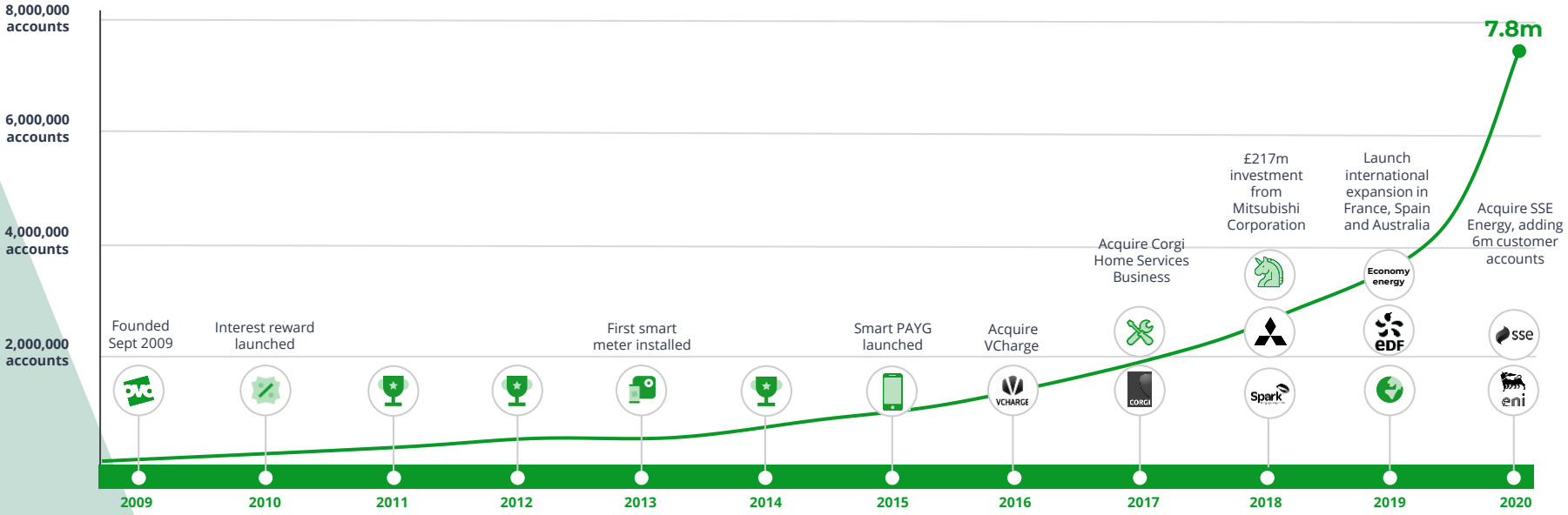
V2G: Democratising the energy system

Tom Pakenham
OVO Energy

OVO'S JOURNEY



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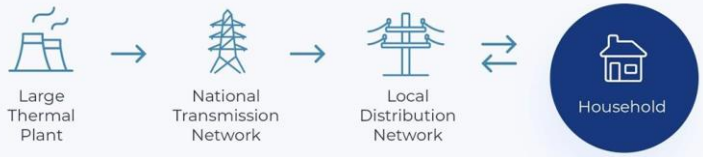
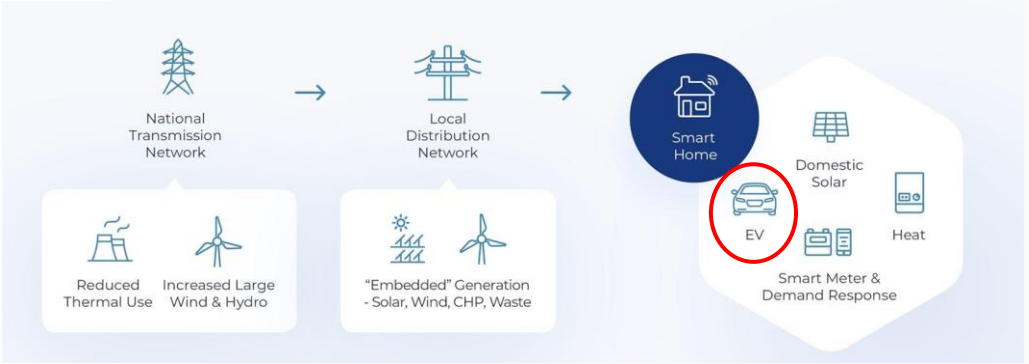
The Energy Transition

