distributed Generation
- Connecting Electric Vehicles
- Adopting Battery Storage
- Facilitating Flexibility

Operations

- Maintaining Reliability
- Strategic Forecasting
- Transitioning to DSO
- Operational Efficiency

Network and Customer Data

Network Improvements and System Operability

- Improved Statistical Ratings for OHL
- DEDUCE
- Primary Networks Power Quality Analysis
- Stochastic Load Flow
- LCT Detection
- Network Islanding
- Common Information Model
- Harmonic Mitigation
- Virtual STATCOM

Transition to a Low Carbon Future

- Virtual Telemetry
- Feeder Fault Level
- Solar Storage
- LV Connect & Manage
- FREEDOM
- Electric Nation (formerly CarConnect)
- Industrial & Commercial Storage
- Hydrogen Heat & Fleet

New technologies and commercial evolution

- MVDC
- 5G Design
- OHL Director
- Entire
- LV Fault Location
- On-street EV Charging

Customer and Stakeholder Focus

- Power Electronic FLM
- Power Electronic FCI
- Self System Design
- New Build Standards
- LCT Response
- Carbon Portal

Safety, Health and Environment

- Simulated Training
- SF6 Alternatives
- Robot Trades
- LV Sensitive Earth Fault Protection
- Wildlife Protection
- Losses Investigation
- Advanced Vegetation Management
- Visual Data Processing

Research, Development and Demonstration of e-Mobility Solutions

- Partnered with E.ON and Birmingham City Council on *CABLED* in 2009
- Europe's first V2G taxi prototype in 2011
- Installed the UK's first inductive charging infrastructure (*Electric Boulevards*) in Milton Keynes in 2013
- Developed integrated vehicle telematics and smart charging algorithms with Mitsui-ARUP in 2015
- *EV Emissions t*esting with Transport Research Labs in 2017
- World's largest EV user trial, *Electric Nation*, from 2016
- Demonstration of a short-term mandated *Connect & Manage* solution for solar, battery storage and EV charging on LV networks
- *Heat & Fleet was* launched in 2018 to research the technical and commercial viability of Hydrogen production and use by commercial vehicles.
- *LCT detection* project just commenced using AI techniques to identify new EV connections

Research, Development and Demonstration of e-Mobility Solutions

- Partnered with E.ON and Birmingham City Council on *CABLED* in 2009

CABLED - engaging with UK public about Electric Vehicles in Birmingham/Coventry

- 35 charging posts, TSB funded.
- IFI R&D to install Power Quality recorders
- Installed 100 Smart meters in domestic properties to measure consumer activity (home charging)
- Cars: Imiev, Smart, Tata, Range Rover (hybrid)

Phase 1:
Reference Phase
Data gathering

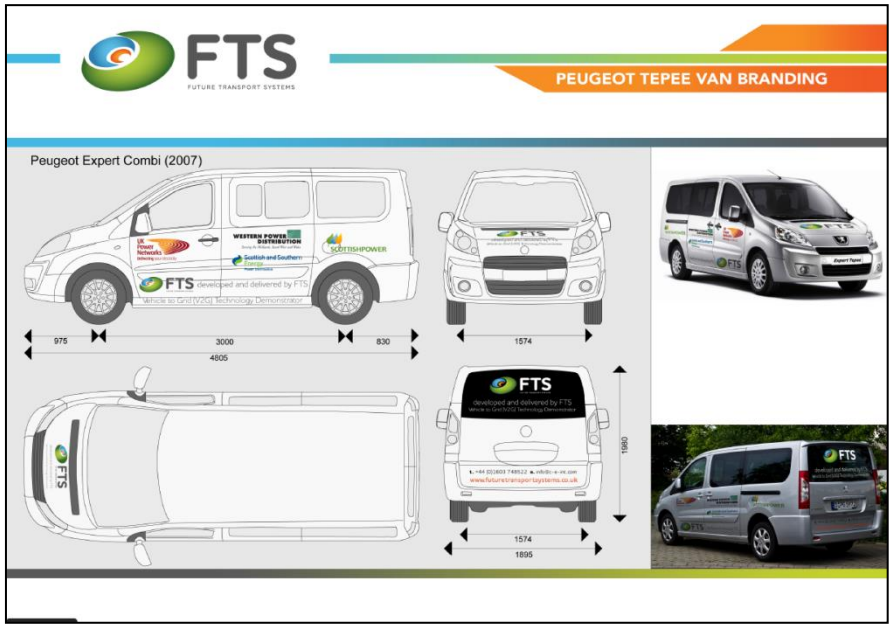
Phase 2:
V2G
Balancing

Phase 3:
Smart EV Grid model
Data and Comms

2010 Jan 2011 Jul 2011

Research, Development and Demonstration of e-Mobility Solutions

- Europe's first V2G taxi prototype in 2011



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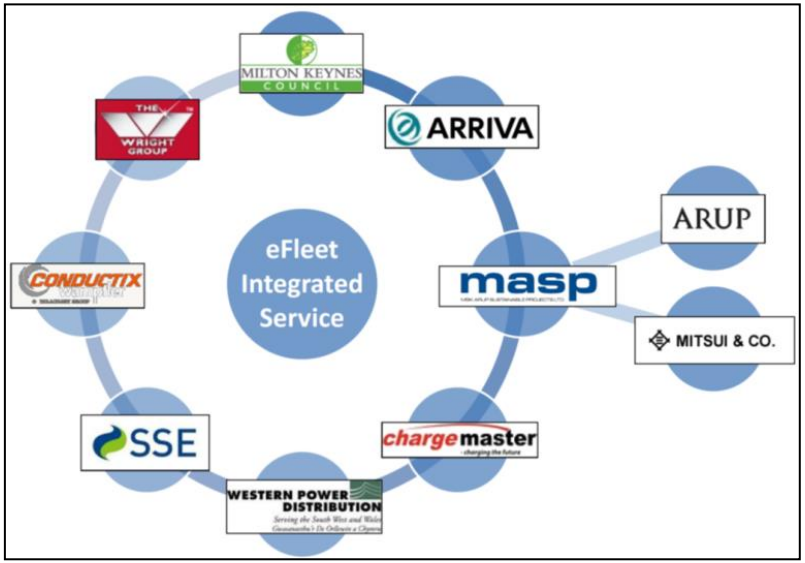

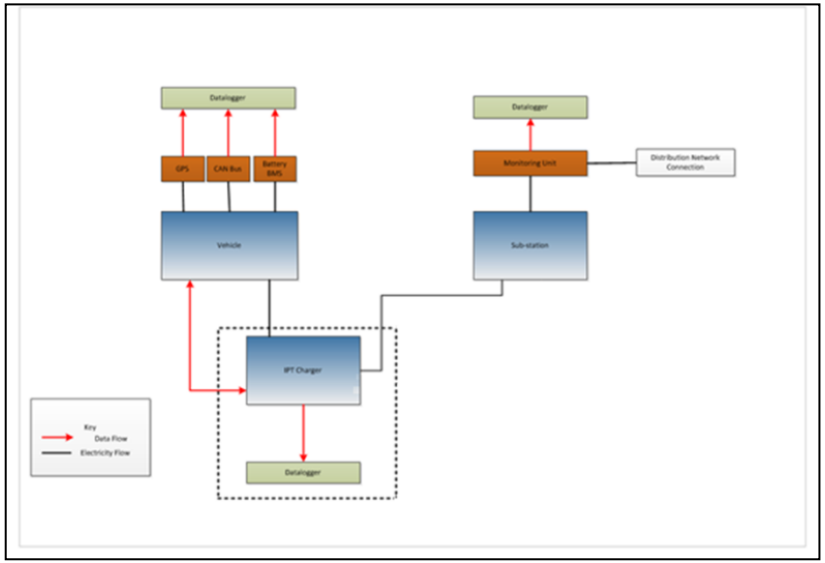

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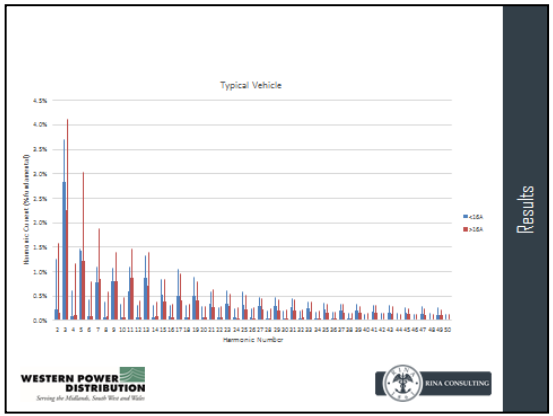

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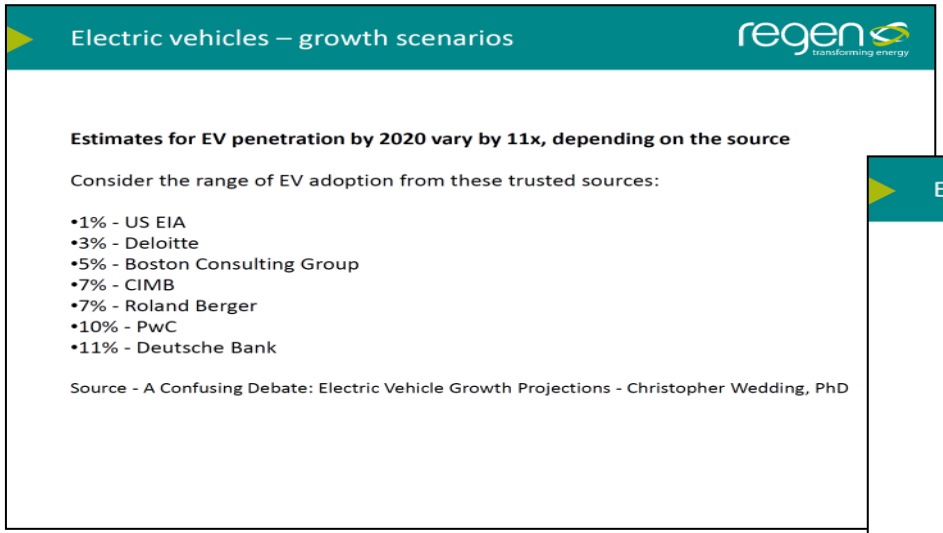
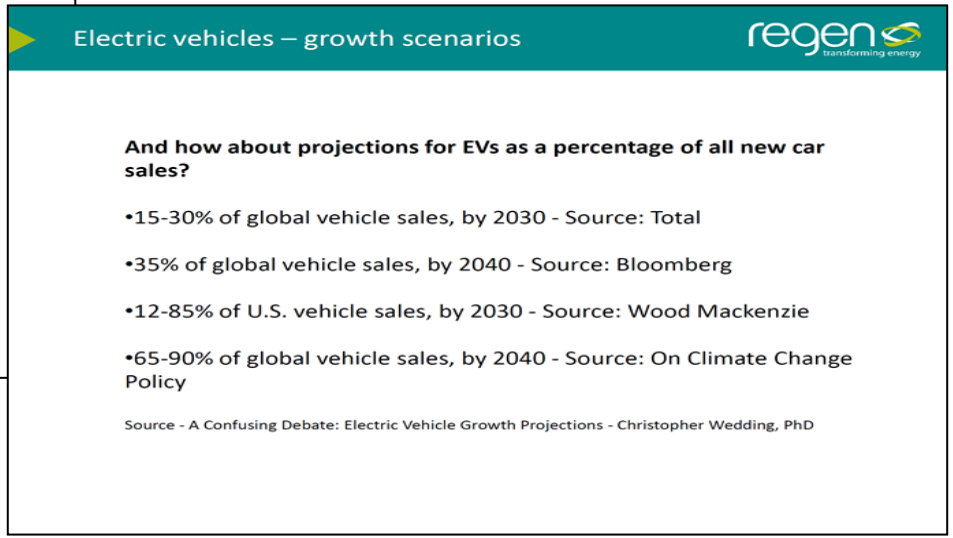
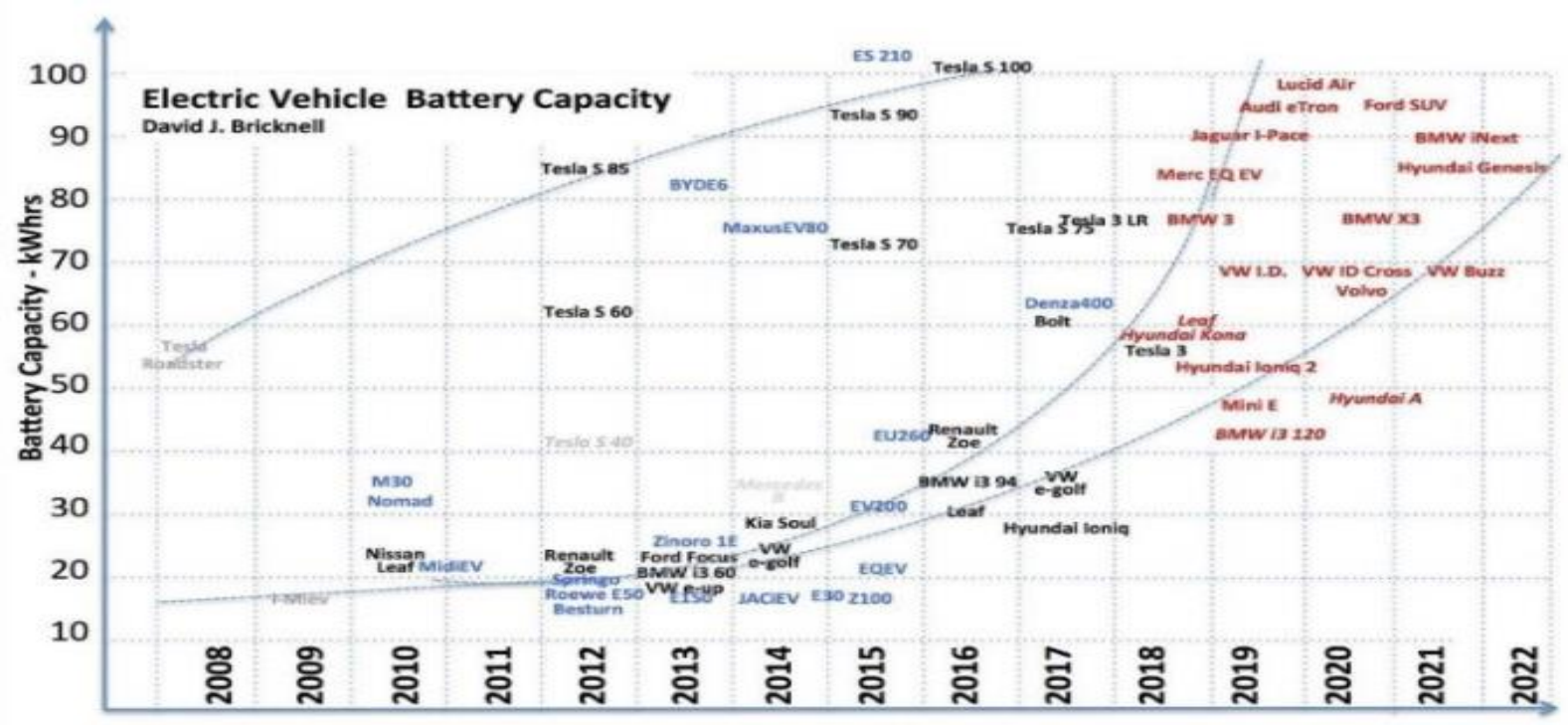
Broad Spread in EV penetration estimates

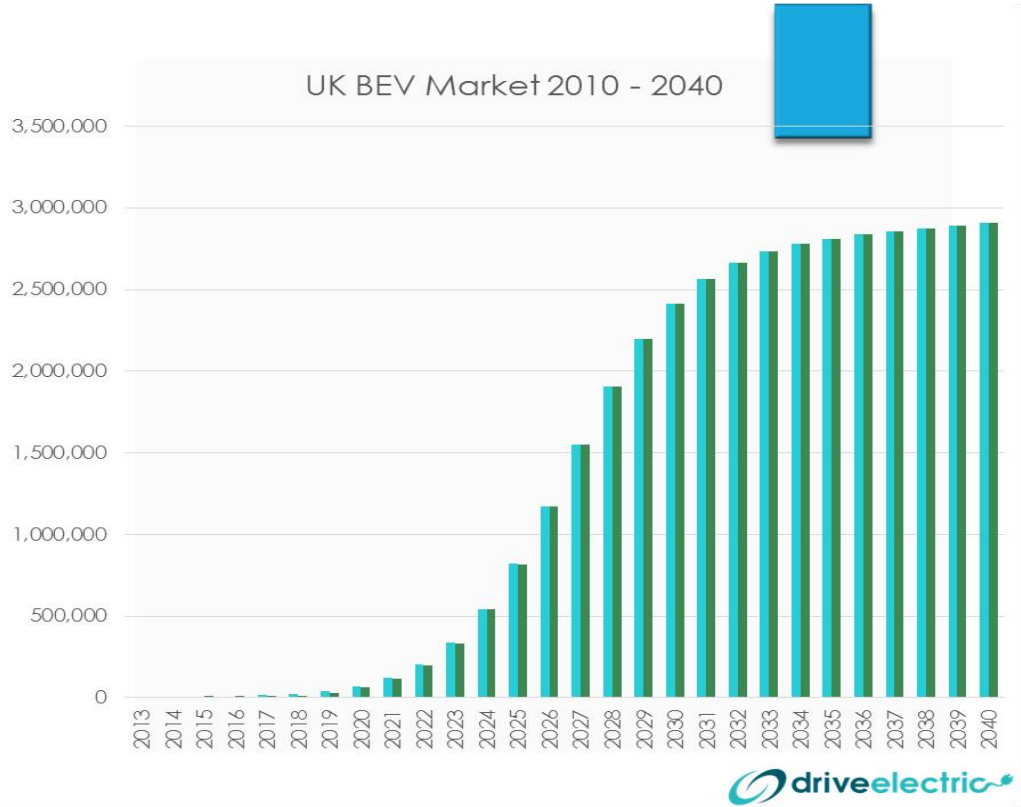




Electric Cars are maturing rapidly

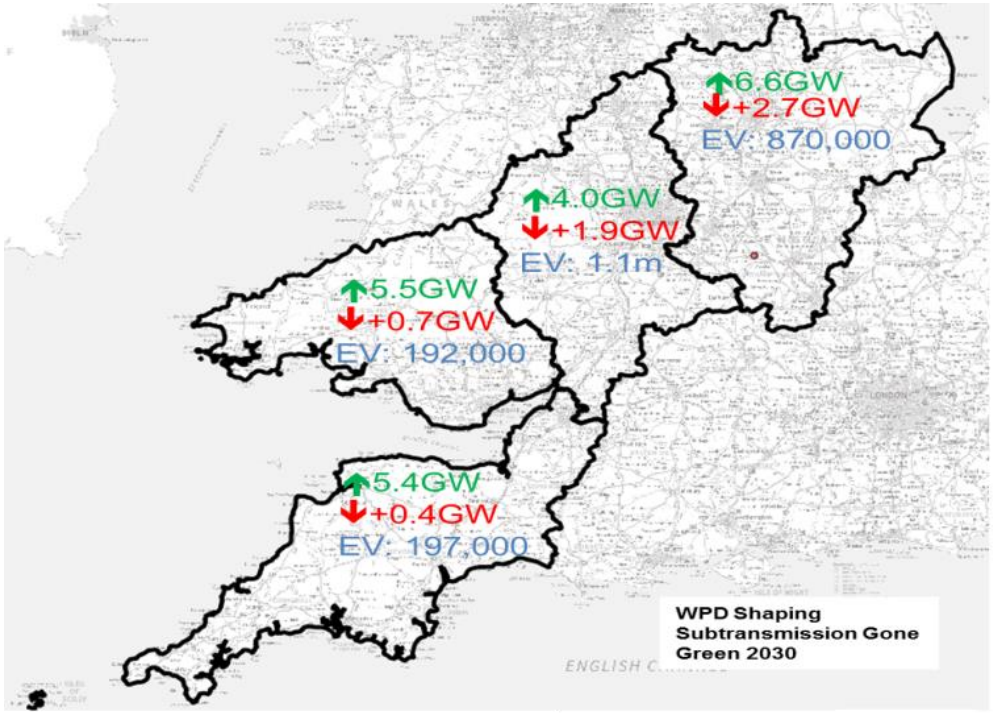


UK BEV Market 2010 - 2040



Future Growth Scenarios

Our Shaping Sub-transmission reports have highlighted significant potential growth for both demand and generation, under current political and economic environments.



Estimation within ED1 business plan

Cumulative number of electric vehicles charged at existing premises at the end of RIIO-ED1

	WPD 'Best View' based on CSE data	Regionalised DECC LOW case	Regionalised DECC MEDIUM case	Regionalised DECC HIGH case
West Midlands	66,761	62,411	181,772	277,613
East Midlands	77,023	68,622	199,863	305,241
South Wales	28,887	21,316	62,084	94,818
South West	45,014	46,691	135,988	207,689

Latest D-FES

- Even most pessimistic scenarios are much higher than ED1 'best view'
- Likely to be 100's of charge points installed per day by end of ED1
- And towards 5000 per day in ED2

SWe
Q1 2018

Number of Electric Vehicles in licence area	Baseline	2020	2025	2030
Two Degrees	7109	54226	311457	831168
Consumer Power	7109	35376	215619	608967
Slow Progression	7109	20498	88967	282958
Steady State	10028	21495	70986	189481

Swa
Q3 2018

Number of Electric Vehicles in licence area	Baseline	2020	2025	2030
Two Degrees	2240	8897	61378	257505
Consumer Power		7884	39429	178995
Slow Progression		5746	28595	106881
Steady State		5569	24869	85373

EM
Q1 2017

Number of Electric Vehicles in licence area	Baseline	2020	2025	2030
Gone Green	7475	57262	310668	873306
Consumer Power		52581	222021	646568
Slow Progression		37915	145451	406177
No Progression		31373	88197	188039

WM
Q3 2017

Number of Electric Vehicles in licence area	Baseline	2020	2025	2030
Gone Green	13124	55120	390117	1102156
Consumer Power		49050	214209	686441
Slow Progression	13088	41311	163929	609822
No Progression		38993	130610	392813

Keep the region moving

- We have been developing solutions to ensure that network connections and capacity are not a barrier to EV adoption
- Solutions already available are:
  - Alternative Connections (eg. Timed connections)
  - Conventional reinforcement
- Near term we will have
  - More diversified profiles based on behavioural data
  - A *Connect & Manage* alternative connection
- Plus we continue to research and innovate

THANKS FOR LISTENING

WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Roger Hey

Western Power Distribution

Future Networks Manager

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WESTERN POWER DISTRIBUTION

INNOVATION

NEXT GENERATION NETWORKS

Current EV Projects

Balancing Act Conference

21st November 2018

Ricky Duke

Innovation & Low Carbon Networks Engineer

WESTERN POWER DISTRIBUTION — NEW REVISE

WESTERN POWER DISTRIBUTION — EFFS

WESTERN POWER DISTRIBUTION — NETWORK EQUILIBRIUM

WESTERN POWER DISTRIBUTION — OPEN LV

WESTERN POWER DISTRIBUTION — SMART ENERGY ISLES

WESTERN POWER DISTRIBUTION — PLUGS AND SOCKETS

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Transition to a Low Carbon Future

- Virtual Telemetry
- Feeder Fault Level
- **Solar Storage**
- **LV Connect & Manage**
- **FREEDOM**
- **Electric Nation (formerly CarConnect)**
- **Industrial & Commercial Storage**
- **Hydrogen Heat & Fleet**

New technologies and commercial evolution

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- 5G Design
- OHL Director
- **Entire**
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- Advanced Vegetation Management
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LV Connect & Manage

- In some areas, the uptake of Low Carbon Technologies such as heat pumps, electric vehicles, photovoltaics or energy storage, may occur rapidly ahead of any planned reinforcement.

- This project together with Nortech will test and demonstrate whether LV Active Network Management, which extends communications and controls to within the customers' installations, is able to deal with bi-directional power flows as a viable short term alternative to network reinforcement.

- Batteries and EV Charge points have been installed in customer's premises and controlled by WPD/Partners during the trial.

LCT Detection

- WPD are working with ElectraLink and IBM to achieve visibility of unregistered Low Carbon Technologies on the low voltage network.

- This project will take industry data from the DTS data set and apply leading-edge analytics to provide a mechanism to identify and validate these installations.