An opportunity for customers to sit at the heart of the energy system

Now: centralised energy generation model



In Future: distributed energy generation and demand model



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V2G will become widespread within this decade

- *Domestic V2G could save the UK energy system £3.5bn per year*
- *Ultimate customer asset - mobility and energy*

Other benefits of V2G include:

- Battery management
- Managing fleet power supply
- Off-grid resilience

Source: Blueprint for a Post-carbon Society, Imperial research 2018

The OVO V2G project in brief

Project Partners

KALUZA
AN OVO COMPANY

Project Funding

Department for Business, Energy & Industrial Strategy

Office for Zero Emission Vehicles

Innovate UK

OVO was the lead partner in a 36 month real world demonstrator to develop and deploy 300-400 V2G chargers with OVO customers.

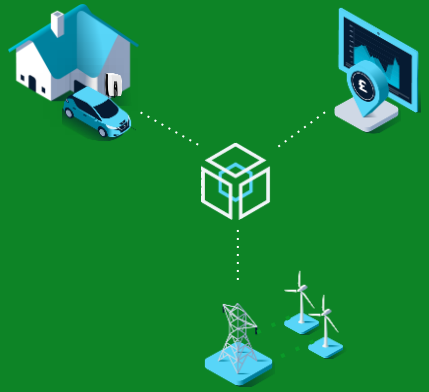
Key Achievements:

- ✓ Bespoke V2G hardware developed and manufactured
- ✓ User & installer apps developed
- ✓ Bespoke V2G tariff proposition launched
- ✓ Onboarded >330 customers
- ✓ Analysed half hourly data from charger fleet over > 12 months
- ✓ Insights collected from V2G customers

OUR V2G OFFERING

THE CUSTOMER PROPOSITION

WORLD'S FIRST DOMESTIC V2G DEVICE



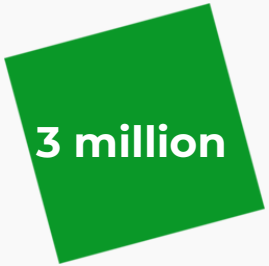
INTELLIGENT ENERGY PLATFORM

OVO V2G project in numbers

Average customer saving per year

Proportion of fleet exporting during Supply Margin Notice event, 6th Jan 2021

Total energy exported to the grid



Free miles driven by V2G customers

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KEY CHALLENGES OVERCOME

	Challenge		*Solution*
	Hardware cost £15k+ (and was oversized)	→	Building the OVO/Indra V2G charger in-house and at scale led to significant cost-down in the tech and a huge reduction in unit size
	Finding a commercial model that works for everyone (solar / not)	→	OVO's proposition ensures customers are fairly compensated for their V2G activity; some customers make up to £700/year
	Back-and-forth often required with DNO at install	→	DNO's are now much more familiar with V2G, e.g. a single form for all EVSE installs including V2G is to be released by UKPN
	User recruitment from small pool of LEAF drivers challenging	→	Collaboration with Nissan marketing team unblocked us for Sciurus, but CCS V2G is needed in the long-term!
	CHAdeMO standard not fully developed for V2G	→	Went through extensive CHAdeMo compatibility testing to build firmware that works with all LEAF and E-NV200 versions