- The main project deliverable will be a proof of concept model – a process design document and demonstration dashboard that will identify Low Carbon Technologies to support network planning and investment strategy.

Electric Nation

- The worlds largest domestic smart charging trial with 673 participants currently in a live trial.
- Understand EV customers charging patterns at home, and their acceptance of smart charging.
- Production of the Network Assessment Tool.
- Trials are now in their final stage and already showing some interesting results.

ELECTRIC NATION

YOUR ELECTRIC VEHICLE YOUR SMART CHARGE

COLLABORATION PARTNERS

ea technology

driveelectric electric car leasing

Lucy Electric

TRL

WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

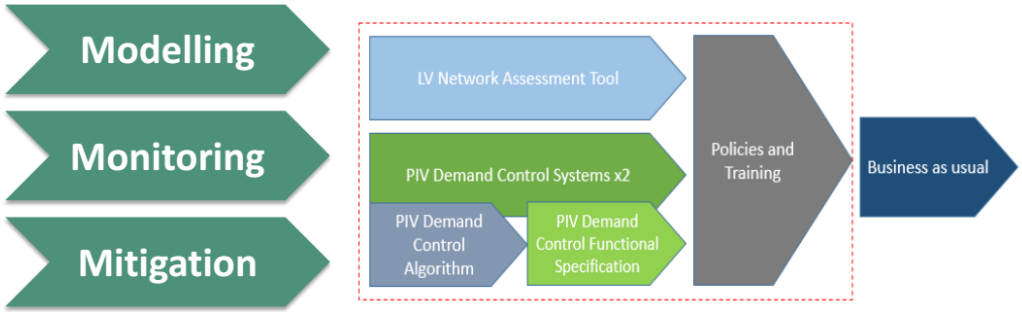
ELECTRIC NATION

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

The world's largest EV Smart Charging trial (673 participants)

3 year project (2016-2019)

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



COLLABORATION PARTNERS

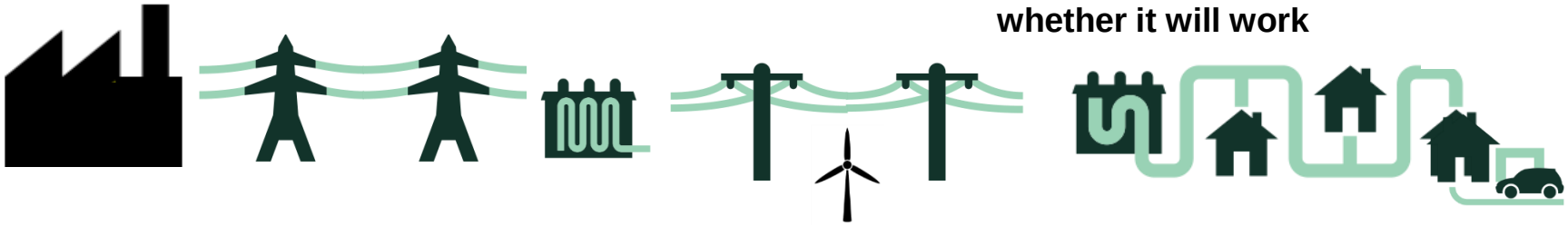
ea technology
driveelectric electric car leasing
Lucy Electric
TRL

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Why do we need smart charging?

- 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

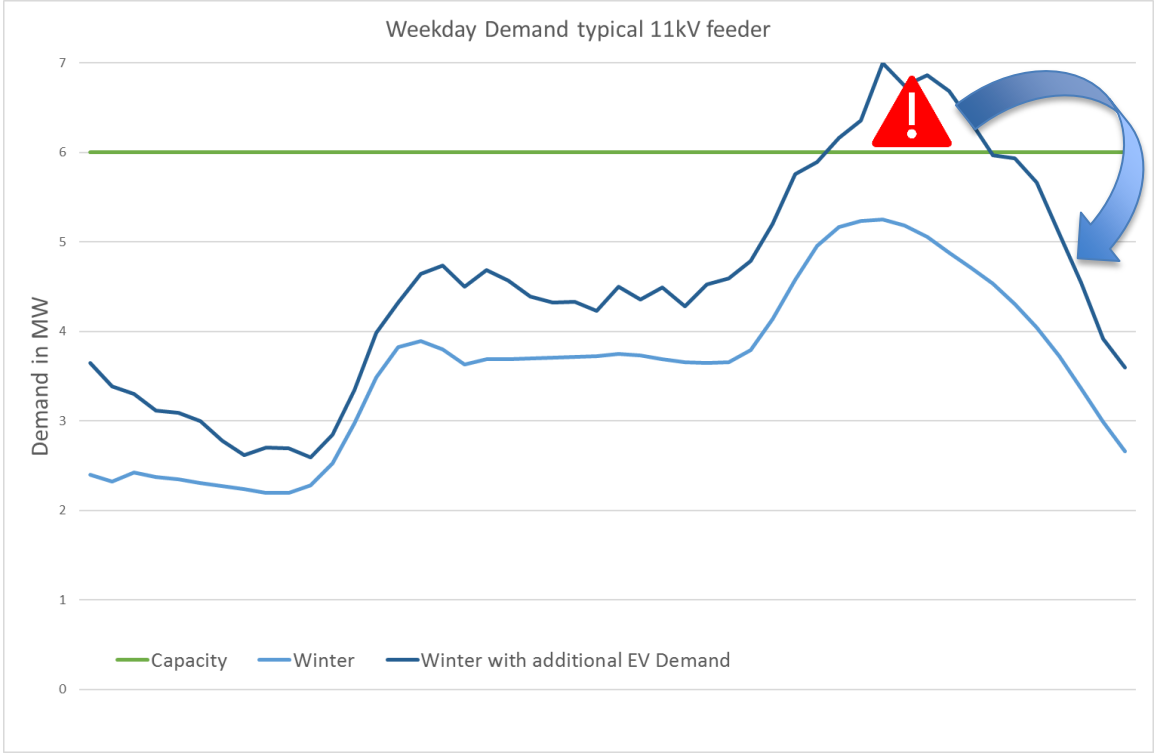
- Additional loading on LV networks would result in at least 30% of these networks in GB requiring investment by 2050 costing at least £2.2bn *(My Electric Avenue)*
- Investment = upgrade/replace these networks – disruption affecting all of us
- Costs of upgrades go onto customer bills – a hidden cost of EV ownership?
- **Smart charging could reduce/delay or avoid the need to upgrade/replace networks**
- **UK Government looking to mandate smart charging**
  - **This project will provide evidence whether it will work**



Smart Charging Trials

2 systems used in customer trials: when network capacity could be breached

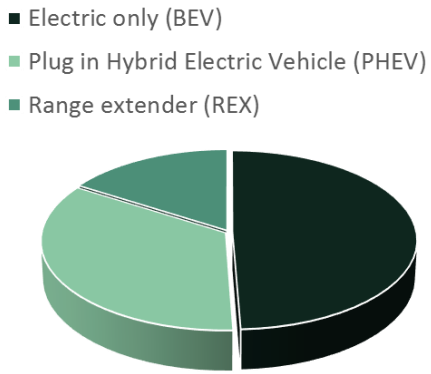
- GreenFlux
  - Periodic 32A/16A/0A allocations to each charger
- CrowdCharge
  - Current allocations reduced across all chargers

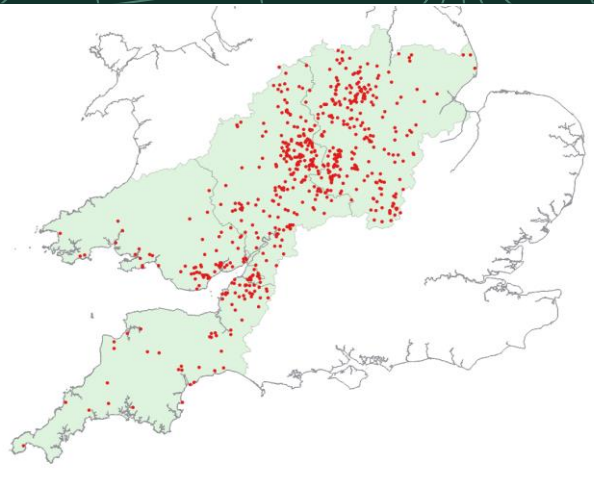


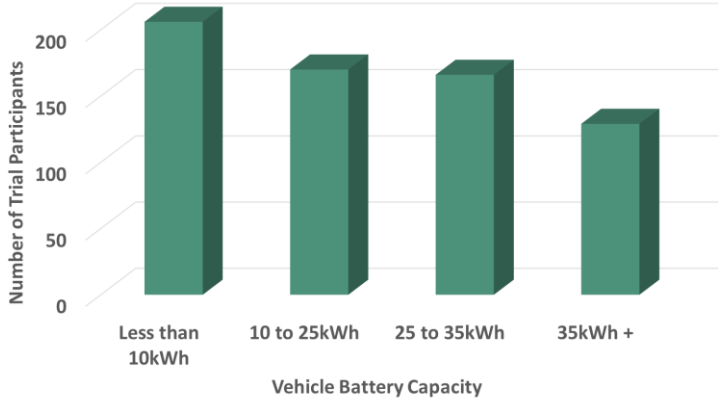
ELECTRIC NATION

The World's Largest EV Smart Charging Trial

- 673 chargers, throughout WPD's licence areas
- 40 different makes/models of EV
- Over 80,000 charging events captured already leading to 1 million hours of charging data

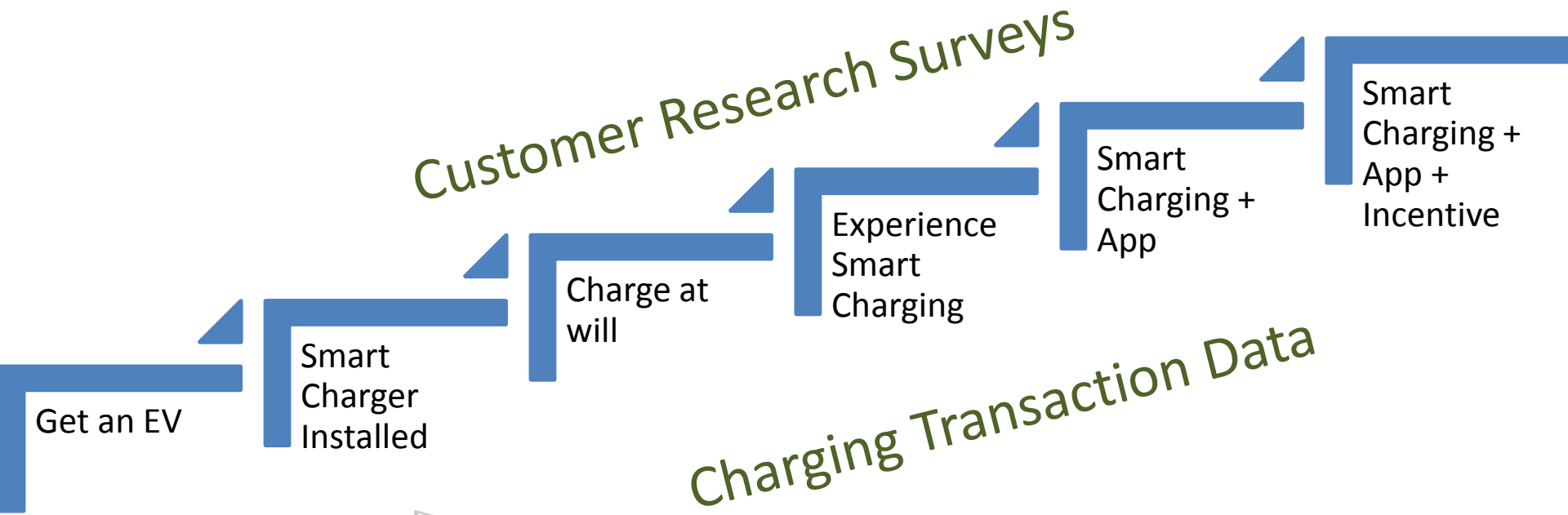






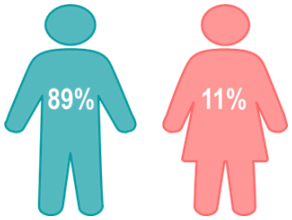
BMW TESLA NISSAN MITSUBISHI

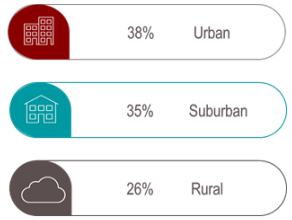
Trial Participant's journey through the Trial

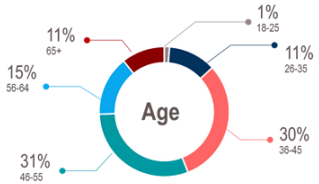


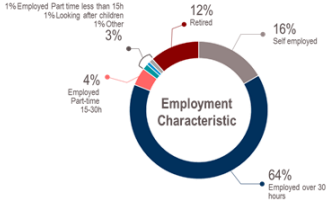
Customer Research

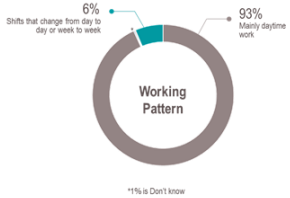
- Trial participant's socio-economic data
- EV usage
- EV charging patterns (as they see it)
- Attitudes to
  - current charging arrangements
  - charge management
- Feedback on Apps

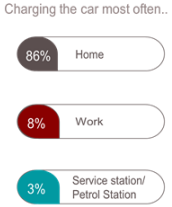












51% owned Electric

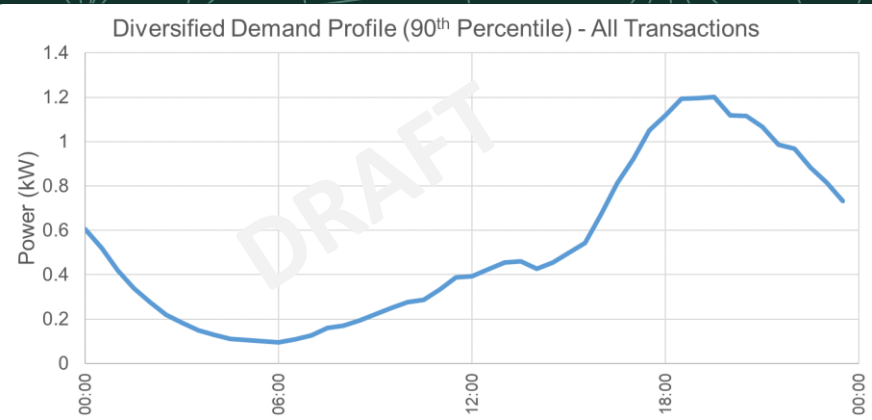
49% owned Hybrid

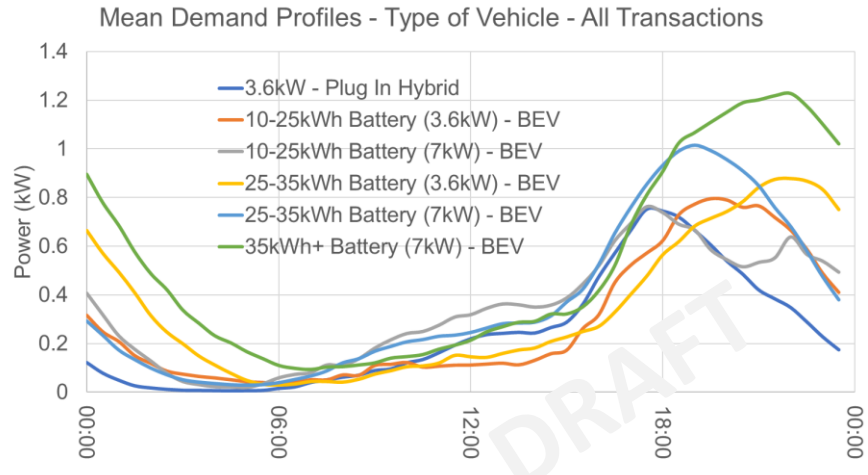
All results presented today are interim findings

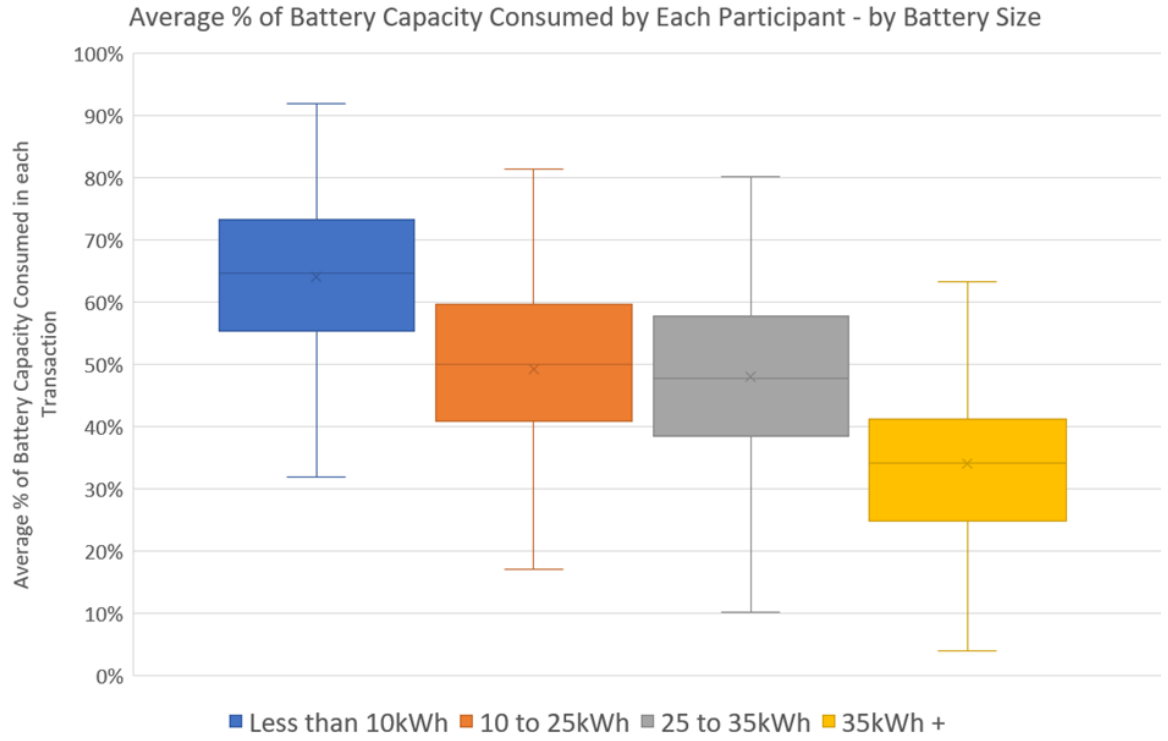
ELECTRIC NATION

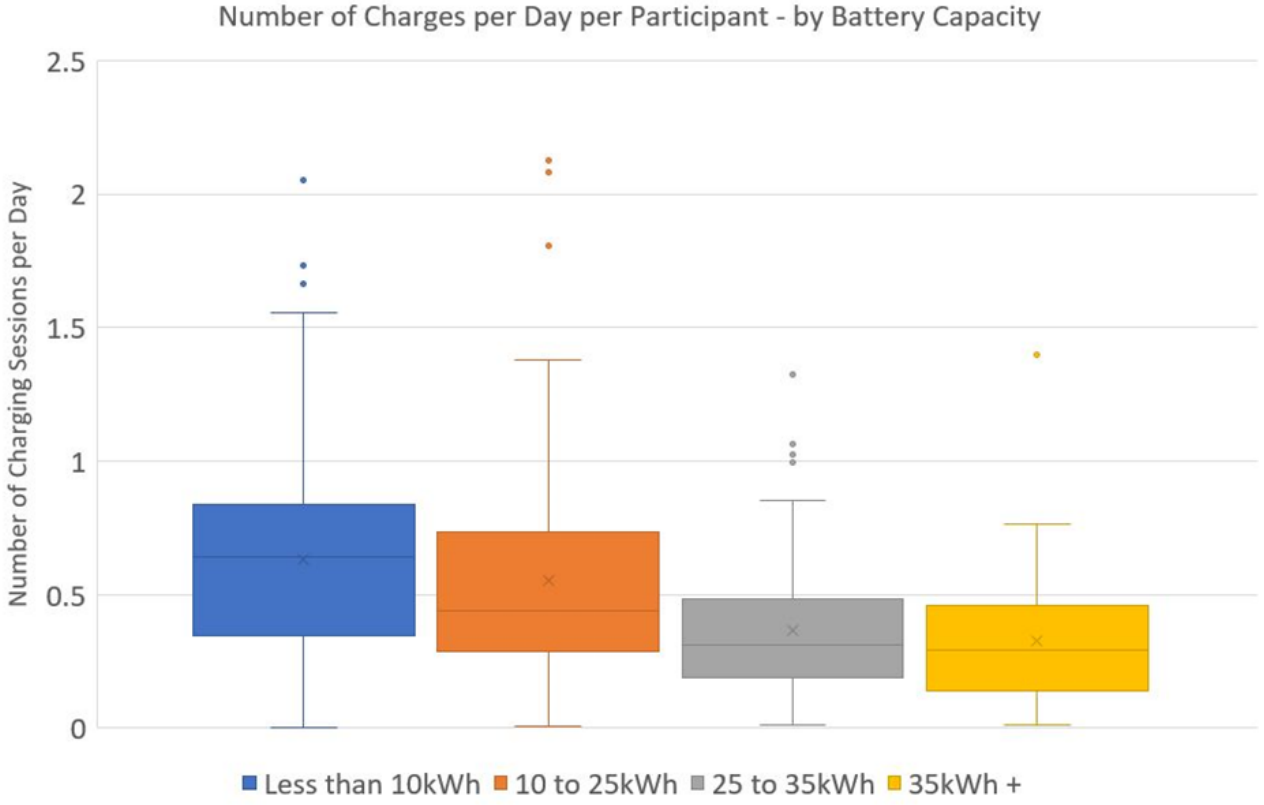
Charging Transaction Data

- Basic:
  - Start & end of transaction
  - Start Charging (includes use of timers)
  - Energy consumed in charge
- Detailed:
  - Periodic meter values
- Smart Charging System activity
  - Demand management events
- App usage & customer inputs



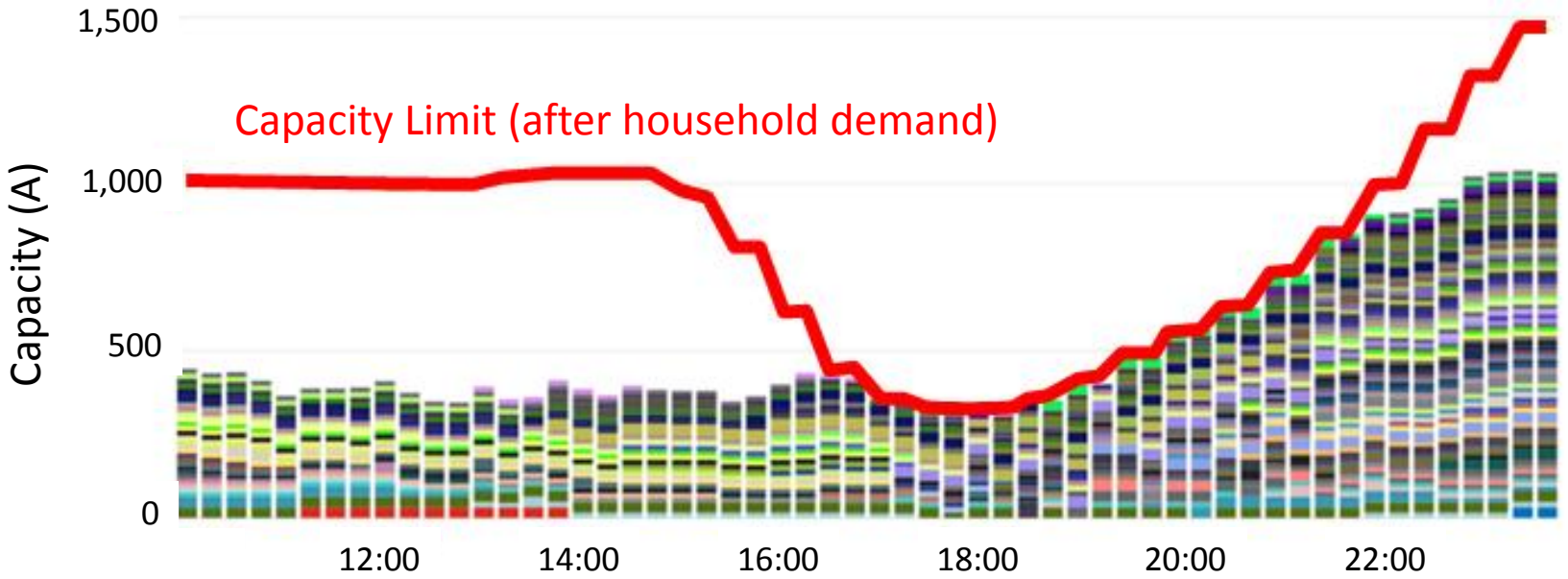



Average % of Battery Capacity Consumed by Each Participant - by Battery Size
Average % of Battery Capacity Consumed in each Transaction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Less than 10kWh
10 to 25kWh
25 to 35kWh
35kWh +


Number of Charges per Day per Participant - by Battery Capacity
Number of Charging Sessions per Day
2.5
2
1.5
1
0.5
0
Less than 10kWh
10 to 25kWh
25 to 35kWh
35kWh +

ELECTRIC NATION

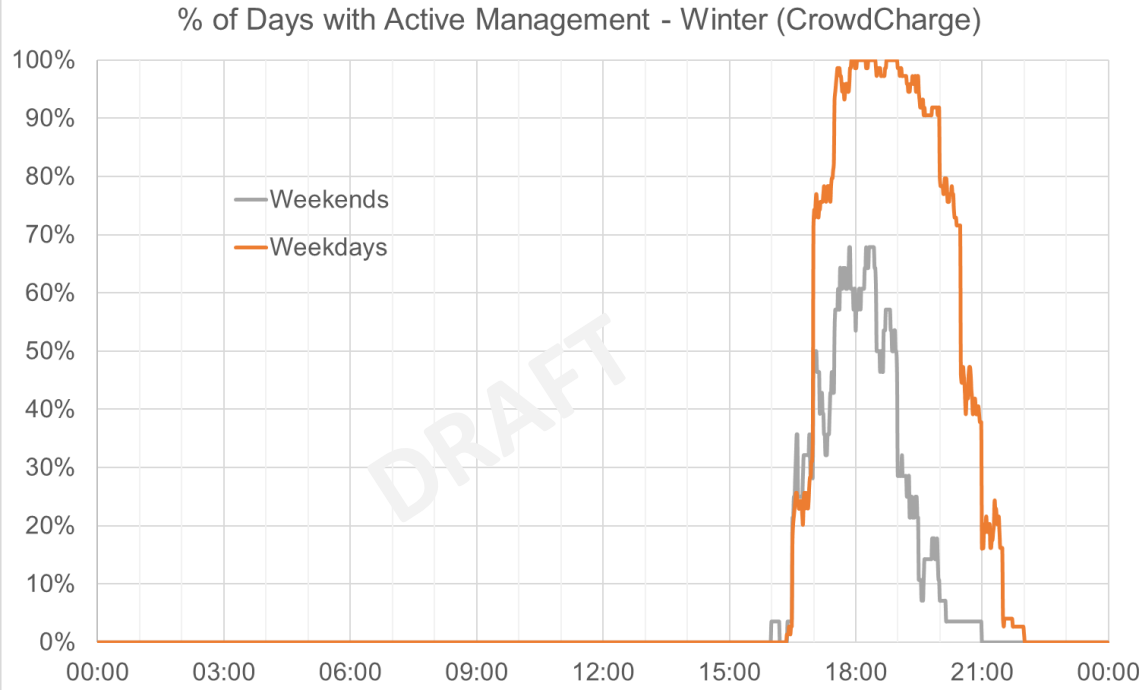
EV Demand Management in Action

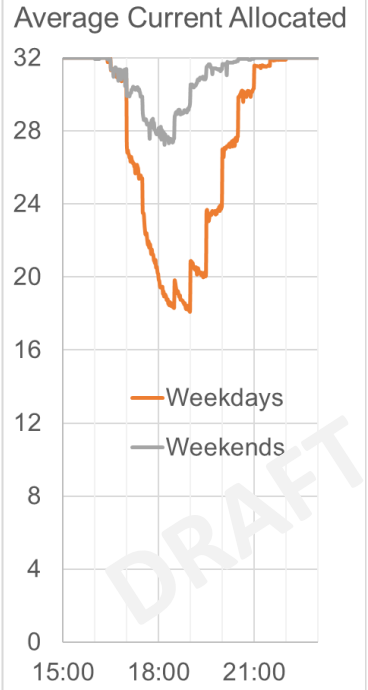


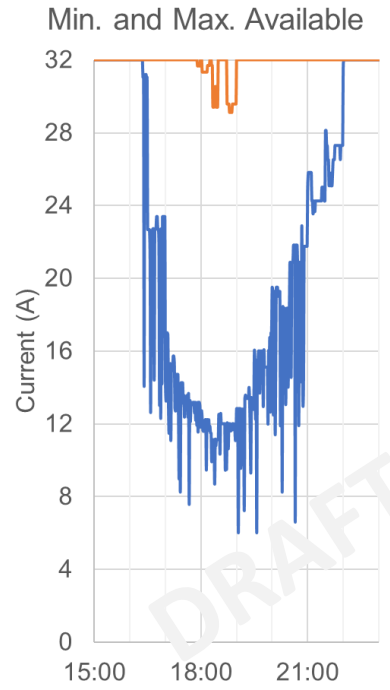
ELECTRIC NATION

When was demand management imposed on Trial Participants?

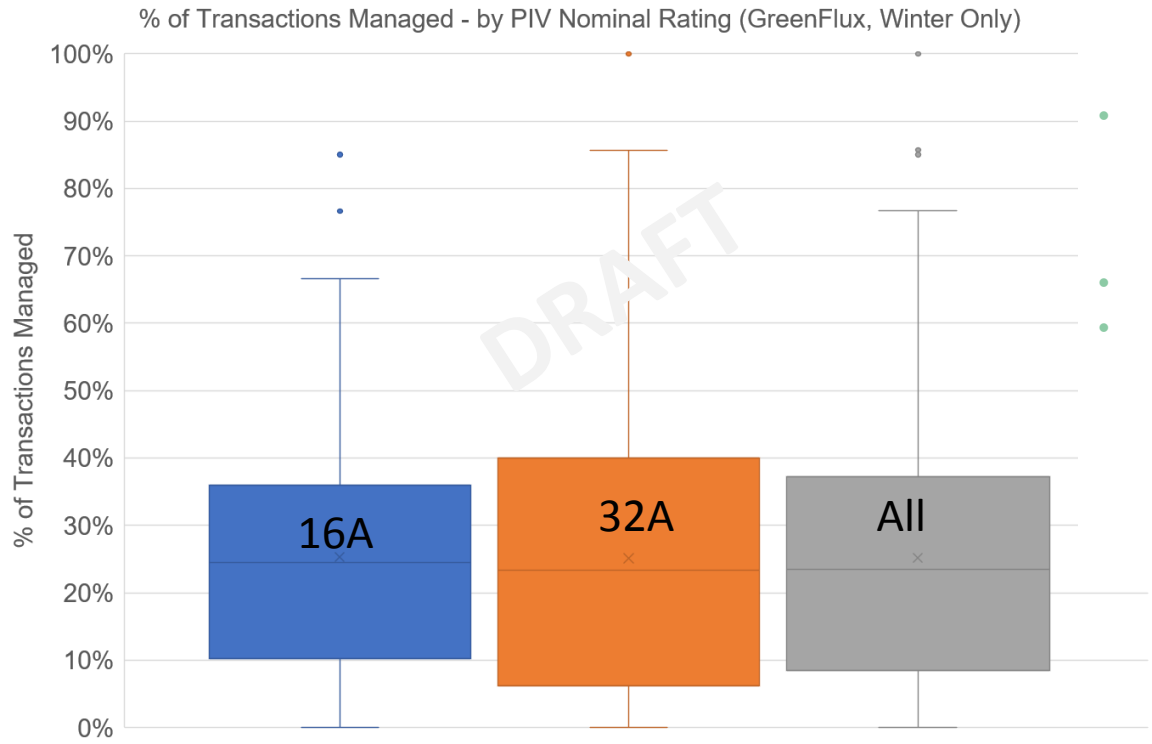
And what was the effect?







Demand Management Effect on Customers - GreenFlux

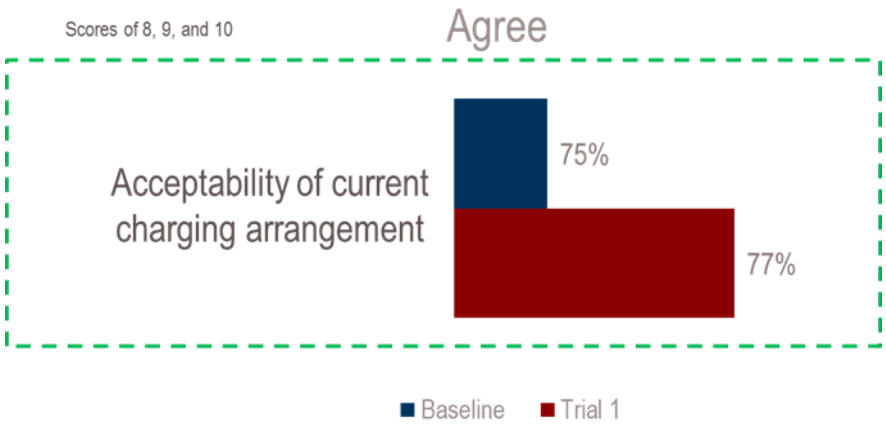


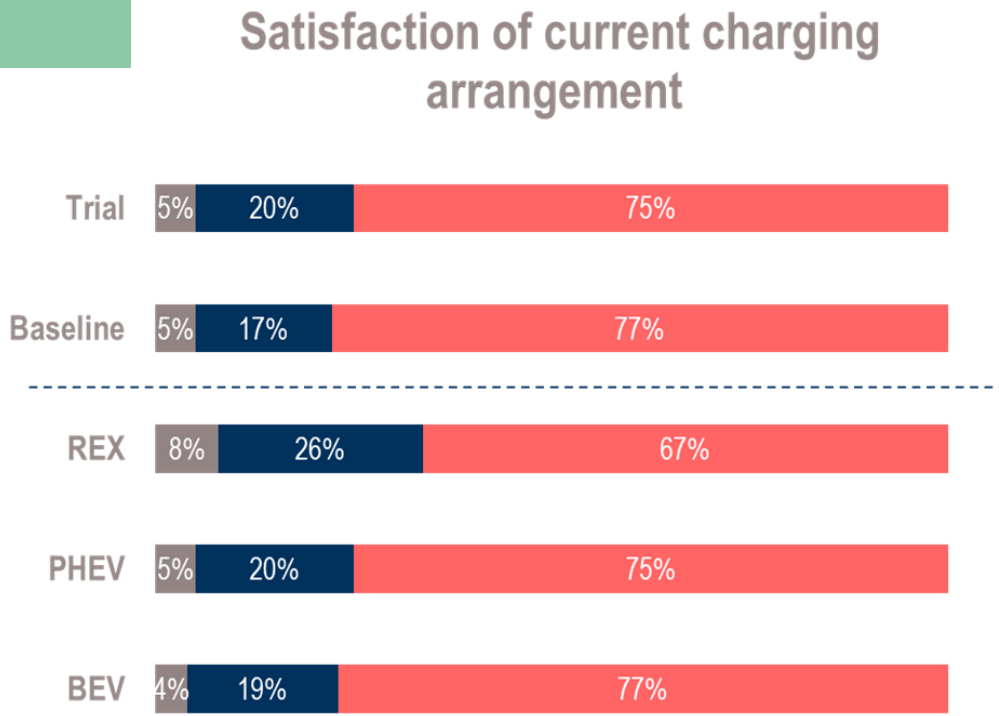
- Mean Transactions Managed = 23%-24%
  - 1 in 4 charge transactions
  - Or 1 in 4 customers affected
    - Depends on WHEN they start charging
- Demand Management under Electric Nation trial is regular
  - In reality will not be required every day in winter
- Few drivers charge every day
- Few charges are “charge from empty”

Even for those affected by demand management the impact on next journey is likely to be low for most

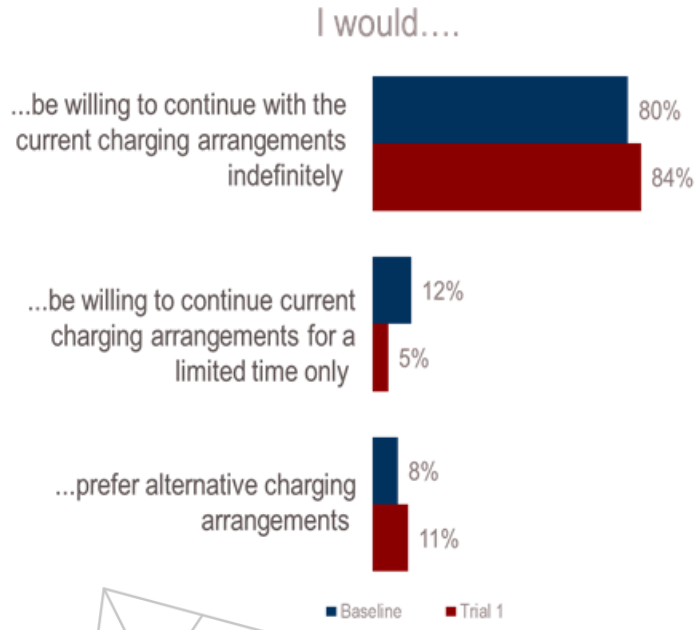
ELECTRIC NATION

Customer Perceptions of Impact of Smart Charging





Willingness to accept smart charging in the long term



There are slight variations in **trial** charging behaviour between charger types and fuel types				
Charger Type		**Fuel Type**		
Green Flux (144)	Crowd Charge (134)	PHEV (102)	BEV (138)	REX (39)
87%	81%	80%	86%	82%
5%	6%	6%	4%	10%
8%	13%	14%	10%	8%

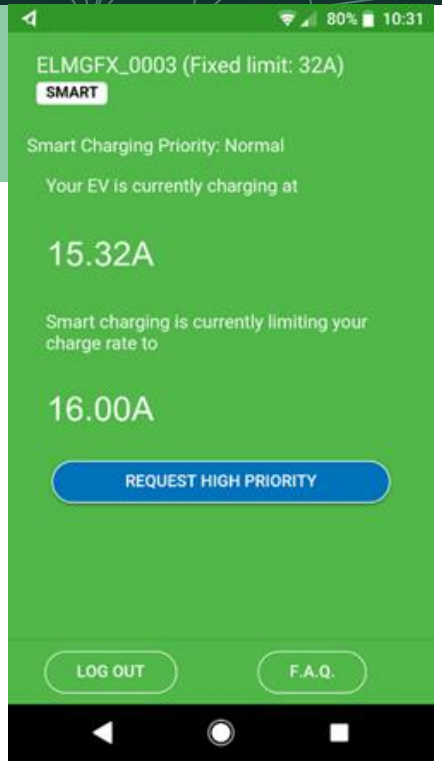
Customer Interaction with Smart Charging & Demand Management

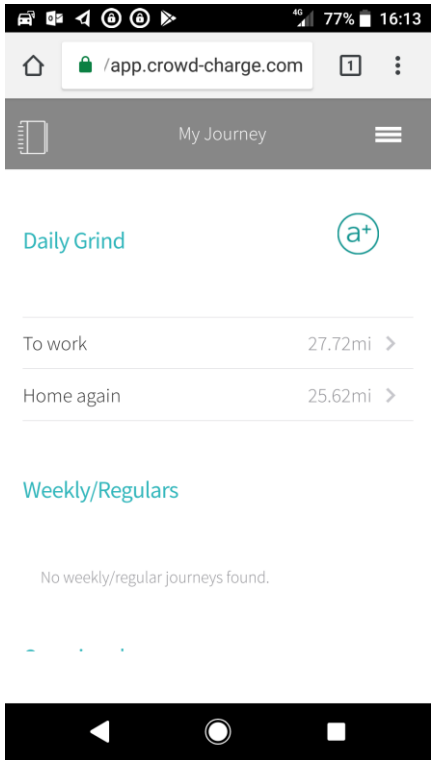
GreenFlux

- Customer can view charging session live
- and request High Priority for that session (excludes them from demand management)
- So long as not all request High Priority

CrowdCharge

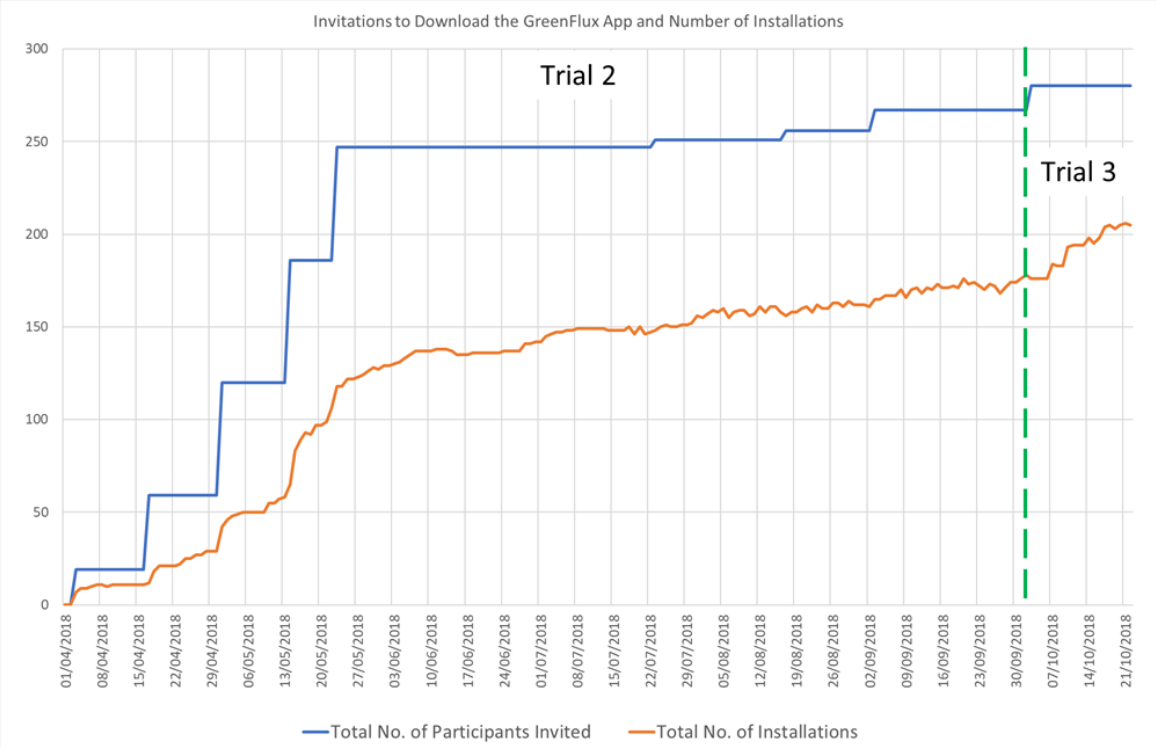
- Customer inputs journey requirements (commute, regular and one-offs)
- SOC customer input or telematics
- System ensures charge for next journey is supplied as a minimum



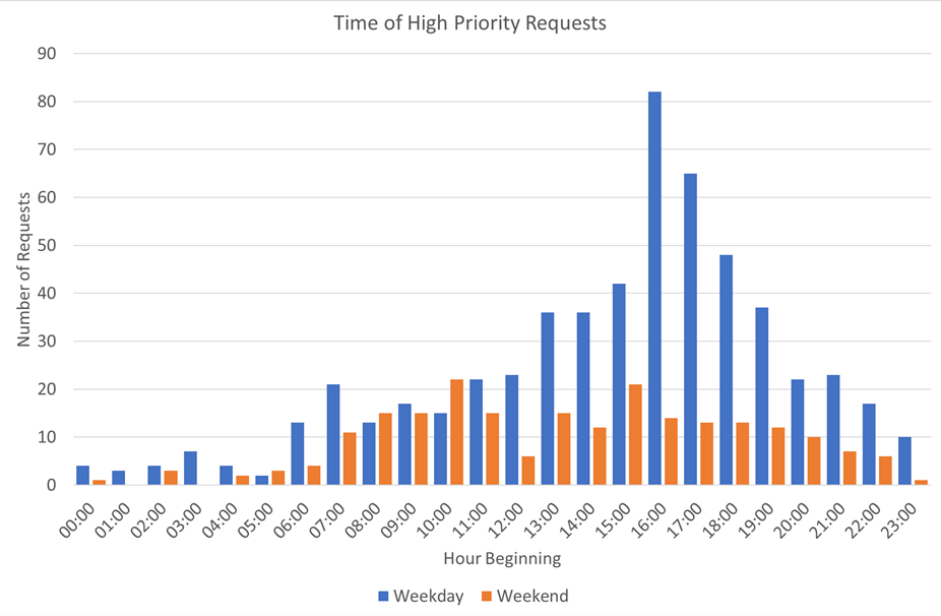


GreenFlux App Installations

- 263 invited
- 176 downloaded app – 67%

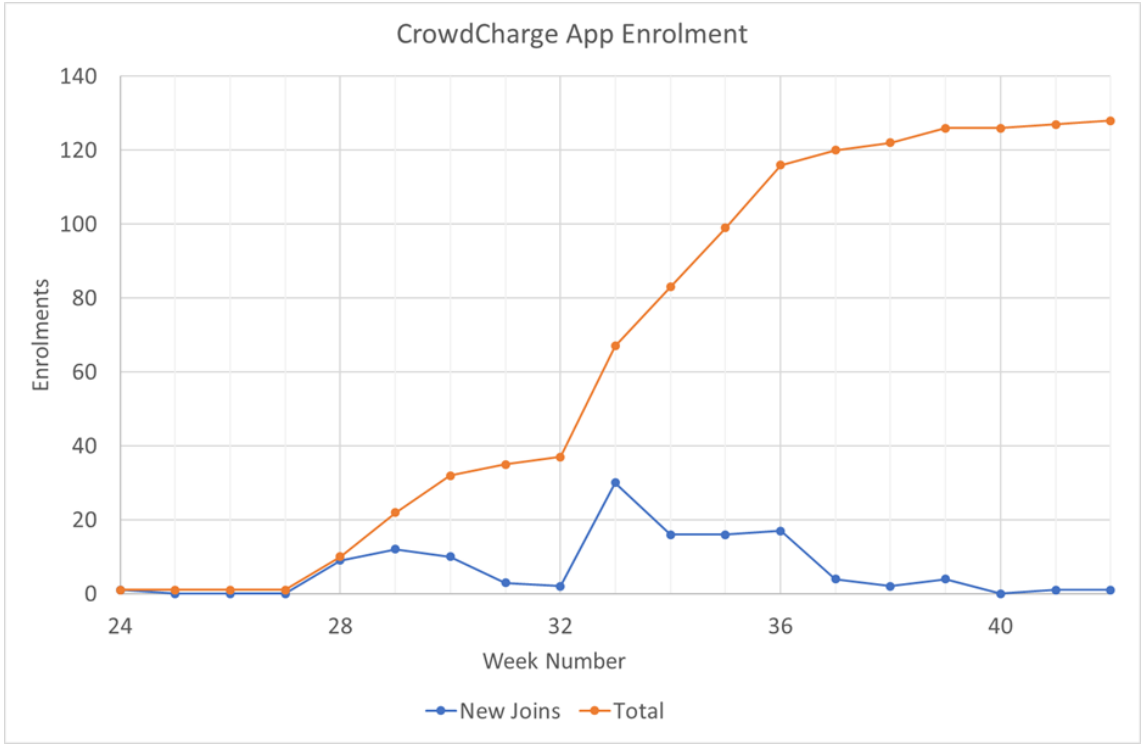


App usage – Request High Priority



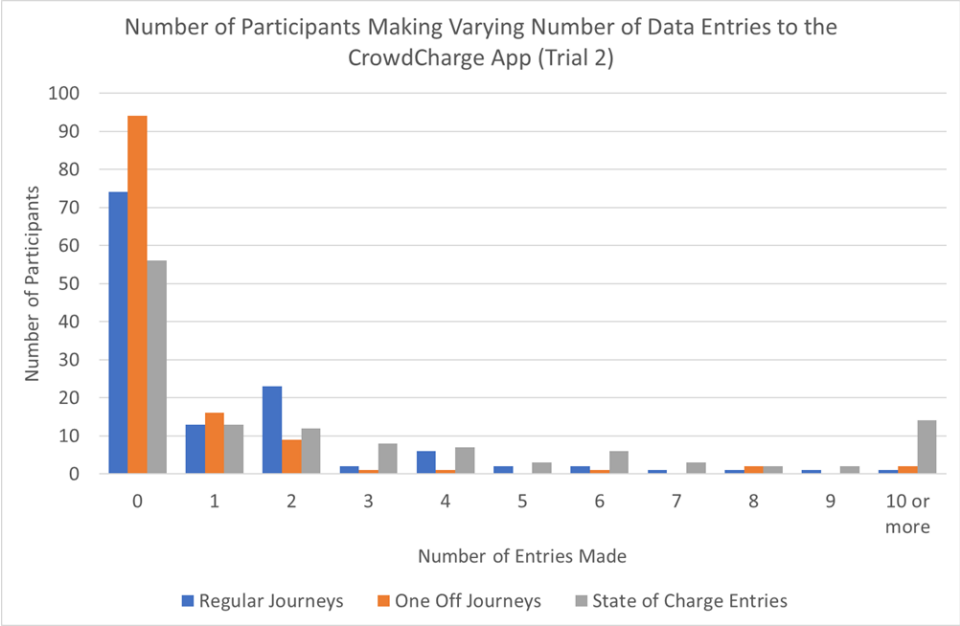
CrowdCharge App Enrolments

- 238 invited to use app
- 2 positively declined
- 108 didn't respond – 45%
- 128 enrolled – 54%