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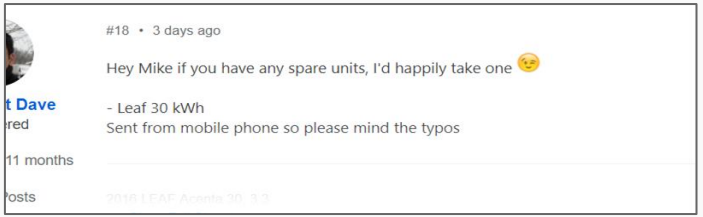
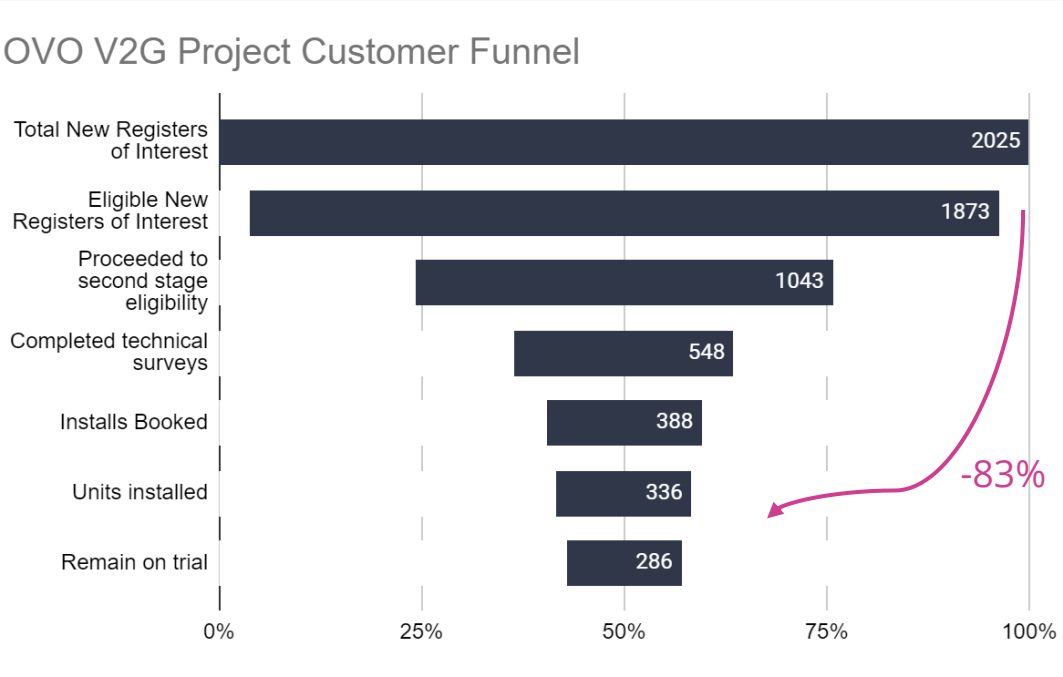
Customer recruitment was helped by hype on social media

Healthy customer demand for V2G units on facebook groups & forums



… but the journey to a V2G install is complex…and expensive

One in six leads made it through to install



The main reasons for customers leaving the trial were Change of Tenancy and getting new EVs (30%) not compatible with V2G (28%)

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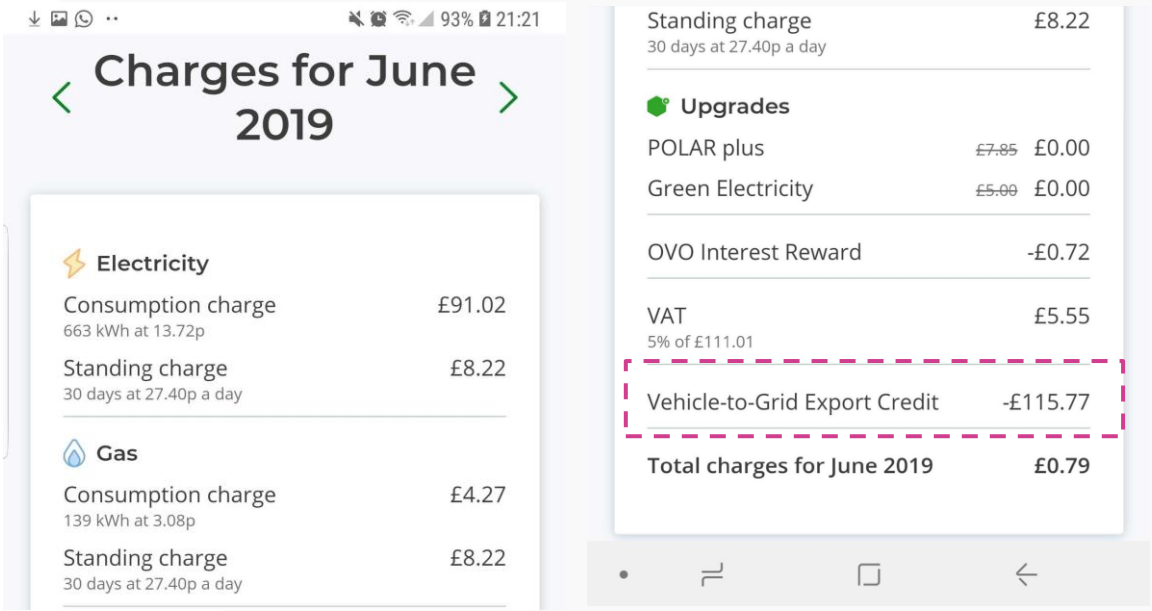
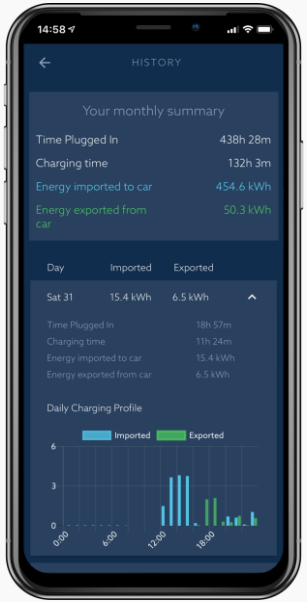
What was it like to be an OVO V2G customer?