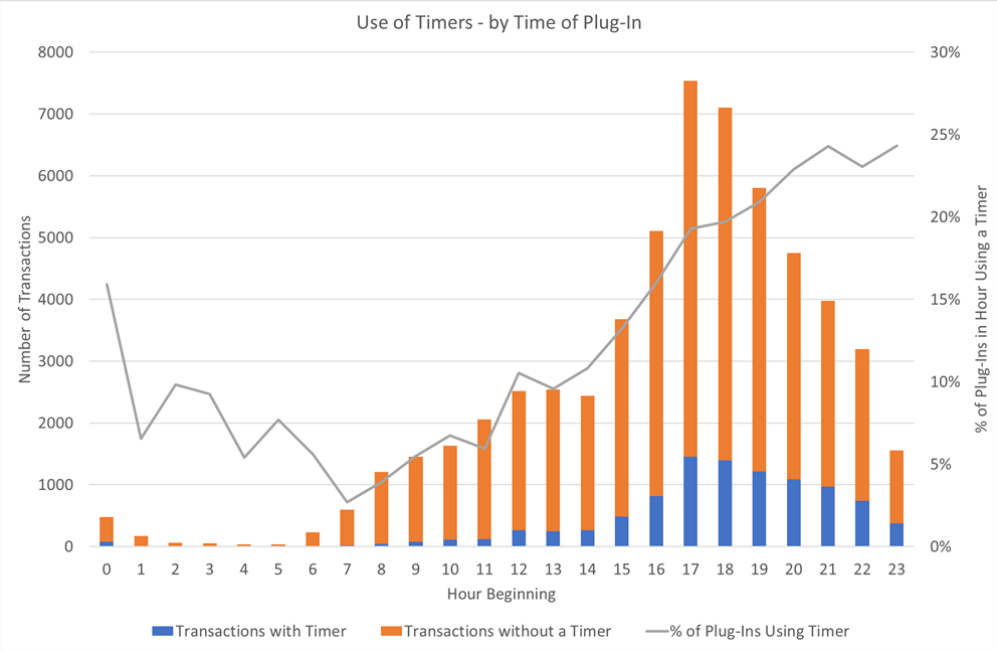


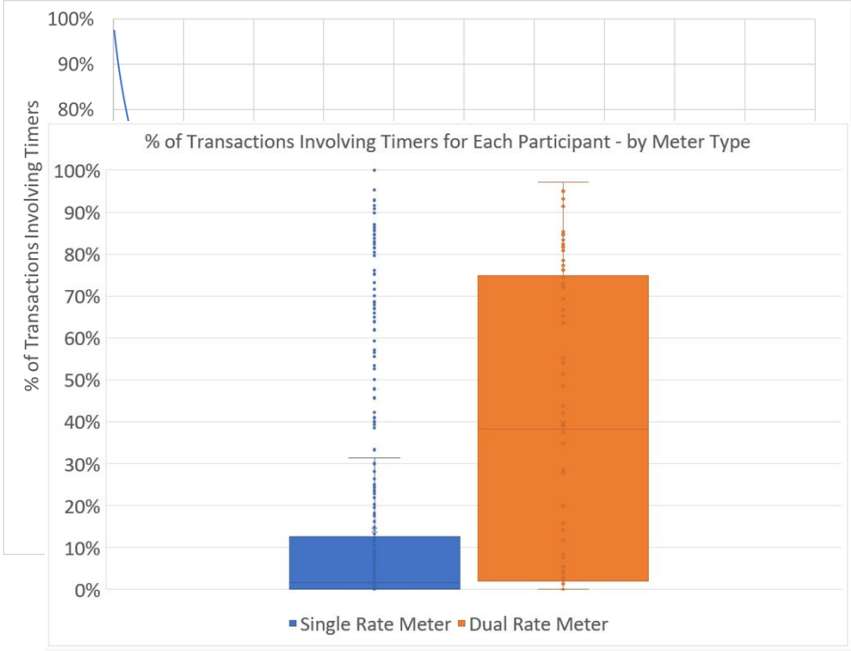
How are they using the CrowdCharge App?

Data Entry	Number of Entries (from 127 participants)	Number of Participants Entering Information at Least Once
Regular Journeys	145	52
One Off Journeys	84	32
State of Charge	485	70
Total	**714**	**21 participants have entered all three types of information**



Economy 7 usage within trial

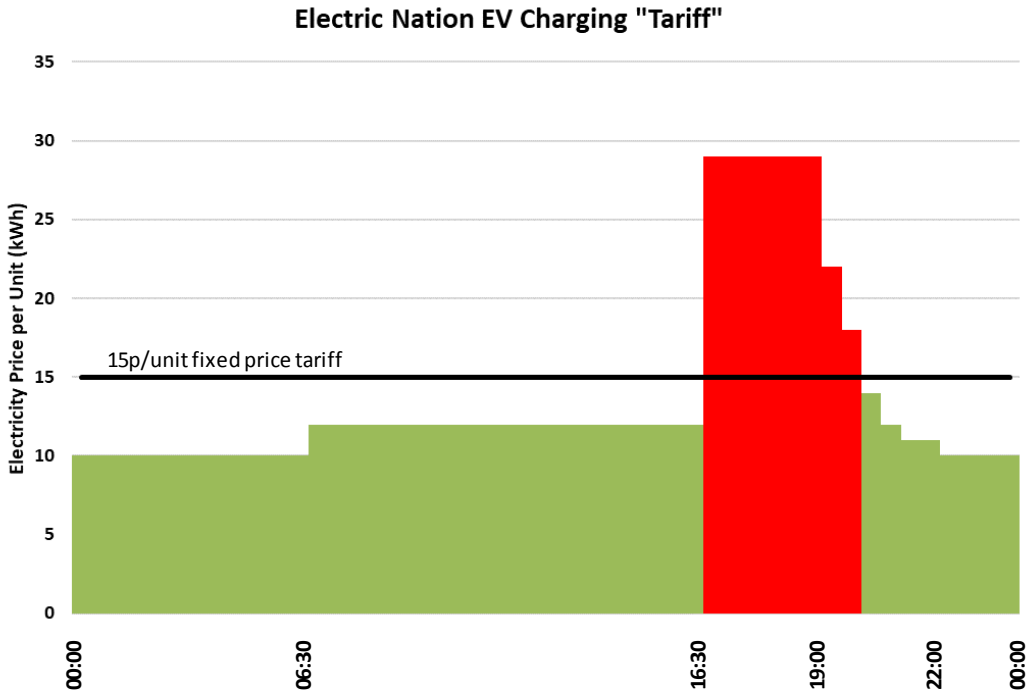




How to Incentivise People to accept Smart Charging?

& Does it Work?

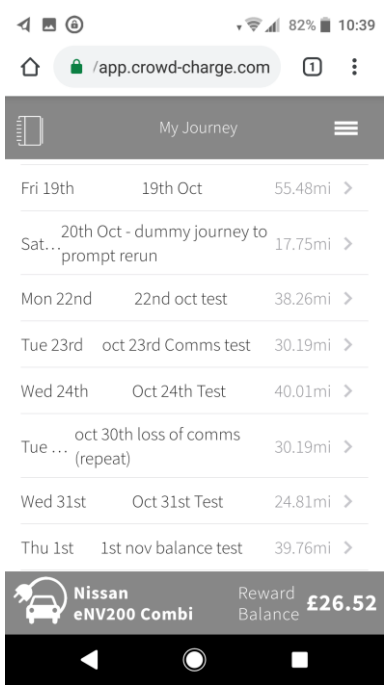
- Many ways this could be done
- Already see a significant proportion of trial participants taking advantage of Economy 7 type tariffs
- We chose a Time of Use Tariff to test in 2nd generation apps

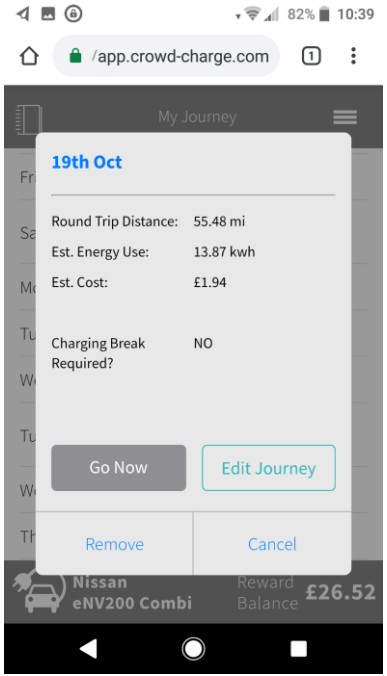


CrowdCharge 2nd Generation App

- Very similar user interface
- Requires driver to input journey plans and SOC
  - Otherwise assumes
  - SOC data from a very few EVs fitted with telematics
- Algorithm now balances
  - Given departure time
  - Energy required
  - Energy cost (ToU tariff)
- Reports energy cost and Reward balance

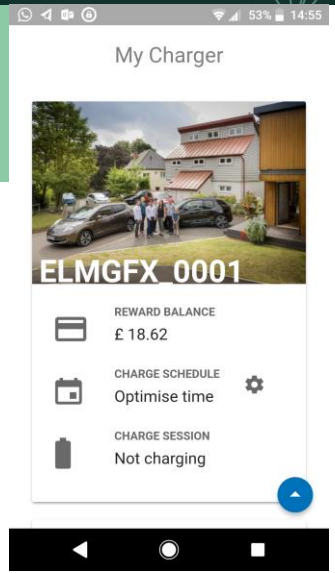
- Launched 6/11/18

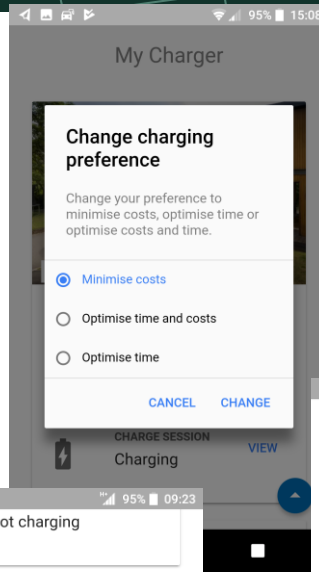


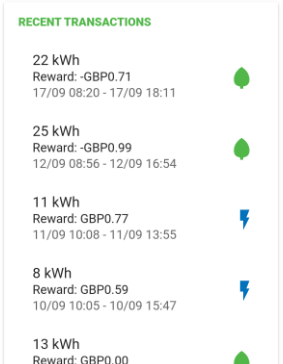


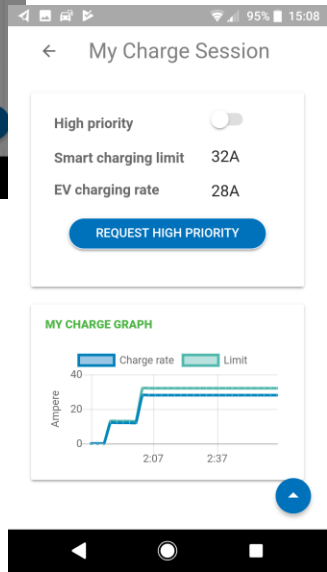
GreenFlux 2nd Generation App

- Includes more information and user options
- Charge Schedule (preference) setting
- Recent transaction records – energy and cost (Reward scheme)
- Current charging session overview and option to request High Priority



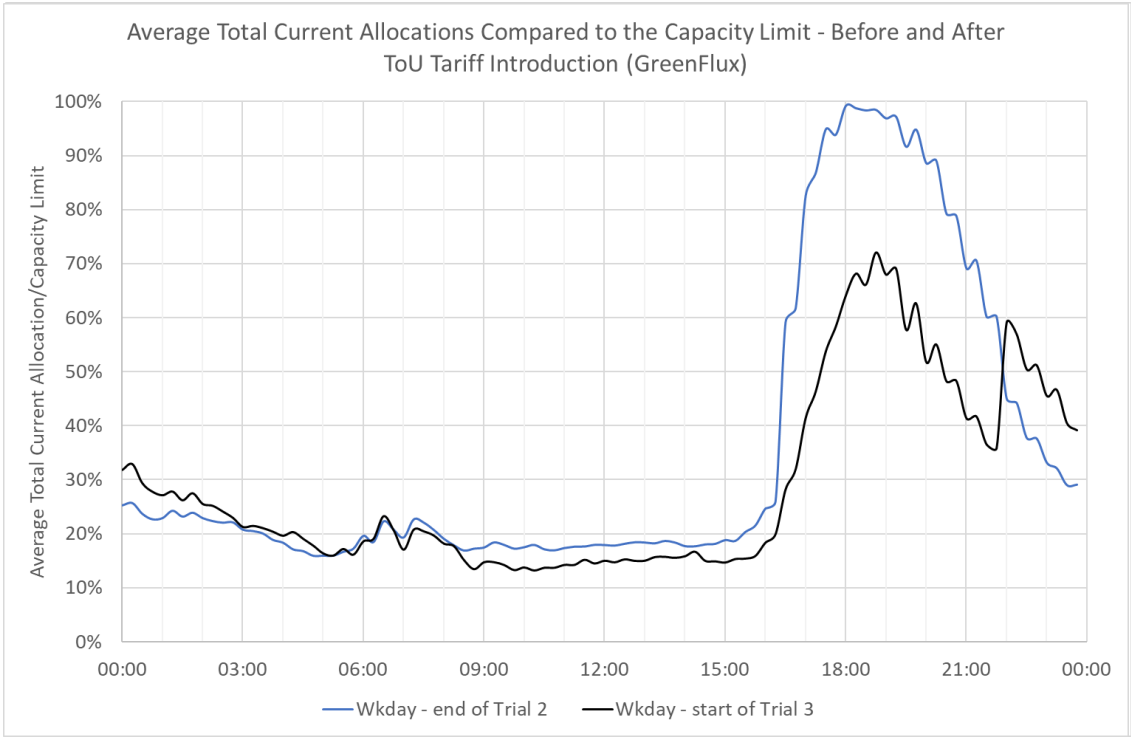






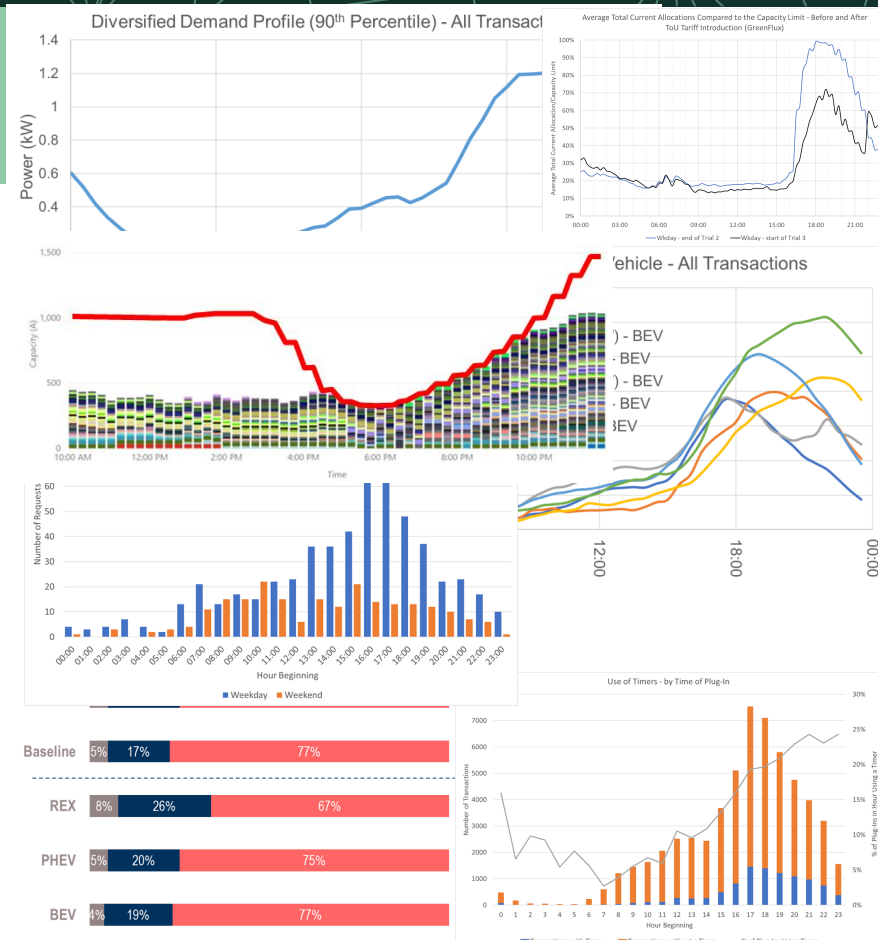
GreenFlux - Very Early Indication…

- No demand management since introduction of updated app with ToU tariff
  - Compared to about 85% of weekdays at 18:00 before
- Customers seem to be making a binary choice
  - Optimise Time & Minimise Cost
- Does create loss of diversity at start of 10pm cheap rate
  - Still well within network capacity
  - But could create problem for generators…



What's Next?

- Complete trial & close down
- Complete customer surveys
- Data analysis and reporting
  - Winter/Spring 2019
- EV load profile development
  - Unconstrained
  - Managed
- Draft Smart Charging Service Specification
- Consult with industry…



Industry Consultation

- Share learning from our Customer Trial
- Present draft specification for a commercial smart charging service for DNOs “Protection of LV networks through EV smart charging”
- Identify opportunities and barriers to industry to provide such a service e.g.
  - Could be an element of a stack of services (+ve)
  - Inter-operability issues (-ve)
- Develop a “road map” from here to a competitive, commercial market offering