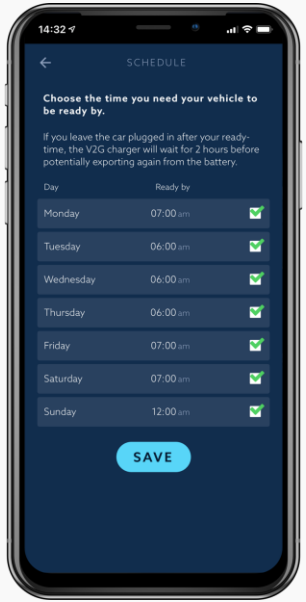
- ✓ Paid 33.7p/kWh for exports from smart meter
- ✓ Average customer saved £420/year



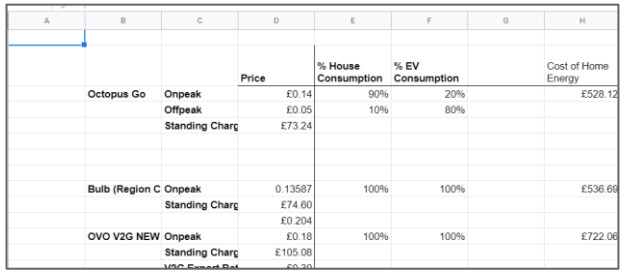
The OVO V2G app

- ✓ Set ready-by time
- ✓ Set max / min charge levels desired
- ✓ View live device status & history





Intensive in-life support was required



		Price	% House Consumption	% EV Consumption	Cost of Home Energy
Octopus Go	Onpeak	£0.14	90%	20%	£528.12
	Offpeak	£0.05	10%	80%	
	Standing Charg	£73.24			
Bulb (Region C	Onpeak	0.13587	100%	100%	£536.69
	Standing Charg	£74.60			
		£0.204			
OVO V2G NEW	Onpeak	£0.18	100%	100%	£722.06
	Standing Charg	£105.08			

- ✓ Most customers called customer support during the project - ⅓ of these were for issues around install
- ✓ Common issues included: charger not meeting customer preferences, network connectivity, customer app queries…
- ✓ …but sometimes, customers just had questions and feedback

Many customers made their own spreadsheets to keep track of their savings!