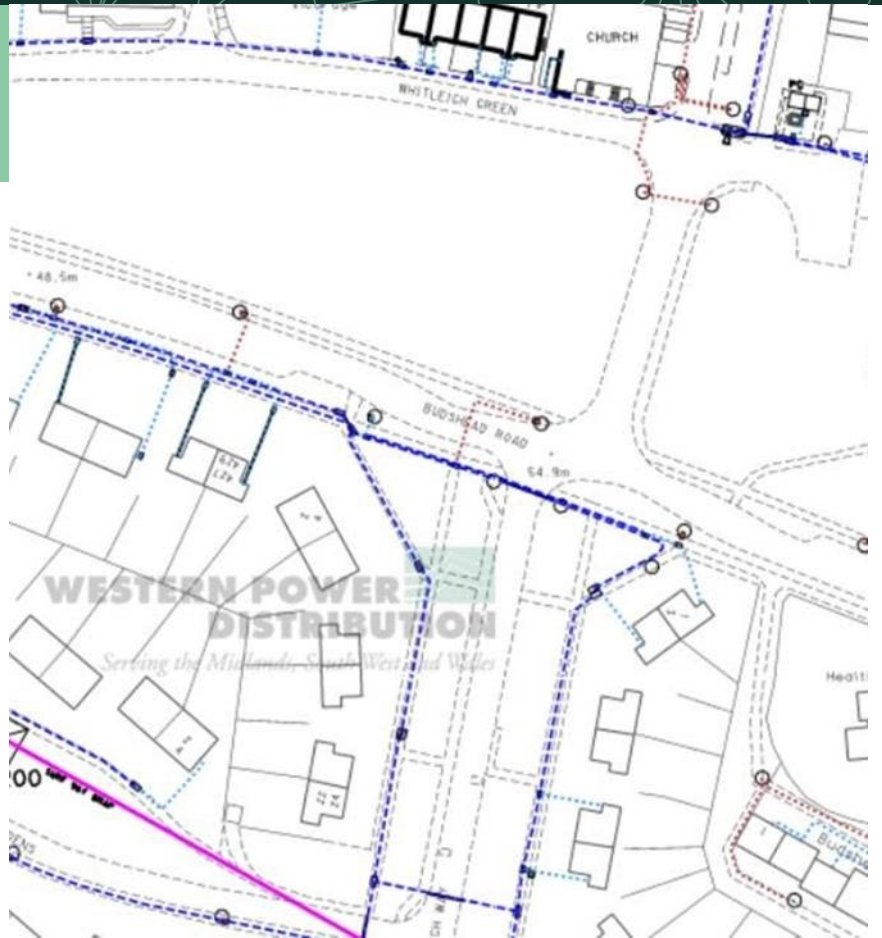
ELECTRIC NATION

YOUR ELECTRIC VEHICLE YOUR SMART CHARGE

NETWORK ASSESSMENT TOOL

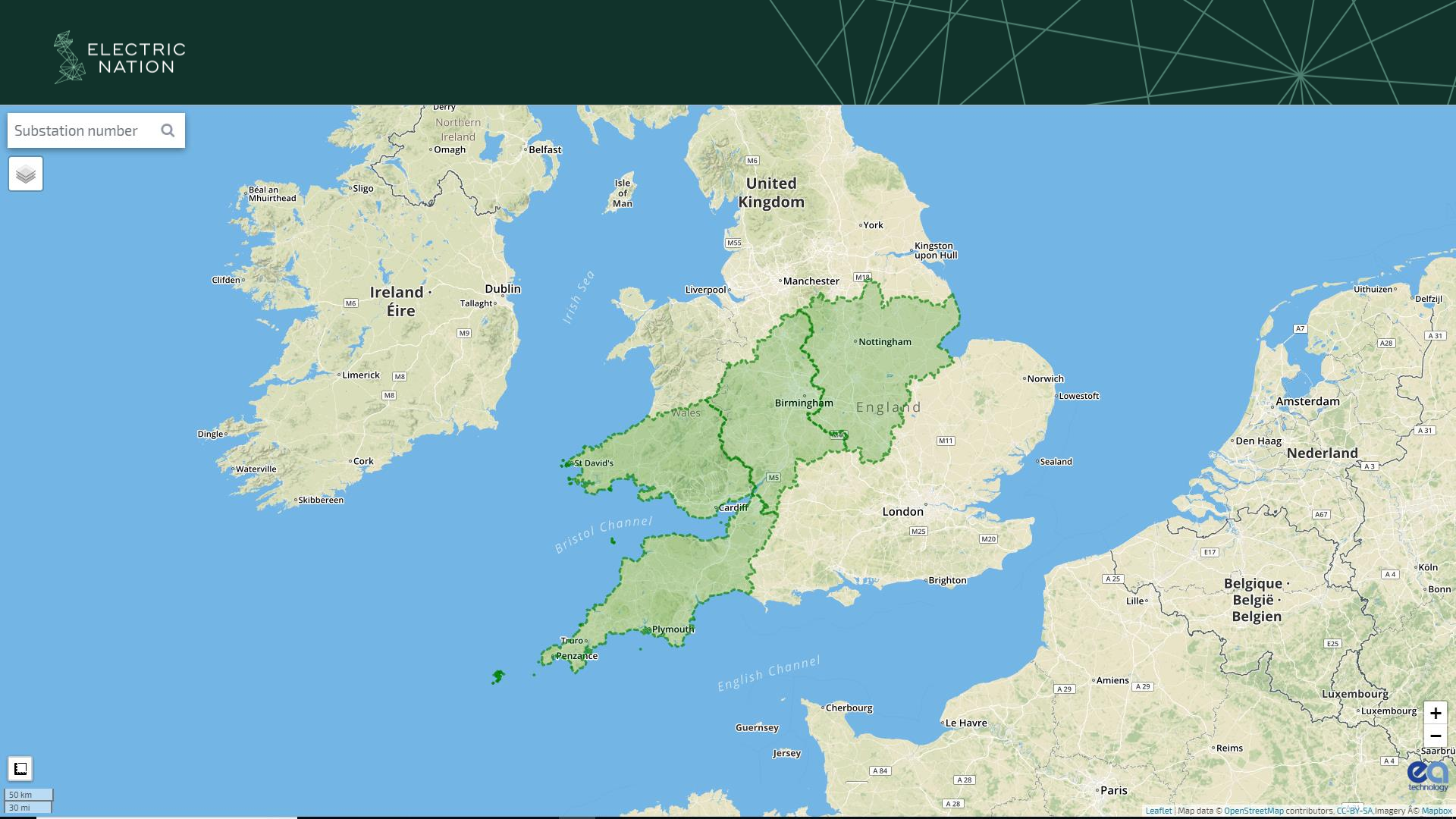
The Problem

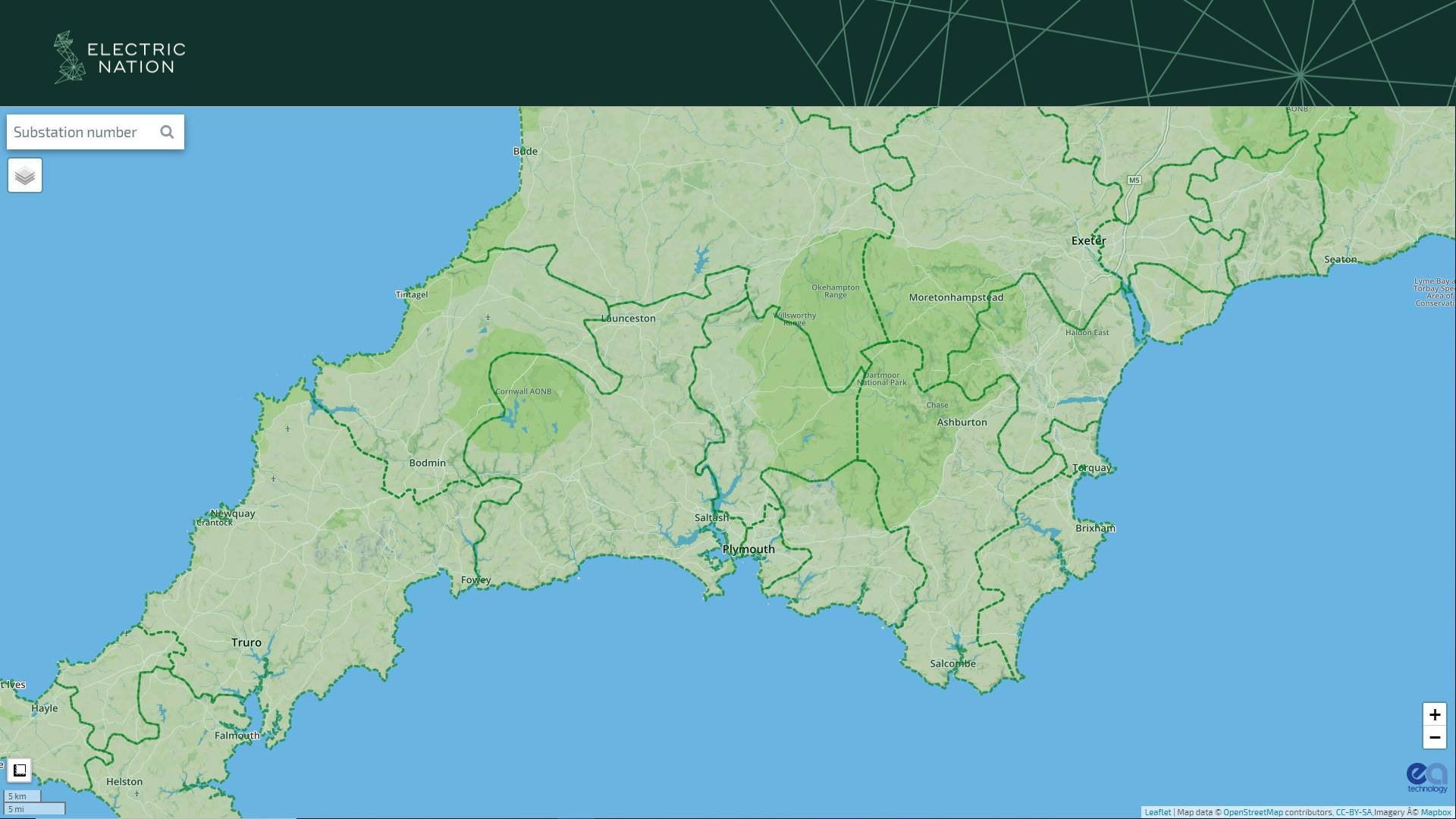
- EV charging will lead to overloads on LV networks
  - In some cases
  - Which will be affected?
- DNOs can’t implement solutions overnight – they need early warning
- Key questions:
  - How many networks will need reinforcement?
  - When will it be needed?
  - Which solution is the most cost effective?
- Answering complex questions usually needs good data



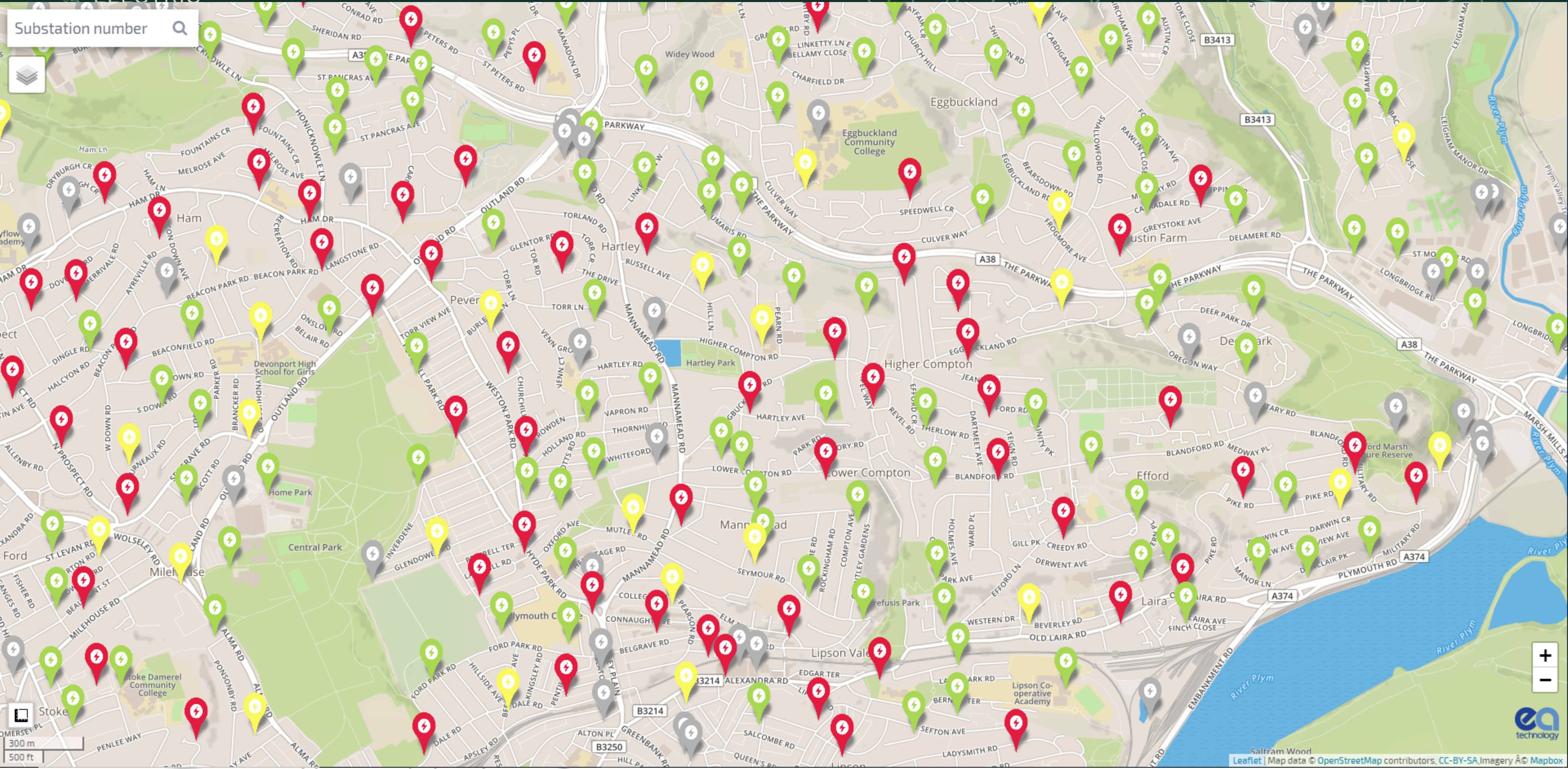
Network Assessment Tool
What is it

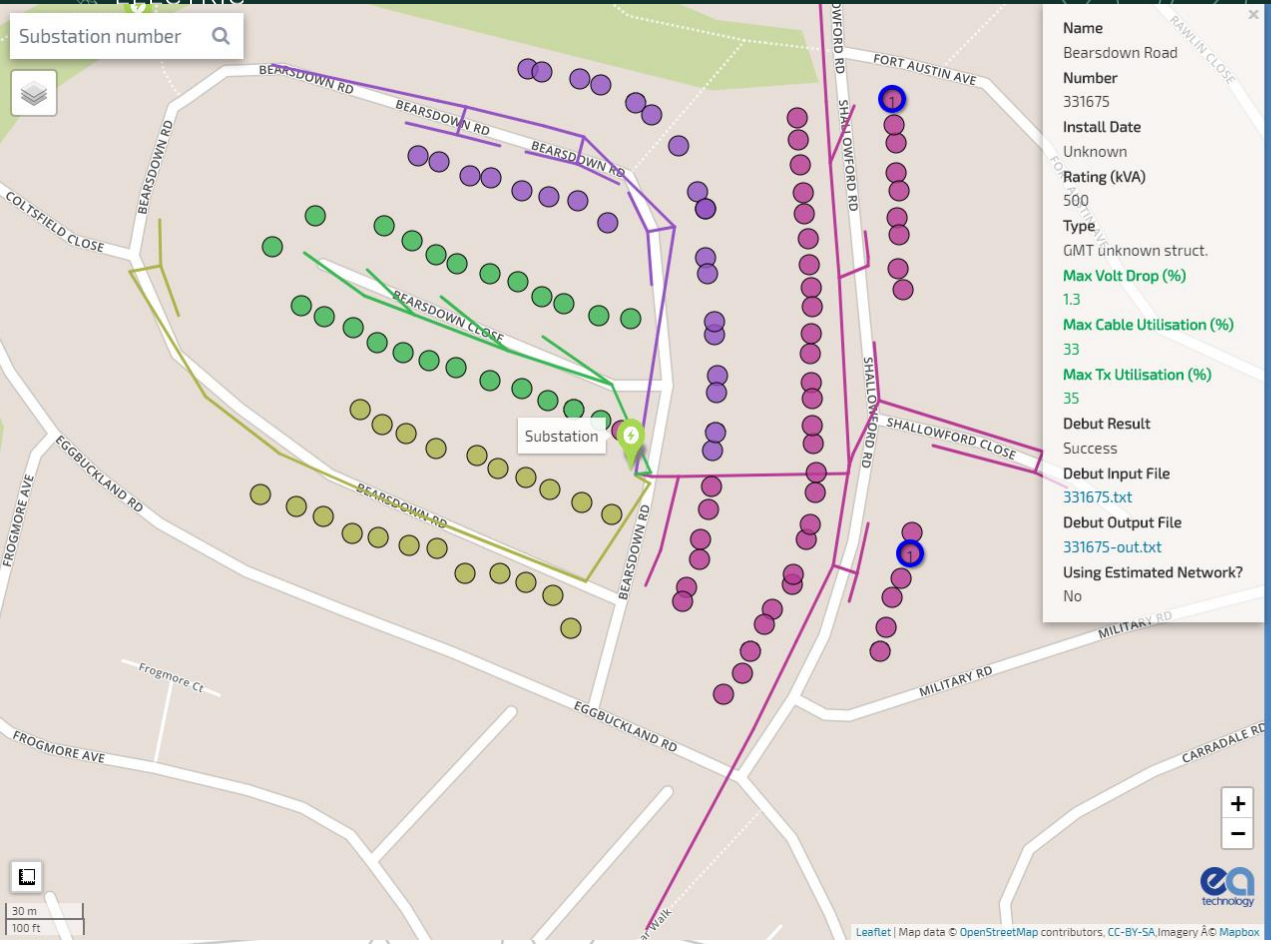
- A modelling tool that can assess:
  - Likelihood of overload and voltage excursion
  - Range of scenarios
    - EV uptake / time
    - Usage characteristics
    - Consumer car choices
- Two main areas:
  1. Network-wide overview
  2. Detailed analysis and solution guidance


ELECTRIC NATION
Substation number
Northern Ireland
Derry
Omagh
Belfast
Sligo
Béal an Mhuirthead
Clifden
Ireland · Éire
Dublin
Tallaght
Limerick
Dingle
Waterville
Cork
Skibbereen
Isle of Man
United Kingdom
York
Kingston upon Hull
Liverpool
Manchester
Irish Sea
Nottingham
Norwich
Lowestoft
Wales
Birmingham
England
St David's
Cardiff
Bristol Channel
Sealand
London
Brighton
Plymouth
Truro
Penzance
English Channel
Guernsey
Jersey
Cherbourg
Le Havre
Amiens
Lille
Reims
Paris
Uithuizen
Delfzijl
Amsterdam
Den Haag
Nederland
Belgique · België · Belgien
Köln
Bonn
Luxembourg
Saarbrü
50 km
30 mi
Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox


ELECTRIC NATION
Substation number
Bude
Tintagel
Launceston
Okehampton Range
Hillsworthy Range
Moretonhampstead
Exeter
M5
Seaton
Haldon East
Dartmoor National Park
Chase
Ashburton
Torquay
Brixham
Cornwall AONB
Bodmin
Newquay
Crantock
Saltash
Plymouth
Fowey
Truro
Salcombe
Hayle
Falmouth
Helston
5 km
5 mi
Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox

ELECTRIC

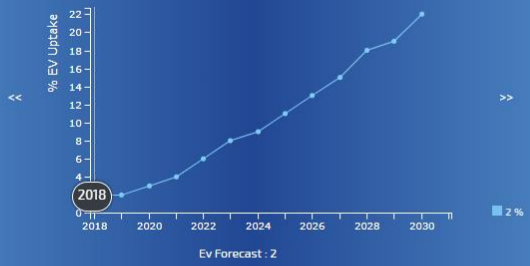

Substation number
Eggbuckland
Eggbuckland Community College
Widey Wood
Hartley
Hartley Park
Ham
Higher Compton
Lower Compton
Efford
Laira
Central Park
Home Park
Lipson Vale
Devonport High School for Girls
Stoke Damerel Community College
Lipson Co-operative Academy
THE PARKWAY
A38
B3413
A374
B3214
B3250
River Plym
Saltram Wood
300 m
500 ft
Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery Â© Mapbox
ea technology



Name
Bearsdown Road
Number
331675
Install Date
Unknown
Rating (kVA)
500
Type
GMT unknown struct.
Max Volt Drop (%)
1.3
Max Cable Utilisation (%)
33
Max Tx Utilisation (%)
35
Debut Result
Success
Debut Input File
331675.txt
Debut Output File
331675-out.txt
Using Estimated Network?
No

BEARSDOWN ROAD (331675)

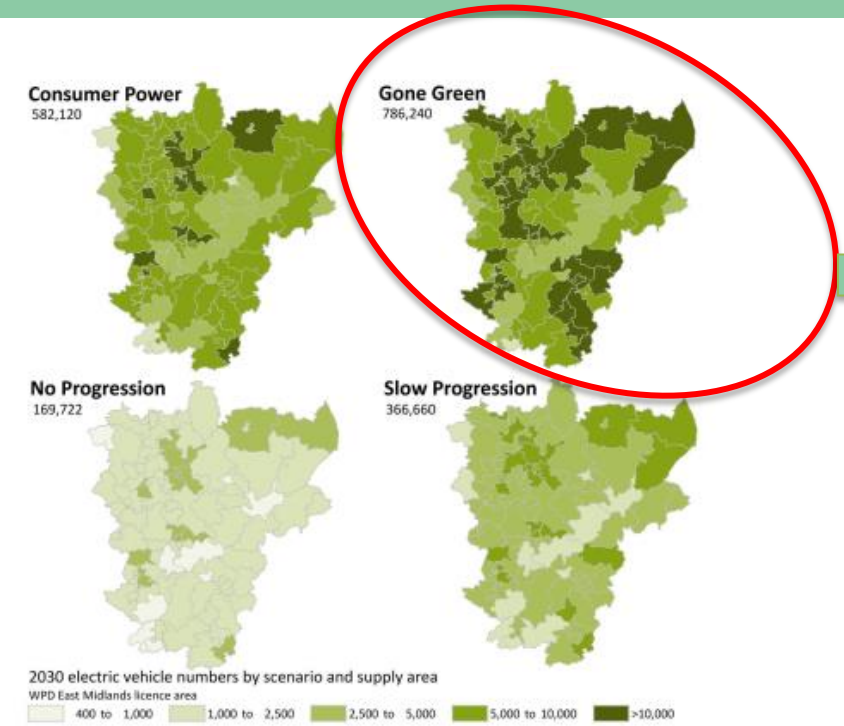
Forecast | Manual



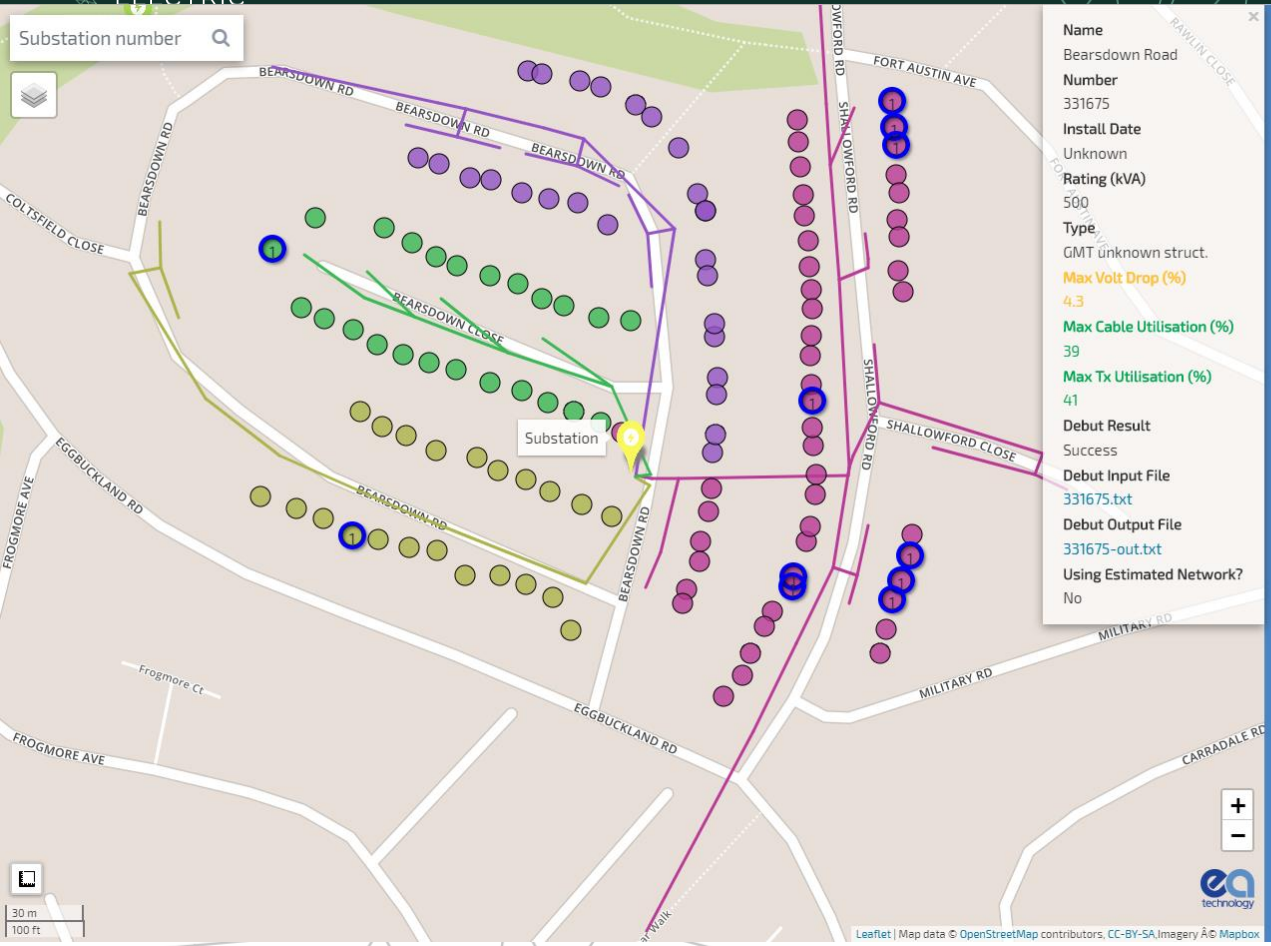
Ev Forecast : 2

	Max Utilisation (%)		Max Volt Drop (%)	
	2018	2018	2018	2018
Substation	35	35	-	-
Feeder 10	33	33	1.3	1.3
Feeder 20	16	16	0.6	0.6
Feeder 30	18	18	0.9	0.9
Feeder 40	16	16	0.8	0.8

EV Uptake Forecasting
Based on Regen forecasts for WPD



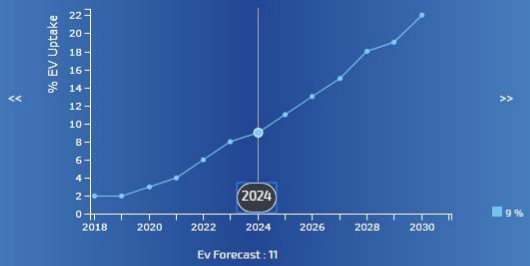
- From ESA level
- To substations
- Then customers
  - For each year 2018-2030
- Recognising
  - Household wealth
  - House type
  - Vehicle ownership
  - Rural/urban setting



Name
Bearsdown Road
Number
331675
Install Date
Unknown
Rating (kVA)
500
Type
GMT unknown struct.
Max Volt Drop (%)
4.3
Max Cable Utilisation (%)
39
Max Tx Utilisation (%)
41
Debut Result
Success
Debut Input File
331675.txt
Debut Output File
331675-out.txt
Using Estimated Network?
No