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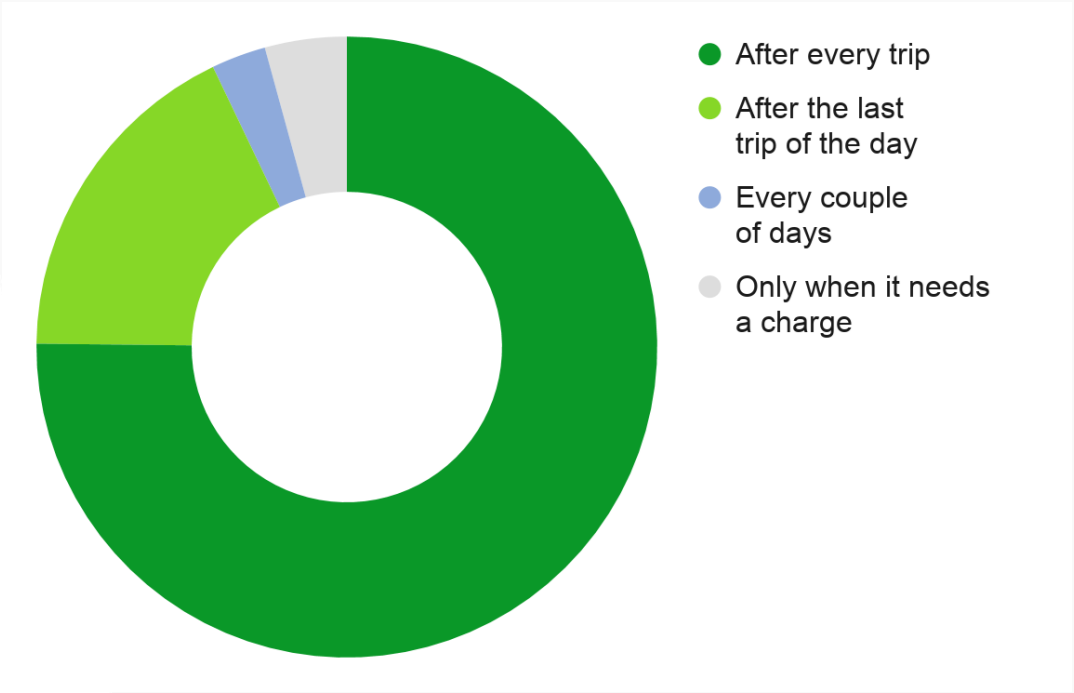
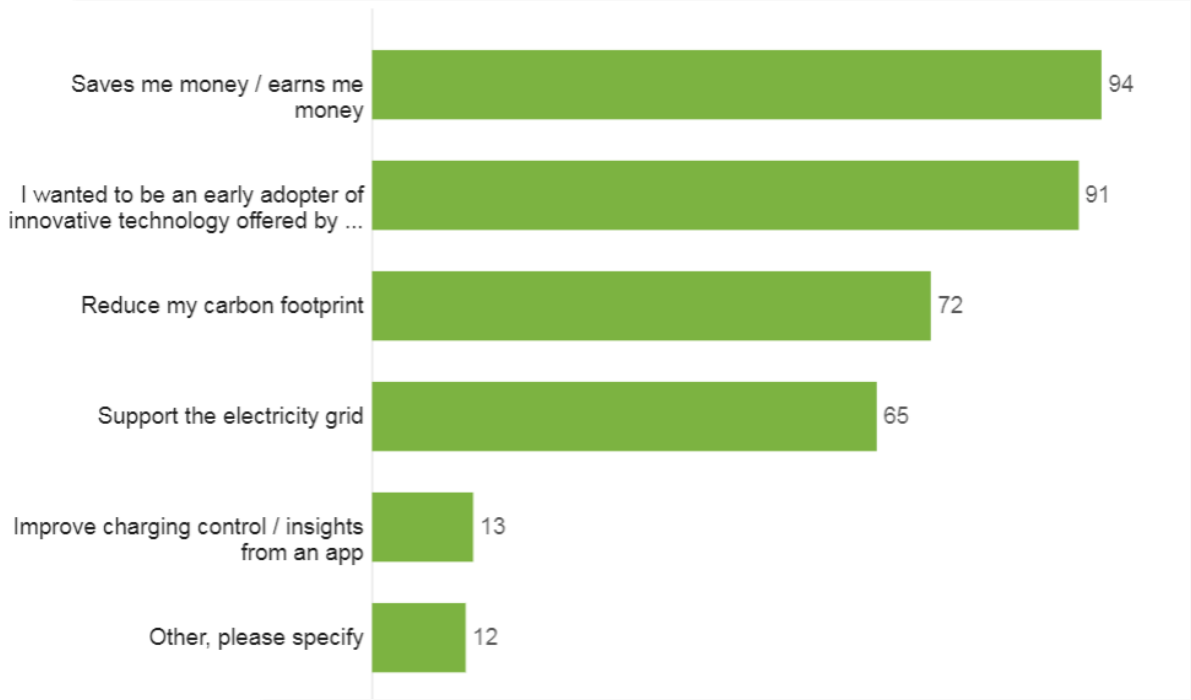
There was strong engagement from customers



There are new posts every day in the OVO V2G Facebook group discussing the technology and proposition

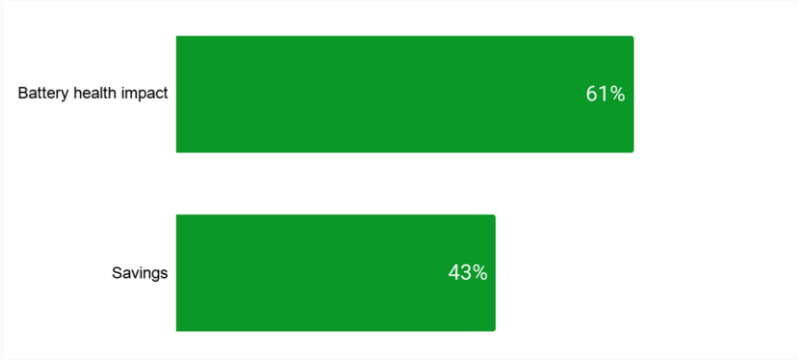
Customer insights: reasons for getting V2G

What were your main motivations for joining the V2G trial? Pick top 3. (N = 119)

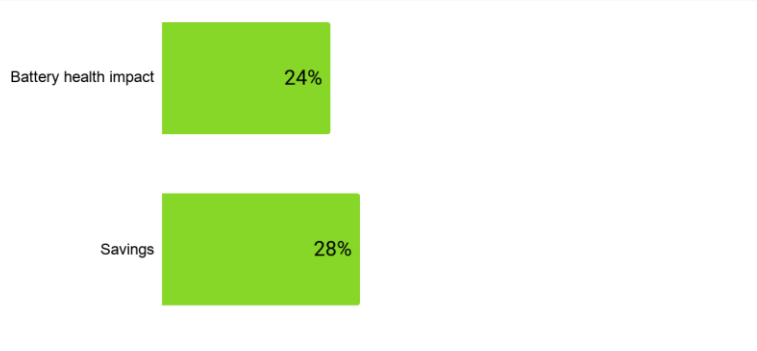


Customer's concerns about V2G have reduced through the trial

Before trial, what concerns did you have about getting the V2G charger? (N = 119)



What concerns do you have about the V2G charger now?



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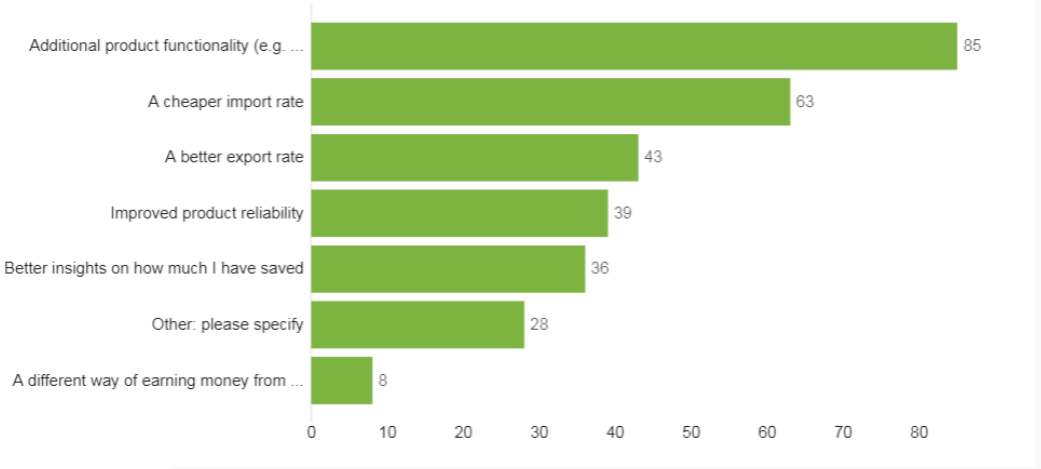
Customer satisfaction

93%

% of V2G customers satisfied with their charger

What are the main ways V2G could be improved for you?