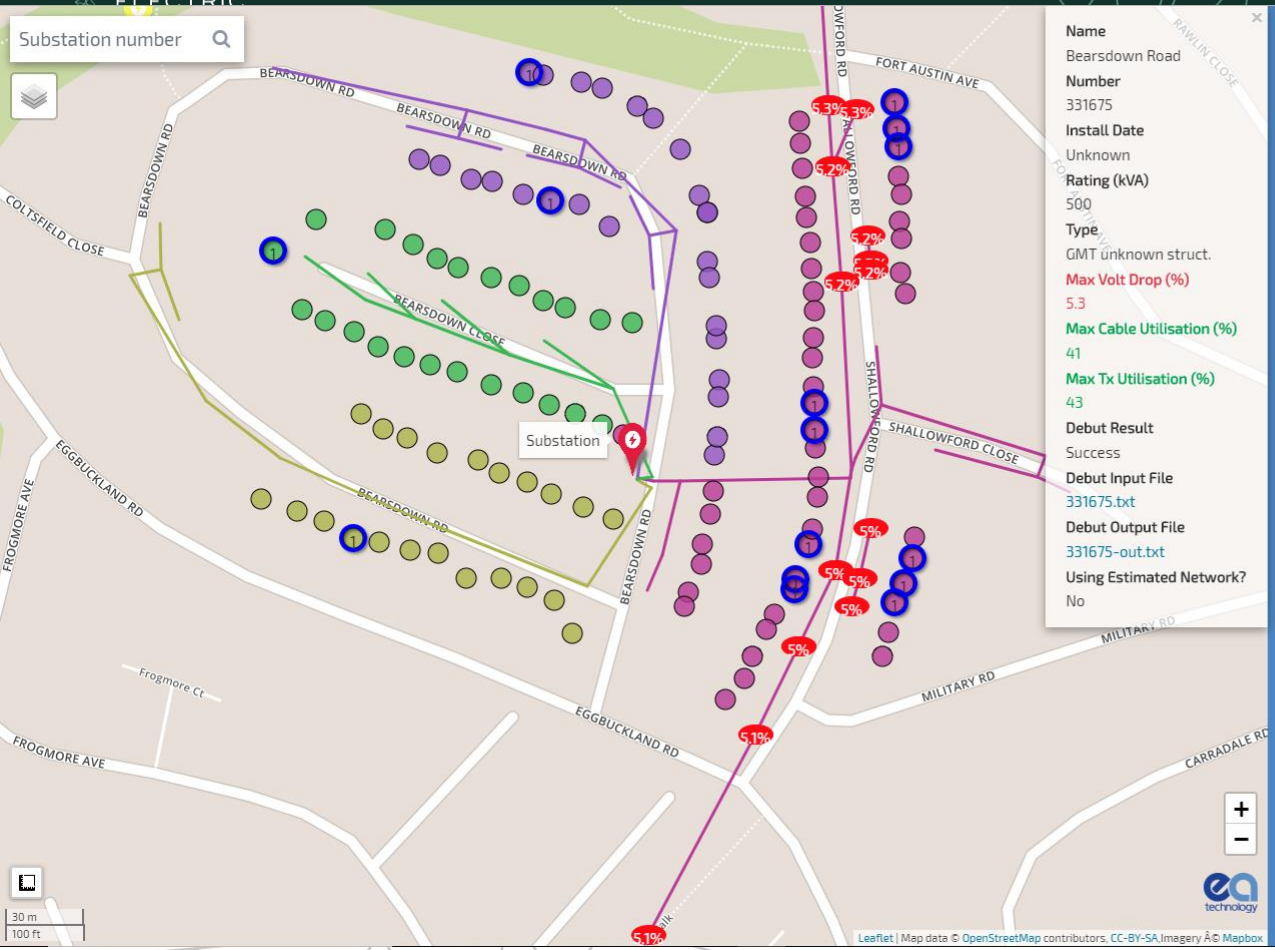
BEARSDOWN ROAD (331675)

Forecast | Manual



Ev Forecast : 11

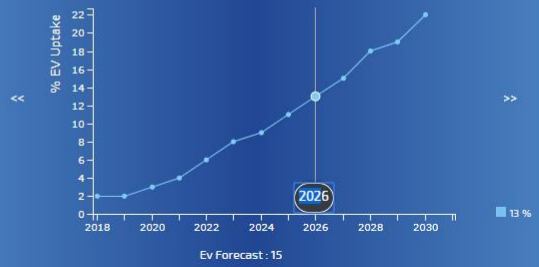
	Max Utilisation (%)		Max Volt Drop (%)	
	2018	2024	2018	2024
Substation	35	41	-	-
Feeder 10	33	39	1.3	4.3
Feeder 20	16	22	0.6	3.6
Feeder 30	18	24	0.9	3.9
Feeder 40	16	22	0.8	3.8



Name
Bearsdown Road
Number
331675
Install Date
Unknown
Rating (kVA)
500
Type
GMT unknown struct.
Max Volt Drop (%)
5.3
Max Cable Utilisation (%)
41
Max Tx Utilisation (%)
43
Debut Result
Success
Debut Input File
331675.txt
Debut Output File
331675-out.txt
Using Estimated Network?
No

BEARSDOWN ROAD (331675)

Forecast | Manual



Ev Forecast : 15

	Max Utilisation (%)		Max Volt Drop (%)	
	2018	2026	2018	2026
Substation	35	43	-	-
Feeder 10	33	41	1.3	5.3
Feeder 20	16	24	0.6	4.6
Feeder 30	18	26	0.9	4.9
Feeder 40	16	24	0.8	4.8

ELECTRIC NATION

113208

Length
2
Type
HYBRID 25
Source
LvRoute
Computed Substation Number
113208
Computed Feeder Number
21
ID
3275012
DEBUT Cable Type
HYBRID 25
Rating (A)
100
Max Current (A)
100
Max Utilisation (%)
100

Segment

GILBERT RD

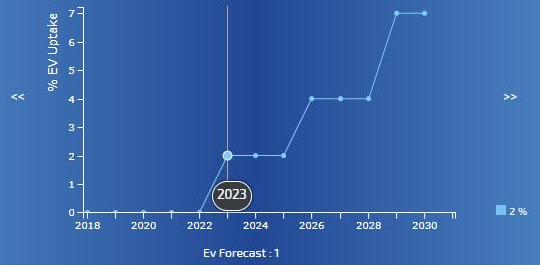
GILBERT RD

GILBERT RD

GILBERT RD

KINGSWOOD SHOP CENT (113208)

Forecast | Manual

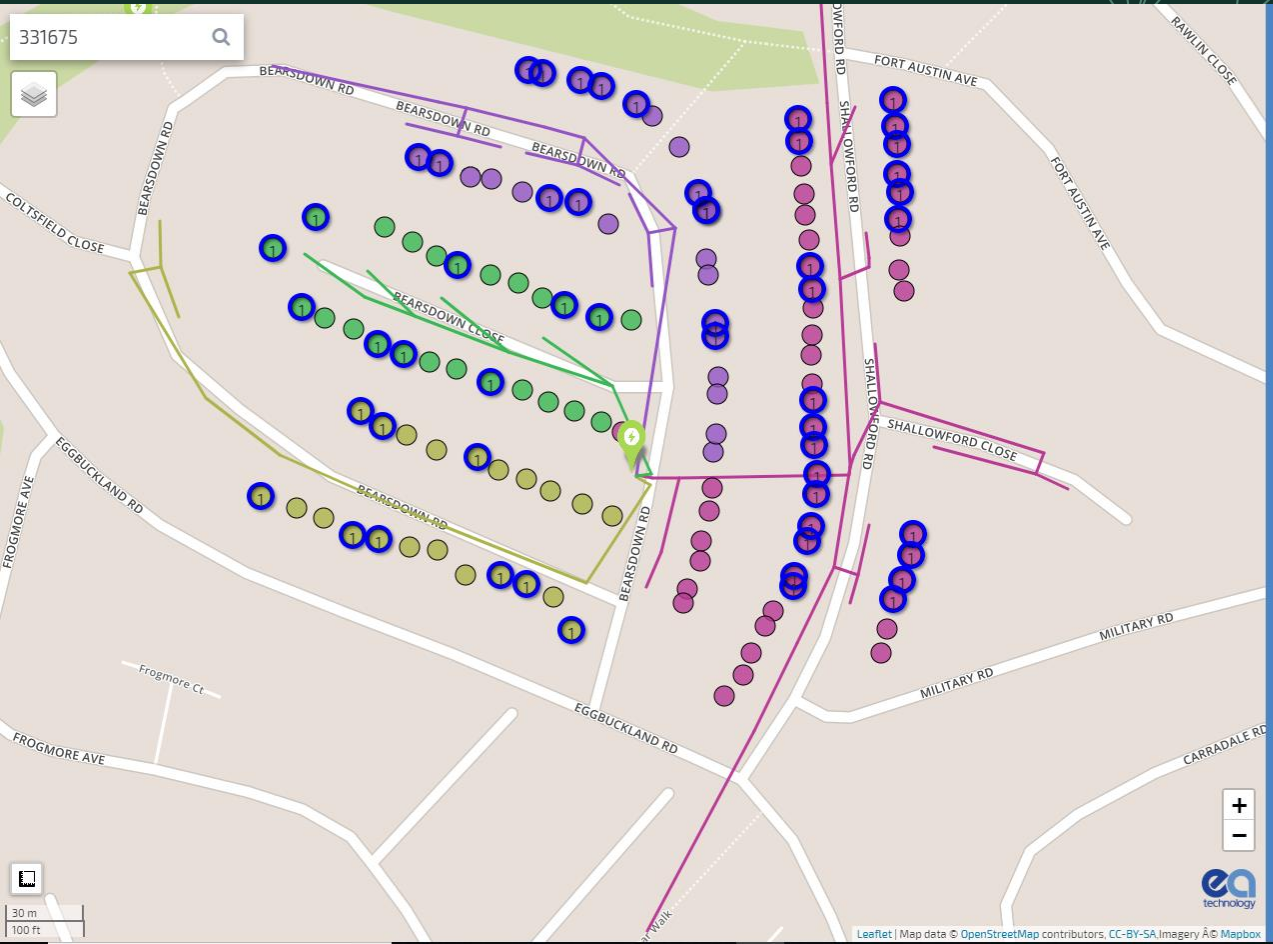


Ev Forecast : 1

	Max Utilisation (%)		Max Volt Drop (%)	
	2018	2023	2018	2023
Substation	11	16	-	-
Feeder 21	95	100	3	5.5
Feeder 31	32	37	3	5.5

3 m
10 ft

ELECTRIC NATION



BEARSDOWN ROAD (331675)

Forecast | **Manual**

Number of EVs

55

45%

Calculate

	Max Utilisation (%)		Max Volt Drop (%)	
	2018	45%	2018	45%
Substation	35	63	-	-
Feeder 10	33	67	1.3	7.1
Feeder 20	16	39	0.6	6.5
Feeder 30	18	45	0.8	8.2
Feeder 40	16	37	0.9	6.9

What's Next?

Immediate future:

- Major recalculation (about a week!)
  - Ca. 200,000 LV substations and networks
- Updates and improvement to mapping and network assessment routines
- Use interim EV load profile to assess network impacts for 2018-2030
  - Ca. 2,000,000 network assessments
- Enable "Manual" network assessment

Longer Term:

- Implement "confidence ratings" to assessments
- Specify & develop
  - "strategic overview" module
  - Data/mapping error report module
  - "solutions assessment module"

ELECTRIC NATION

YOUR ELECTRIC VEHICLE YOUR SMART CHARGE

THANK YOU

rduke@westernpower.co.uk

nick.storer@eatechnology.com

WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Refreshments Break

Served in Ballroom Suite 2

Resume at 11:40pm

WESTERN POWER DISTRIBUTION
INNOVATION

EV Panel Session

Making owning an EV simple and easy…

Chair: Merlin Hyman - Regen

Panellists:

Joscelyn Terrell – OLEV

Alex Minshull – Bristol City Council

Mike Potter – Drive Electric

Paul Jewell - WPD

WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Lunch

Served in Ballroom Suite 2

Resume at 13:00pm

WESTERN POWER DISTRIBUTION

INNOVATION

NEXT GENERATION NETWORKS

LV Connect & Manage

Balancing Act Conference
21st November 2018

Samuel Jupe
Network Innovation Manager (Nortech)

Overview

- Background, Outline, Objectives and Benefits
- Solution Architecture and DLC Box Design
- Hereford Depot: Equipment Installations and Trials
- Site Selection, Customer Engagement and Customer Installations
- Live Trials of LCT equipment in Customers' Homes
- Learning Outcomes, Dissemination Activities and Next Steps

Project Background

Low carbon technologies (LCT) connections on LV network:

- Trend for clustering of LCTs
- Hard to predict and plan ahead reinforcement
- Traditional reinforcement is expensive and takes time
- Delayed customers' connections
- Reverse Power Flow (RPF) impact on distribution network

Project Outline

- £1.7m NIA project (April 2016 - March 2019)
- Ability to provide more power during non – peak hours
- Bi-directional power flow control via “Domestic Load Controller” (DLC) hardware
- Accelerate connection of LCTs (storage, EVs, heat pumps)
- Protect WPD assets from overload
- 6 distribution substations and 100 customers in Furzton, Milton Keynes (Energy Storage) and West Bridgford, Nottingham (EV Chargers)

Customer Propositions	2016	2017	2018	2019	2020	2021	2022	2023	Cost (£m)
DSR products by customer segment									0.5
DSM tariff structure									0.5
Alternative Connection Agreements									2
Managed Connection Agreements									0.5
Settlement and Billing									2

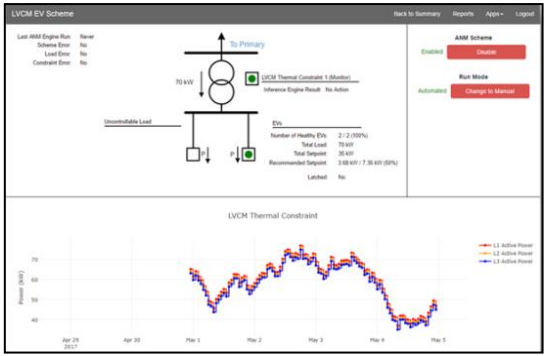
Project Objectives

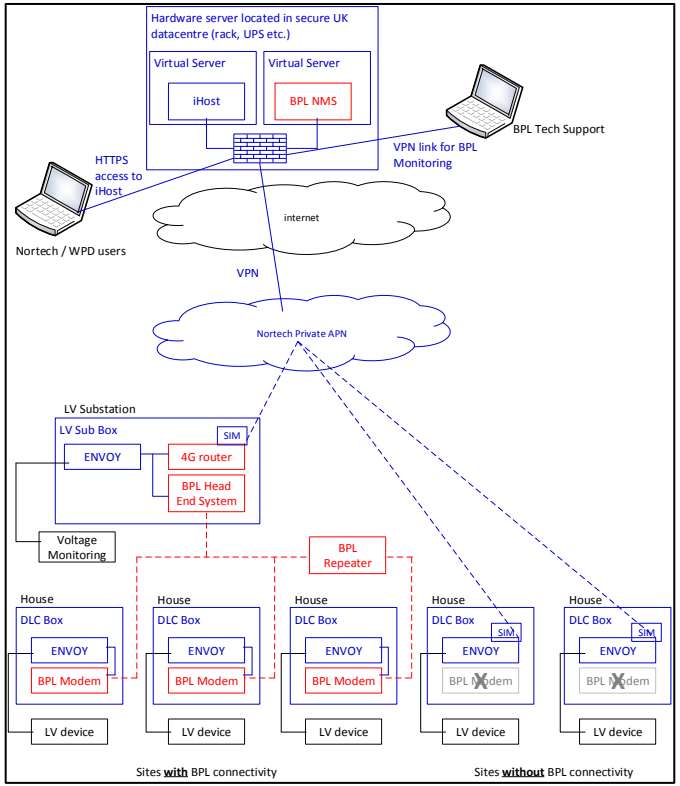
1. Smart ANM solution for LV networks
2. Load management as an alternative to network reinforcement
3. BPL communication - Broadband over powerline (substation into customers' homes)
4. New business processes, which can be quickly and cost effectively deployed

Customer Benefits

1. Intelligent interface to accelerate connection of LCTs (storage, EVs, heat pumps)
2. Avoid costly reinforcement
3. Reduced amount of street works
4. Provide flexibility to export more power during non – peak hours or/and use stored energy in ‘self consumption’ mode
5. Consume energy in more sustainable, environmentally friendly way, reducing amount of CO_2 emissions

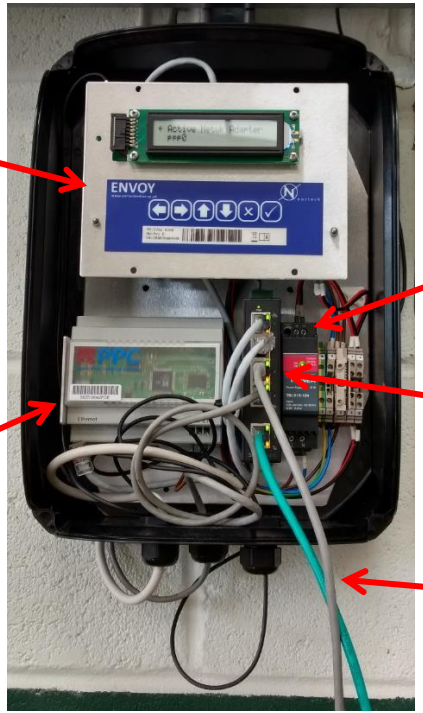
Solution Architecture





Domestic Load Controller (DLC) Box Design

Envoy RTU (controller)



Power supply

Ethernet hub

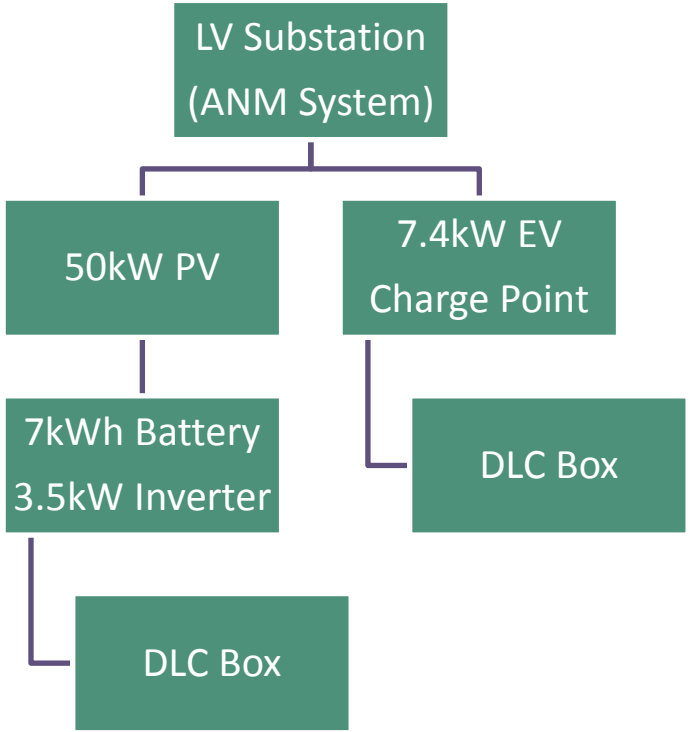
Project-specific communications modem (BPL)

Ethernet connection to controlled device e.g. EV charge point

Hereford Depot Trial Installations

- Trial project solution in real life environment
- De-risked customers installations
- Develop business processes for substation installations

Hereford Depot: Testbed Architecture



DLC Box

Domestic Load Control Box – incorporates modules for load control and communication

Hereford Depot Trial Installation (Part 1)

LV substation installation

Hereford Depot Trial Installation (Part 2)

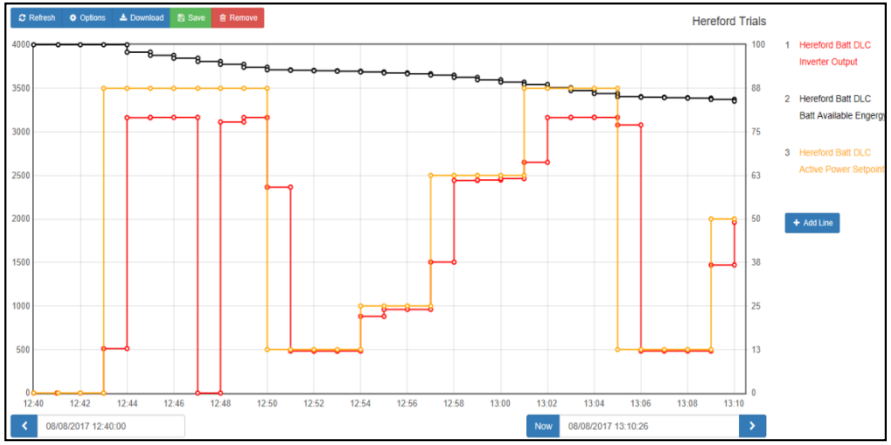
Customer side

PV/battery export limitation

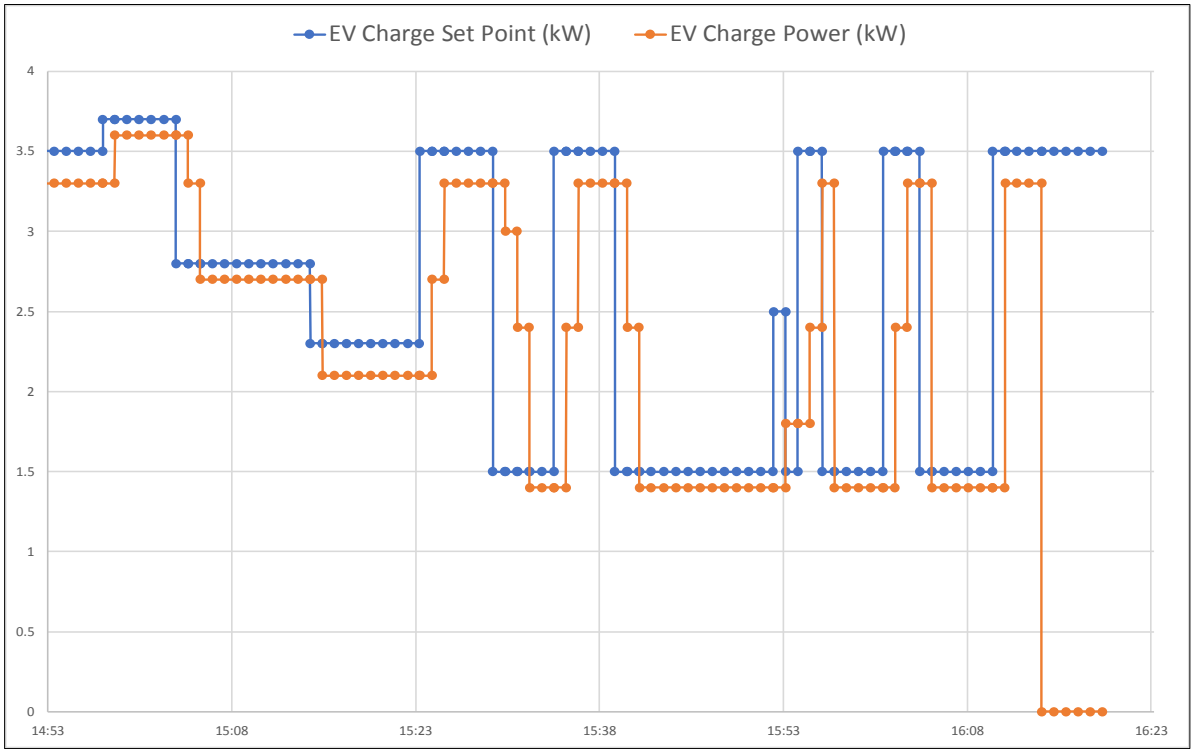
EV charge import limitation

Hereford Depot Trials

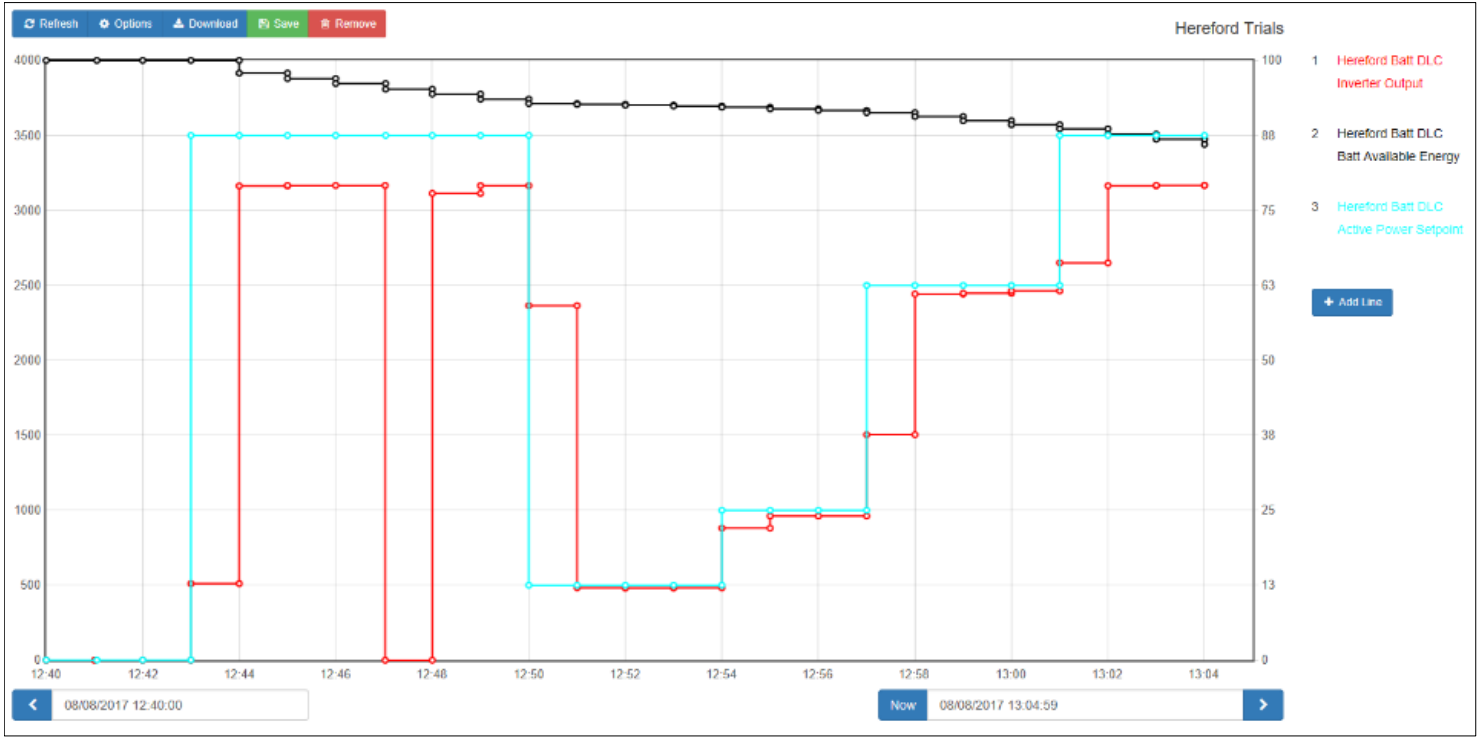
- Technical tests:
  - Proved feasibility to manage EV charging rate (0-16-32A) via BPL/GSM
  - Proved feasibility to manage rate of PV/Energy Storage discharge via BPL/GSM
  - Tested auto failover of communications
  - Confirmed iHost demand / export management



Hereford Depot Trials: EV Charge Management (Import Limitation)



Hereford Depot Trials: PV/Battery Charge Management (Export Limitation)



Site Selection and Customer Engagement

- Control & monitoring equipment is installed in 6 distribution substations:

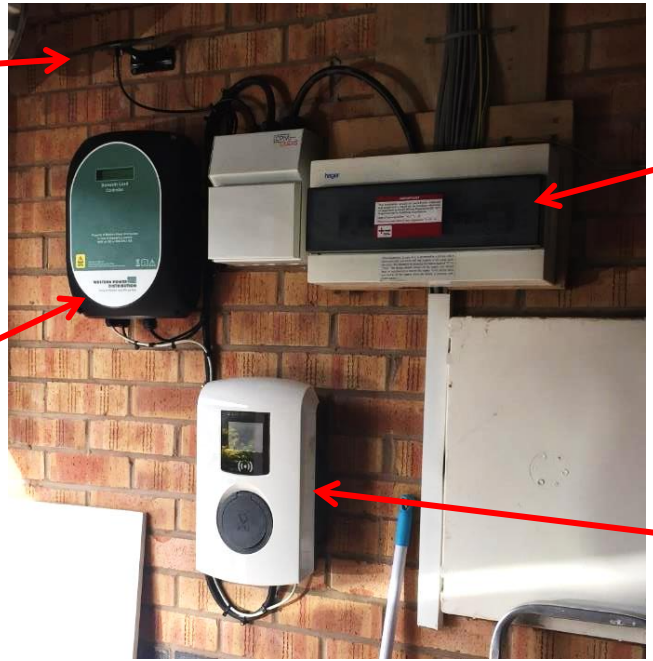
942197	GRASSCROFT BLETCHLEY (FURZTON)	881417	WEST BRIDGFORD RUGBY ROAD
942196	PARKSIDE FURZTON	881418	WEST BRIDGFORD COMPTON ACRES
942183	PERRACOMBE FURZTON	881089	WEST BRIDGFORD HAWTHORNE PARK

- Customers engagement activities:
  - Customer engagement meetings
  - Leaflets
  - Social networks
  - Customer engagement video
  - Website: www.wpdconnectandmanage.co.uk

Project Equipment Installations in Customers' Homes

External GSM antenna

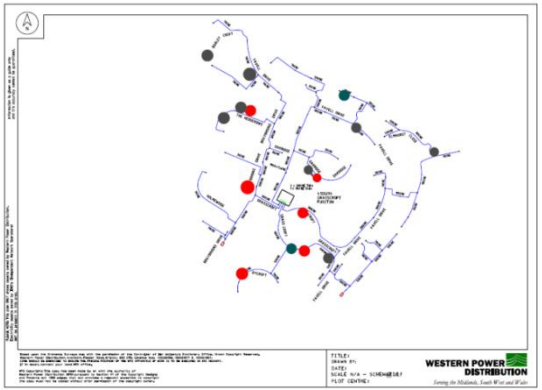
Domestic Load Controller (DLC) box

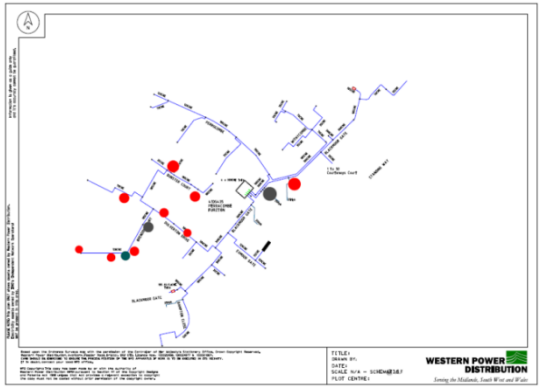


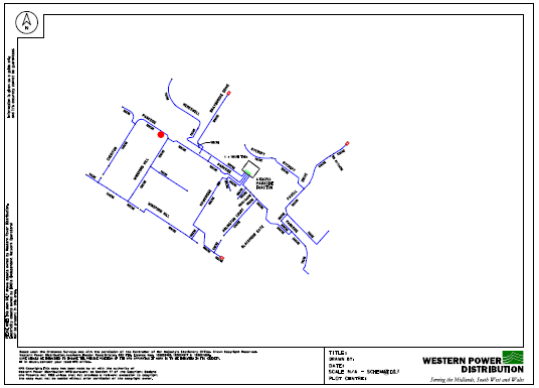
Consumer unit

Charge point under control

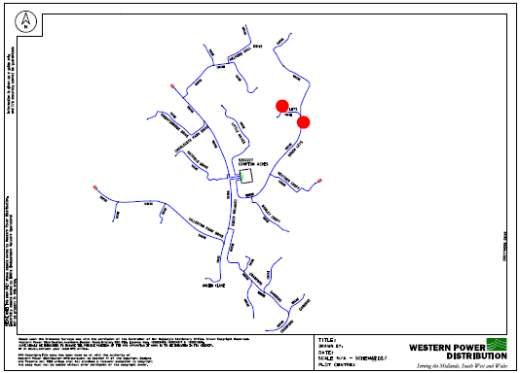
Customer Installations: Milton Keynes Clusters

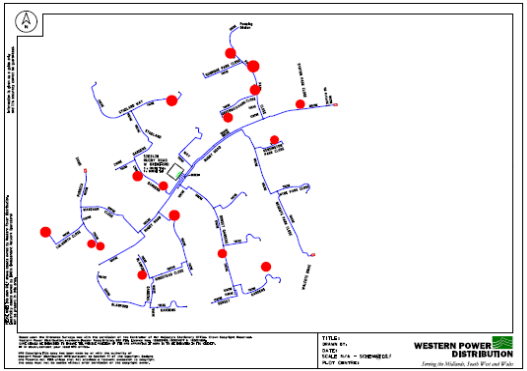


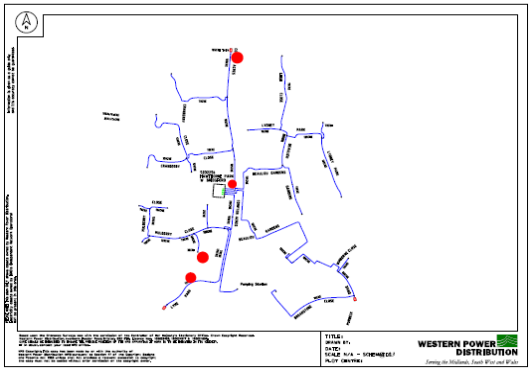




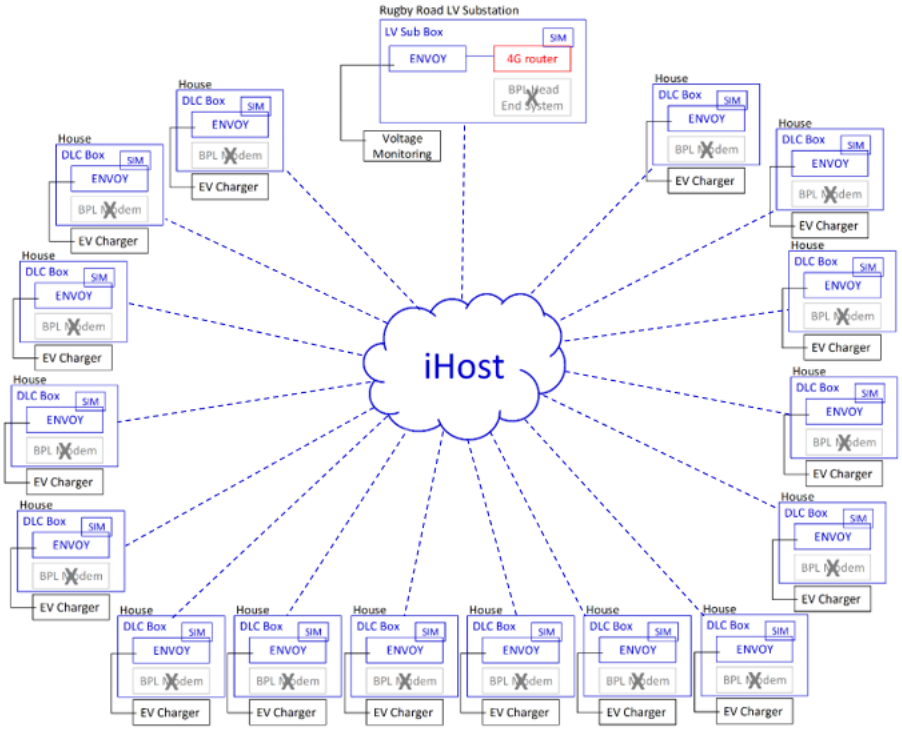
Customer Installations: West Bridgford Clusters

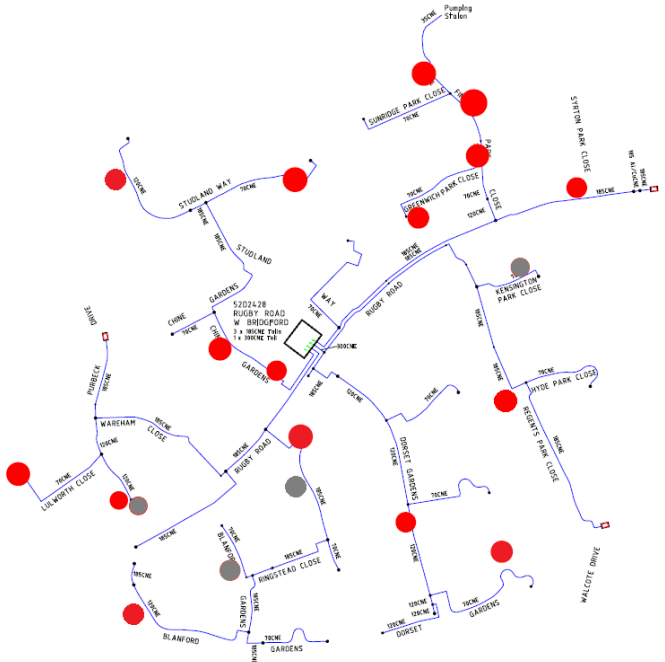






Live Trials: EV Charge Management (Import Limitation)





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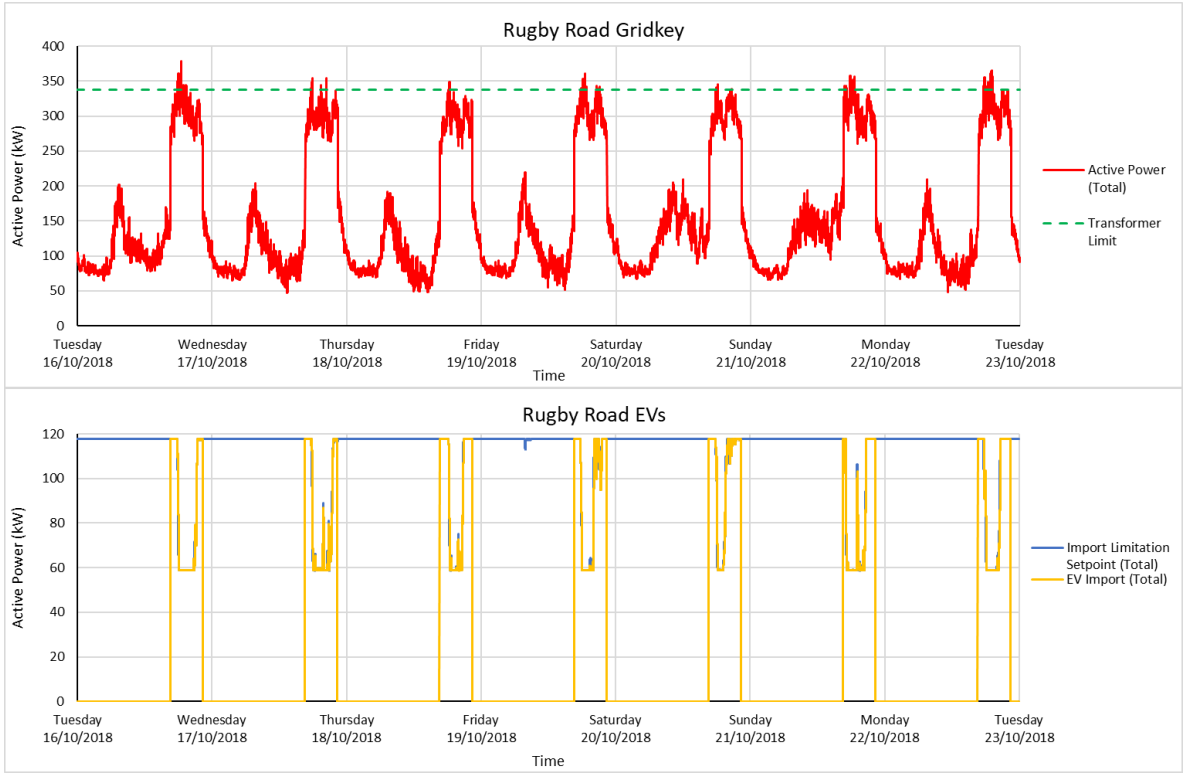

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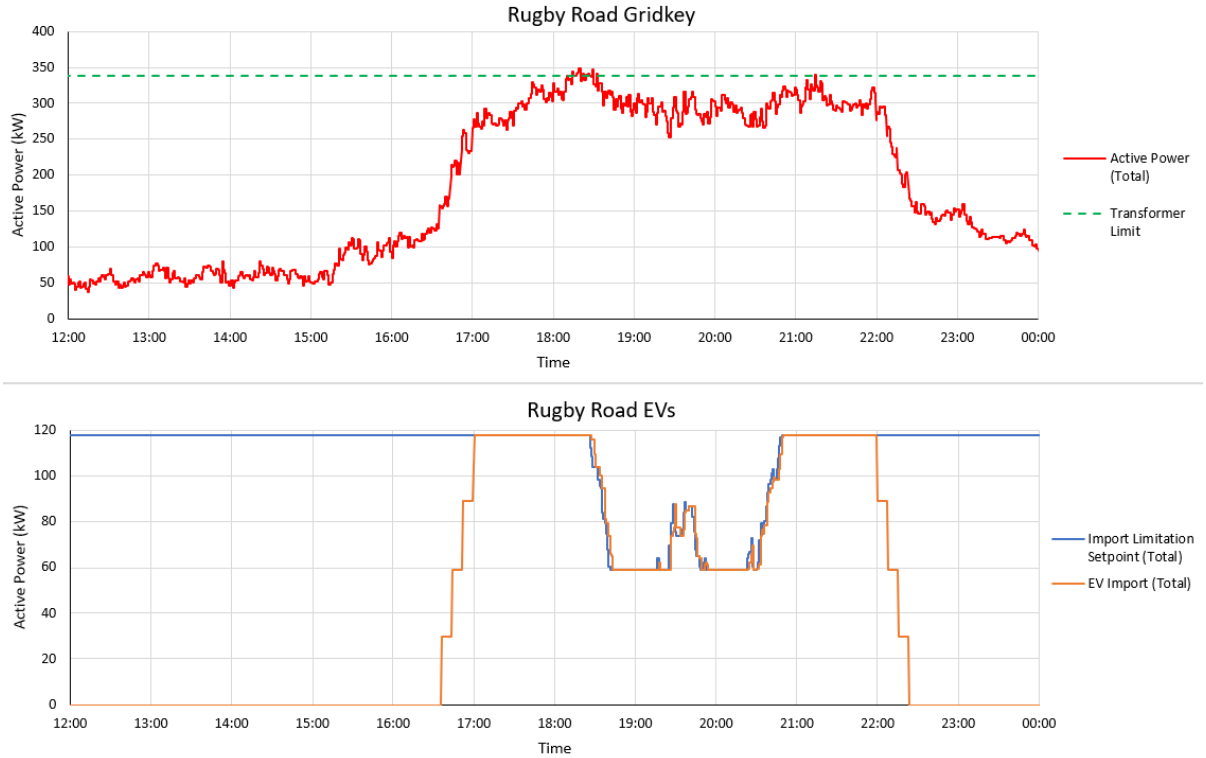
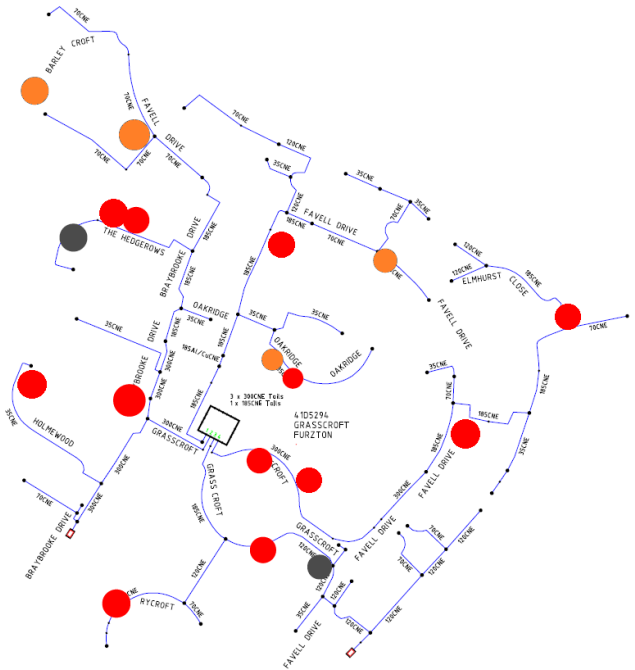
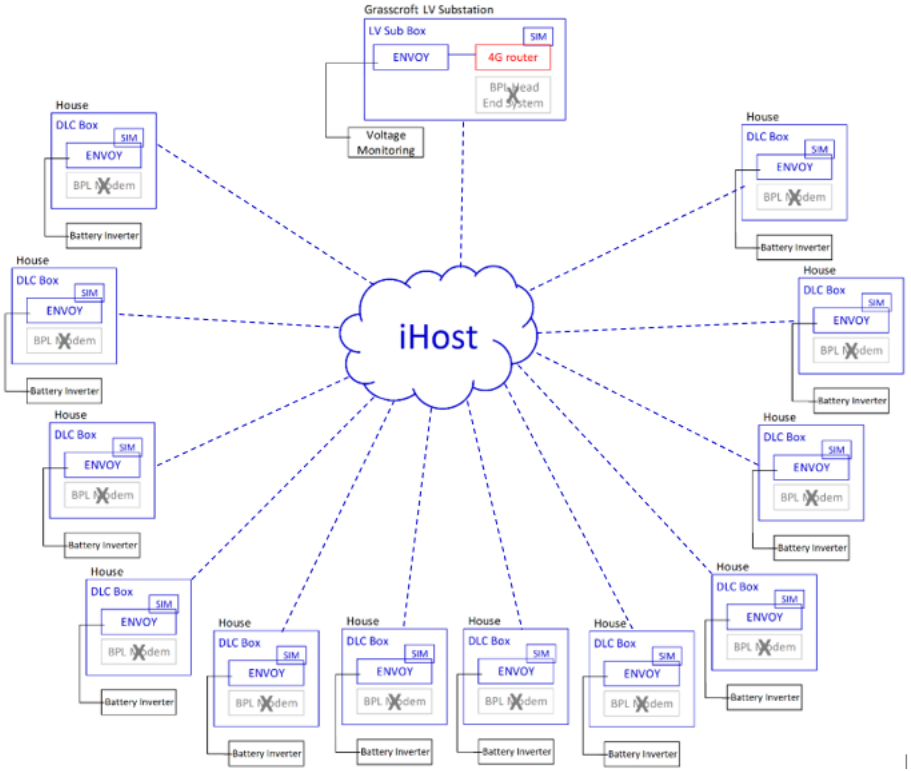
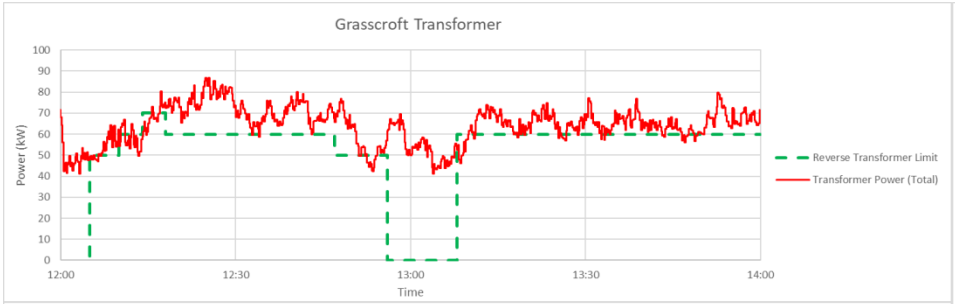


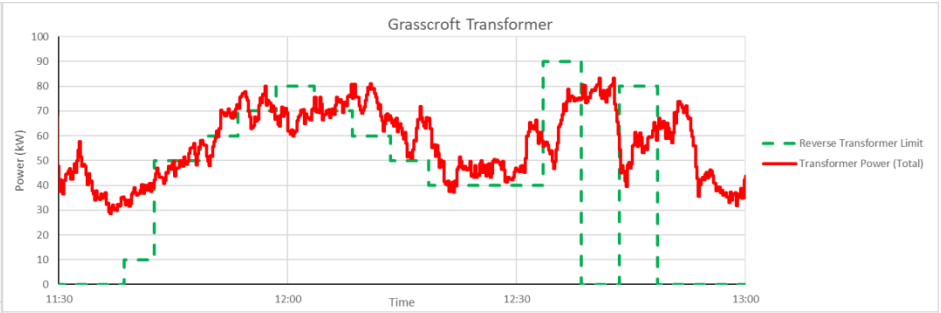
Live Trials: PV/Battery Charge Management (Export Limitation)

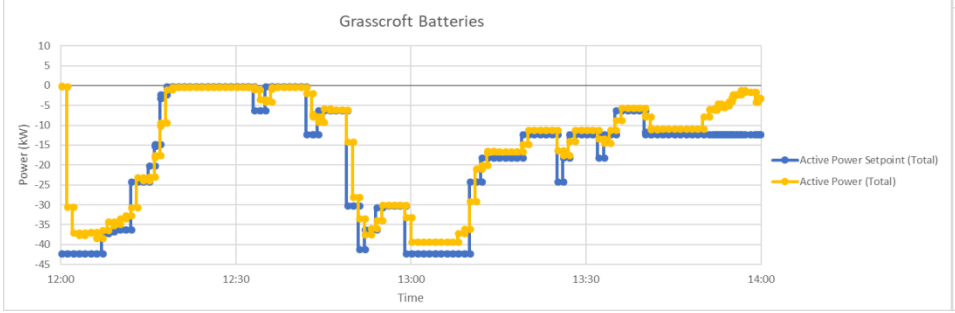


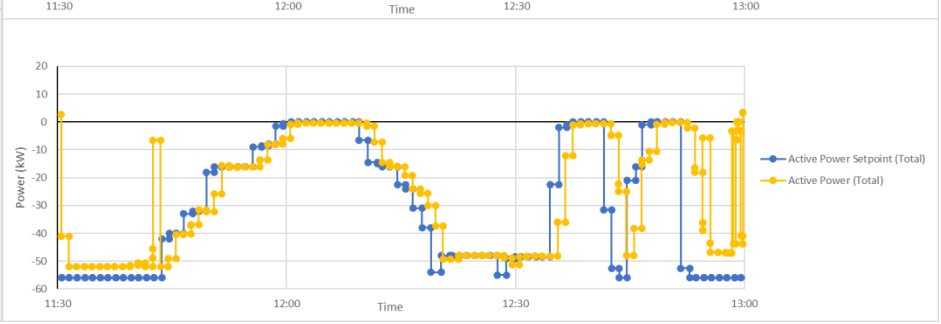


Live Trials: PV/Battery Charge Management (Export Limitation)









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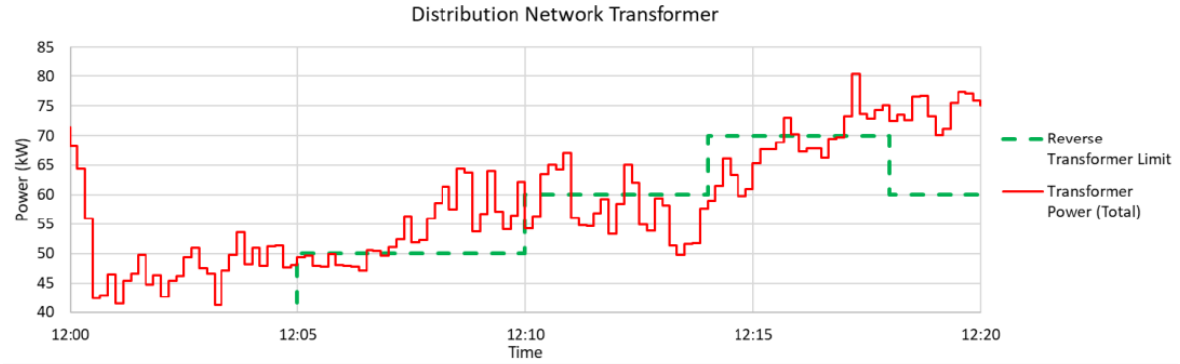
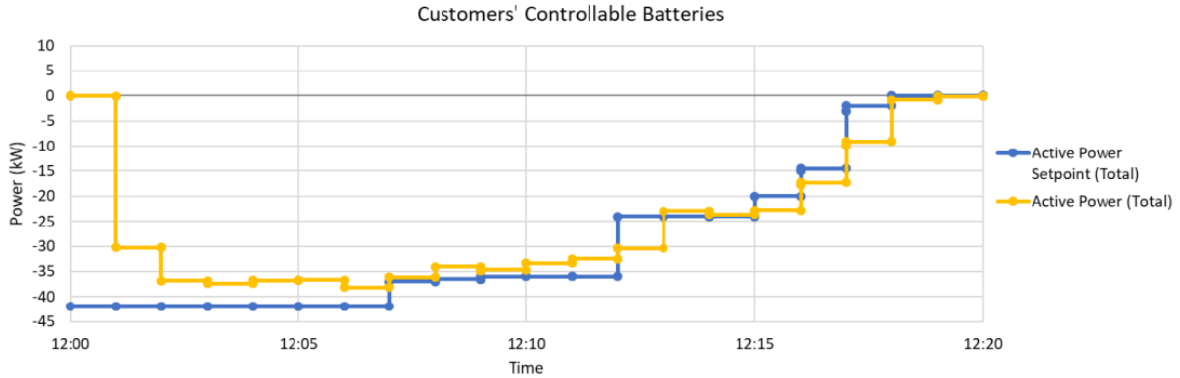




Live Trials: Set Point Response Times (over GSM)

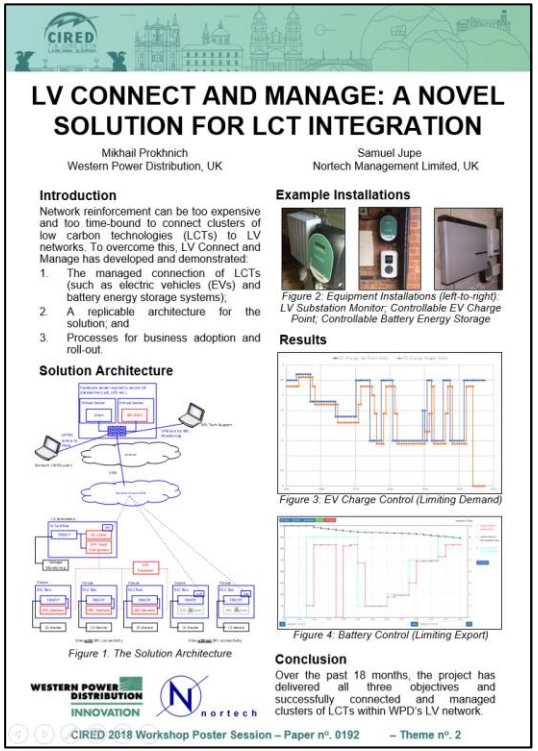
Time for readback confirmation of setpoint	Number of setpoint controls	Percentage out of 288 controls
Less than 1 minute	276	95.8 %
1 - 2 minutes	8	2.8 %
2 - 3 minutes	3	1.0 %
3 - 4 minutes	1	0.3 %

Time for readback confirmation of setpoint	Number of setpoint controls	Percentage out of 7573 controls
Less than 1 second	891	11.77%
1-2 seconds	4126	54.48%
2-3 seconds	1156	15.26%
3-4 seconds	1151	15.20%
4-5 seconds	169	2.23%
Longer 5 seconds	80	1.06%

Learning Outcomes

- ✓ Demonstrated managed charging of EV clusters (through peak loading times of day)
- ✓ Demonstrated export limitation of PV/battery customers (through peak generation times of day)
- ✓ Dual tariffs create a tangible business case for customers to connect batteries into their homes (even without PV)
- ✓ Designing interoperability into the project allowed for supply chain technology changes, outside of the project's control
- ✓ Different LCTs have different control response times:
  - ✓ Battery inverters: 96% of controls achieved within 1 minute
  - ✓ EV charge points: 99% of controls achieved within 5 seconds
- ✓ GSM has proven to be fit-for-purpose for LV ANM, providing flexibility for commissioning and reliable control

Example Dissemination Activities



CIRED

LV CONNECT AND MANAGE: A NOVEL SOLUTION FOR LCT INTEGRATION

Mikhail Prokhnich
Western Power Distribution, UK

Samuel Jupe
Nortech Management Limited, UK

Introduction

Network reinforcement can be too expensive and too time-bound to connect clusters of low carbon technologies (LCTs) to LV networks. To overcome this, LV Connect and Manage has developed and demonstrated:

1. The managed connection of LCTs (such as electric vehicles (EVs) and battery energy storage systems);
2. A replicable architecture for the solution; and
3. Processes for business adoption and roll-out.

Solution Architecture

Figure 1. The Solution Architecture

Example Installations

Figure 2. Equipment Installations (left-to-right): LV Substation Monitor; Controllable EV Charge Point; Controllable Battery Energy Storage

Results

Figure 3: EV Charge Control (Limiting Demand)

Figure 4: Battery Control (Limiting Export)

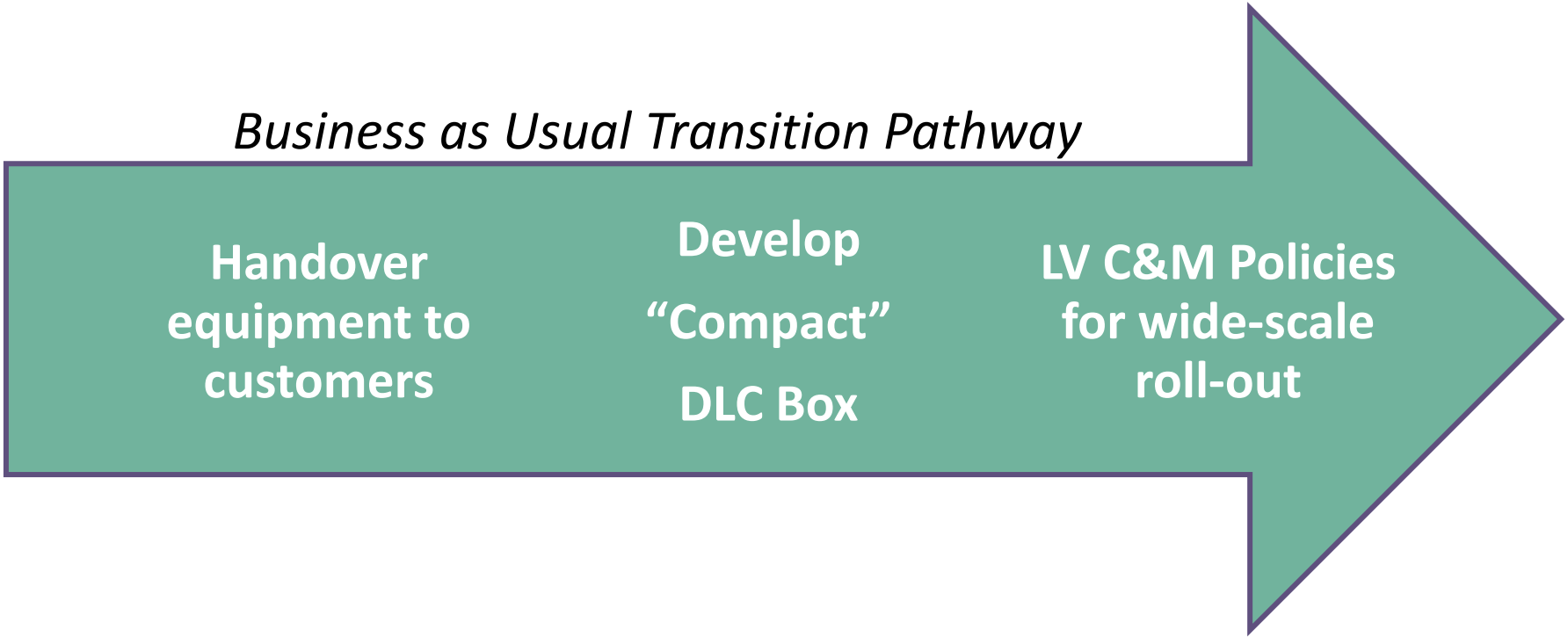
Conclusion

Over the past 18 months, the project has delivered all three objectives and successfully connected and managed clusters of LCTs within WPD's LV network.

CIRED 2018 Workshop Poster Session – Paper nº. 0192 – Theme nº. 2

Next Steps

Business as Usual Transition Pathway



Summary

- Background, Outline, Objectives and Benefits
- Solution Architecture and DLC Box Design
- Hereford Depot: Equipment Installations and Trials
- Site Selection, Customer Engagement and Customer Installations
- Live Trials of LCT equipment in Customers' Homes
- Learning Outcomes, Dissemination Activities and Next Steps

THANKS FOR LISTENING

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Refreshments Break

Served in Ballroom Suite 2

Resume at 14:00pm

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LCT Detection Project

Balancing Act Conference
21st November 2018

Gill Nowell (ElectriaLink)
Max Hudson (IBM)

Agenda – LCT Detection project

Introduction to the project — Gill Nowell, ElectraLink

- Fast facts about the project
- ElectraLink's Energy Market Data Hub
- The EV challenge
- The data-based solution

Cognitive computing, design thinking — Max Hudson, IBM

- IBM intro
- Method
- The Proof of Concept
- What we hope to learn

Fast Facts

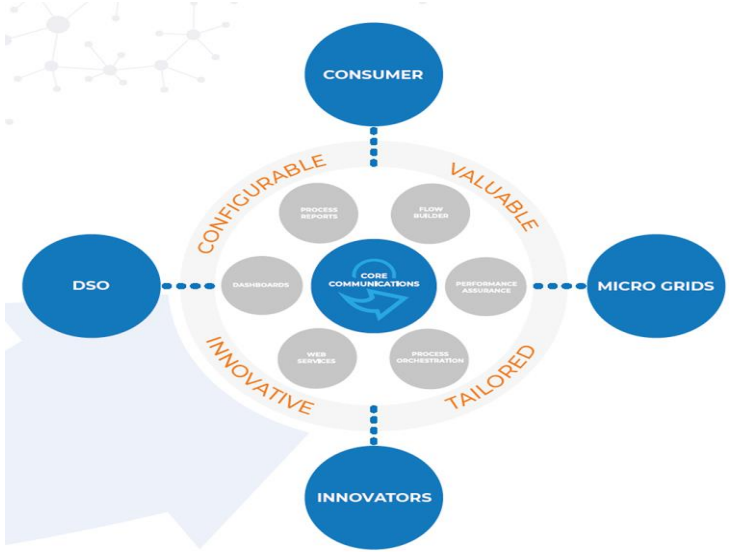
- Funded through the Network Innovation Allowance (NIA) - £311k
- Hosted by WPD, delivered by ElectraLink and supported by IBM
- Project will report in March 2019
- Will provide WPD with the tools to begin virtually monitoring its Low Voltage networks, which will enable WPD to identify areas where there is a high proliferation of electric vehicles, solar or other Low Carbon Technologies (LCTs).

ElectraLink

- Owned by all six GB DNOs
- Established 1998
- **Data Transfer Service**
- Governance Services
  - E.g. DCUSA
- Energy Market Insights

- Operates the Data Transfer Service as part of the **Energy Market Data Hub**

Energy Market Data Hub



The EV (and other LCT) challenge

Courtesy of Electric Nation

The Data-based Solution

The project will establish a mechanism for identifying EV and other LCTs on the network:

- ElectraLink will extract data sent across the DTS regarding consumption and export relating to WPD's network.
- This data will be analysed by IBM's cognitive analytics and where appropriate combined with third party datasets, to develop candidate locations for validation.
- Once validated, this improved WPD substation information can be used to develop a reporting framework to enable WPD to forecast future requirements for network monitoring and potential sites for active network management.

Cognitive Computing, Design Thinking

Max Hudson - IBM

IBM Advanced Analytics

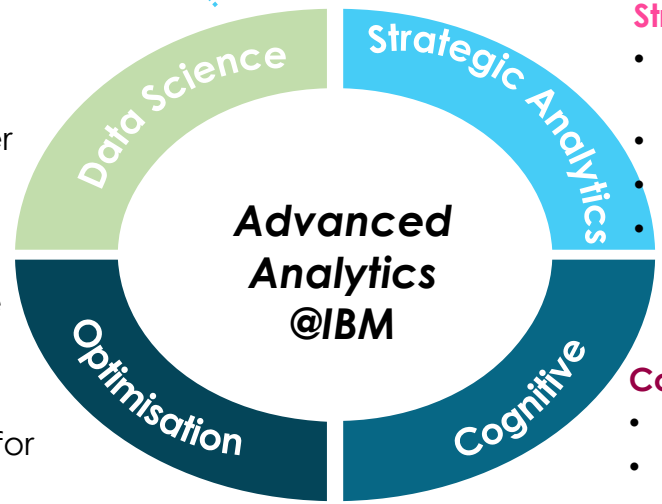
Maximise the power of data.

Data Science

- Predicting asset performance
- Anticipating customer behaviour
- Predicting product performance
- Maximising workforce performance

Optimisation

- Optimising strategy for pricing
- Optimising supply chain efficiency
- Informed risk management



Strategic Analytics

- Data driven business cases
- Value chain mapping
- Campaign management
- Scenario Analysis

Cognitive

- Machine learning
- Natural language processing
- Optimising cognitive solutions

1,000 university partnerships

15,000 analytics consultants

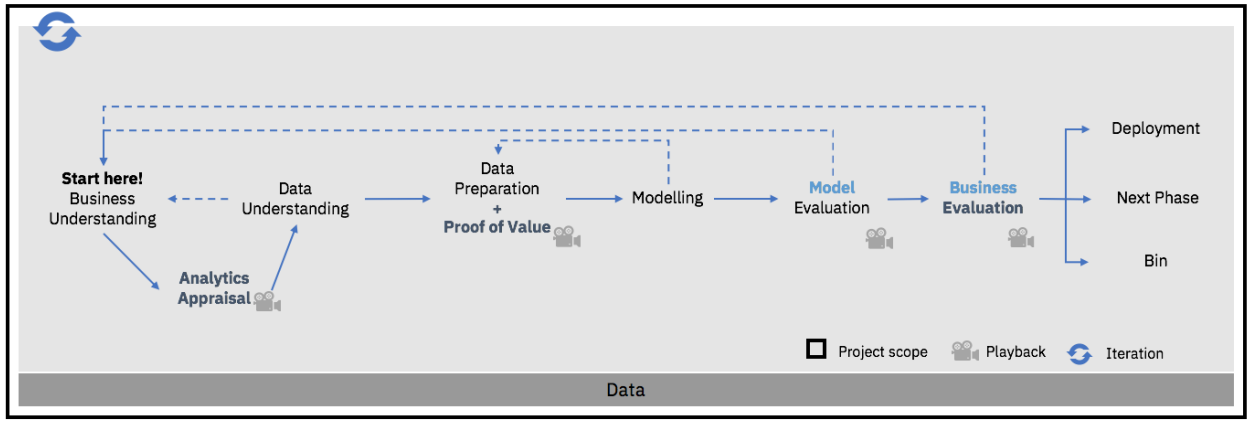
500 analytics-based patents generated each year.

> 40,000 engagements in Big Data & Analytics

1/3rd of IBM Research is focused on Data and Analytics.

Method

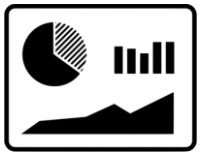
IBM will use a hybrid methodology of **agile principles** and best practise for **data modelling** that leverages WPD's subject matter expertise as well as IBM's cognitive and analytics capability.



Kicking-off with a Design Thinking workshop and having regular playbacks through-out will ensure business feedback is incorporated in the iterative approach to give a robust model that is of value to the business users.

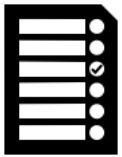
The Proof of Concept

Using IBM's cognitive and analytics technology, a model will be developed that extracts key information about EV and other LCT from ElectraLink's DTS dataset and third party data.



Outputs from the model will be visualized to display key insights relating to EV and other LCT proliferation in order to support network planning.

Learnings from exploratory analysis will be captured, including insights from analysing patterns where EV and LCT are present.



A quality assessment of provided data sources will be performed and recommendations made for data enhancements and how new data that could improve model performance.

What We Hope To Learn

To what degree can a model accurately predict the presence of LCTs?

How is the performance of the model affected by the data sets available to it?

What are the options to validate the presence of different LCTs identified by the model?

What steps are needed to scale the model across the industry?

Early View of the Output

	MPAN #	Has Known LCT	Known LCT Type	Model Classified LCT	Classified LCT Type	Confidence in Classification	Meter details
Description	MPAN Number	If presence of LCT has been validated	Type of known LCT	Does the model classify the MPAN as having LCT present?	The type of LCT the model classifies as being present	A confidence level in the classification	A number of columns with information about the MPAN
Example 1	MPAN1	No	None	Yes	EV	60%	Meter Type = Smart meter, Address etc.
Example 2	MPAN2	No	None	No	PV	80%	Meter Type = Pre-payment, Address etc.

THANKS FOR LISTENING

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Future Projects

Balancing Act Conference

21st November 2018

Ricky Duke

Innovation & Low Carbon Networks Engineer

Future Projects

- On Street Charging
- EV Service Stations
- Vehicle to Grid
- Smart Homes &
  Superfast Electricity Projects

Image courtesy of Electric Nation

On-Street Charging

- Electric Nation is giving us a lot of of valuable data, but it focusses on off-street parking.

- Circa 30% of properties have no off street parking, so there will be a need to charge at home through on-street chargers.

- How do EV users charge using on-street chargers, and do the charging patterns or behaviour differ to those we see in Electric Nation?

- Modelling of processes and locations for installation of kerbside chargers, ensuring compliance with planning laws and complex earthing arrangements.

EV Service Stations

- A block of currently available rapid chargers arranged in a forecourt style, connected to the network at one point would require heavy network re-enforcement.

- Customers will want the fastest charge possible, this means bigger chargers and more load. We aim to explore the different connection options for these sites ensuring that customers costs and impacts on the networks are minimised.

- We need to gather data on how and when these sites are used by EV owners, and whether any patterns emerge that would allow a smart management of the chargers to minimise network impact.

Vehicle to Grid

Vehicle to grid is currently being looked at as an addition to smart charging to balance the loading spike of EV's.

- We will be installing 3 V2G units as part of Electric Nation to develop a streamlined connection process and see how customers respond and their acceptance of V2G.

- WPD already participate in Vehicle to Grid Britain (V2GB) Project.

Image courtesy of Electric Nation

Super Fast Electricity

Superfast Electricity - Background

- Historically the UK has always connected domestic supplies at single phase.
- Typically the load was lighting and heating, with a few small power single phase motors.
- Early single phase cut-outs were nominally rated at 60A. The latest grey DMC single phase cut-outs have a 100A rating.
- In the past this 60A supply has been sufficient, as the majority of homes remain gas heated; and even those homes that utilised economy seven electric heating fell within the single phase 60A capacity.

Superfast Electricity – The effect of the carbon plan

- The Government's Carbon Plan 2050 reduces carbon emissions by decarbonising heat and transport.
- WPD expect to see flexible LCT loads that include battery storage, small scale generation, heat pumps and 32A/7kW electric vehicle chargers to escalate.
- The new LCT demand is likely to increase beyond the current single phase 60A/15kVA standard, worst case could see a circa 40% increase.
- DNO's need to be ready to accept this additional demand as it develops.

Superfast Electricity – The way forward

- In order to future proof homes WPD are pioneering a “superfast electricity” approach to the LV service cables, where customers with higher demands could use a three phase larger capacity service to help balance their demands and reduce overall losses in the service cable.

- WPD believe now is the time to mandate that all new service cables to new build housing change to a three phase design, giving customers 3 times the conventional capacity.

- An added societal benefit is that the losses in the service cable would reduce as the high single phase current would now be spread across the three phases thereby reducing the LV losses.

Superfast Electricity – The benefits

- Increased capacity for domestic Low carbon technology, including fast 21kW three phase home charging for future EV's.

- Increased capacity for domestic storage systems, linked with larger PV arrays and heat pumps gives greater flexibility.

- Potential social landlord opportunities to provide vulnerable customers with cheaper energy by managing energy flows to fuel poor developments whilst giving fixed energy bills included in the rent.

Superfast Electricity – The benefits

- Installation of air source heat pumps typically of the order 9kW.
- Innovative uses for three phase generation and battery storage to complement /support local electricity networks.
- A reduction in Losses on the LV network, by spreading the current over three phases.
- The use of three phase services to homes will reduce out of balance losses on the local WPD LV network and 11/0.4kV transformers.

Tonyrefail

- WPD have partnered with Pobl and SERO Homes in a project to equip 250 New Build Homes with with Solar, Energy Storage, Heat Pumps and Electric Vehicle Charge points, all with 3 phase services.

Blaen-Y-Maes

- WPD have partnered with Pobl and SERO Homes to retro-fit 640 homes with 3 phase services and LCT Technology. This project will be using findings from SOLA Bristol and the WPD LOSSES project.

Caldicot

- Working with the Welsh Government and Monmouth County Council, looking at where housing regulations should be in the future. Project consists of 250 new build home initially, and then increasing the 6,400 homes. Each home will have the full suite of LCT technology installed and a 3 phase service. Homes will also use district heating systems.

THANKS FOR LISTENING

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WPD Panel Session

Q&A from the day…

Panellists:

Nigel Turvey – Network Strategy & Innovation Manager

Roger Hey – Future Networks Manager

Paul Jewell – Policy Manager

Ricky Duke – Innovation & Low Carbon Networks Engineer

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