Customers want the product to do more for them, e.g. optimise for solar or 'black start'



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V2G at OVO: what's next

- Utility and OEM partnerships
- Global reach
- Commercial readiness


THANK YOU FOR
LISTENING
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Sciurus Webinar

Design, certification and manufacture of a world first domestic V2G (20 min)

Mike Schooling

Founder and CTO - Indra

March 2021

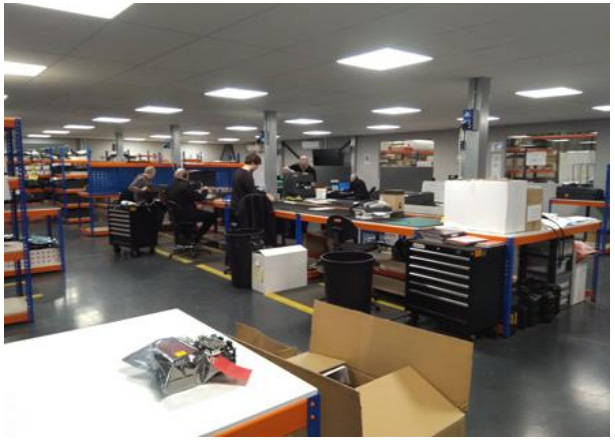
Introduction to Indra

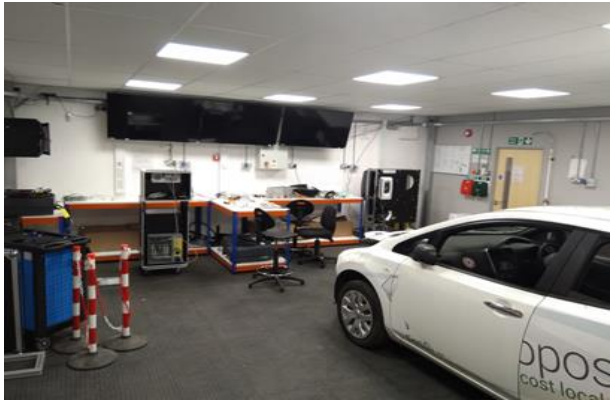
NET ZERO means the transition from internal combustion cars to 100% electric vehicles by 2030, not just upending the way we think about mobility but requiring the total transformation of the way the power system is operated if we are to keep the lights on.

OUR PRODUCTS enable fast and intelligent charging of electric vehicles, delivering zero carbon mobility whilst at the same time following price signals and instructions to charge cars at the cheapest and/or most manageable times of day.

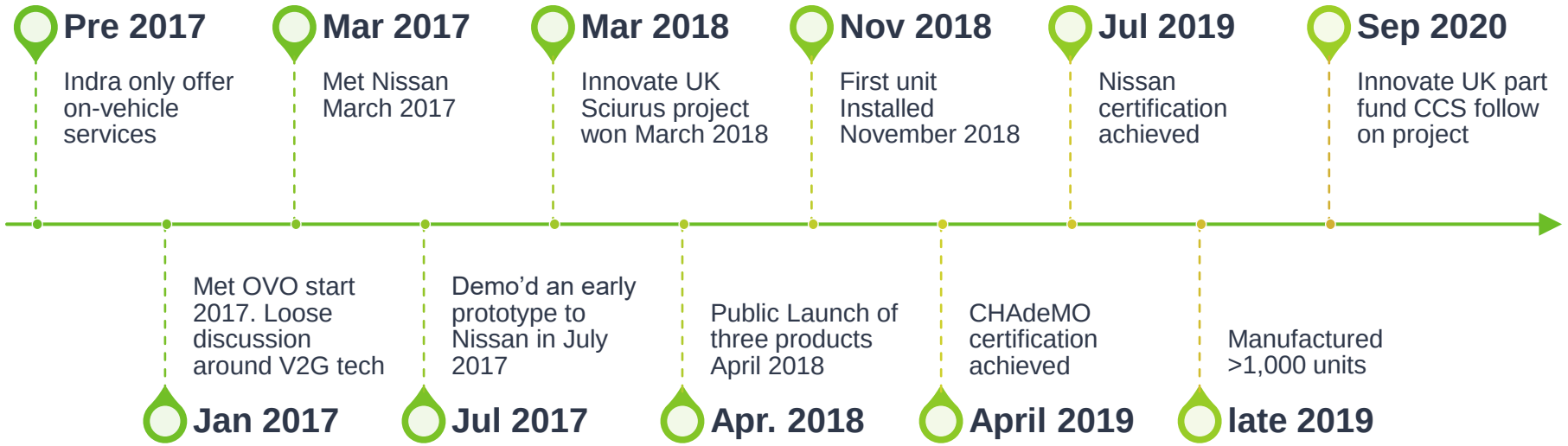
OUR VISION is to deliver a world of net zero transportation, enabled through Indra's innovation and intelligent charging technology.

Introduction to Indra

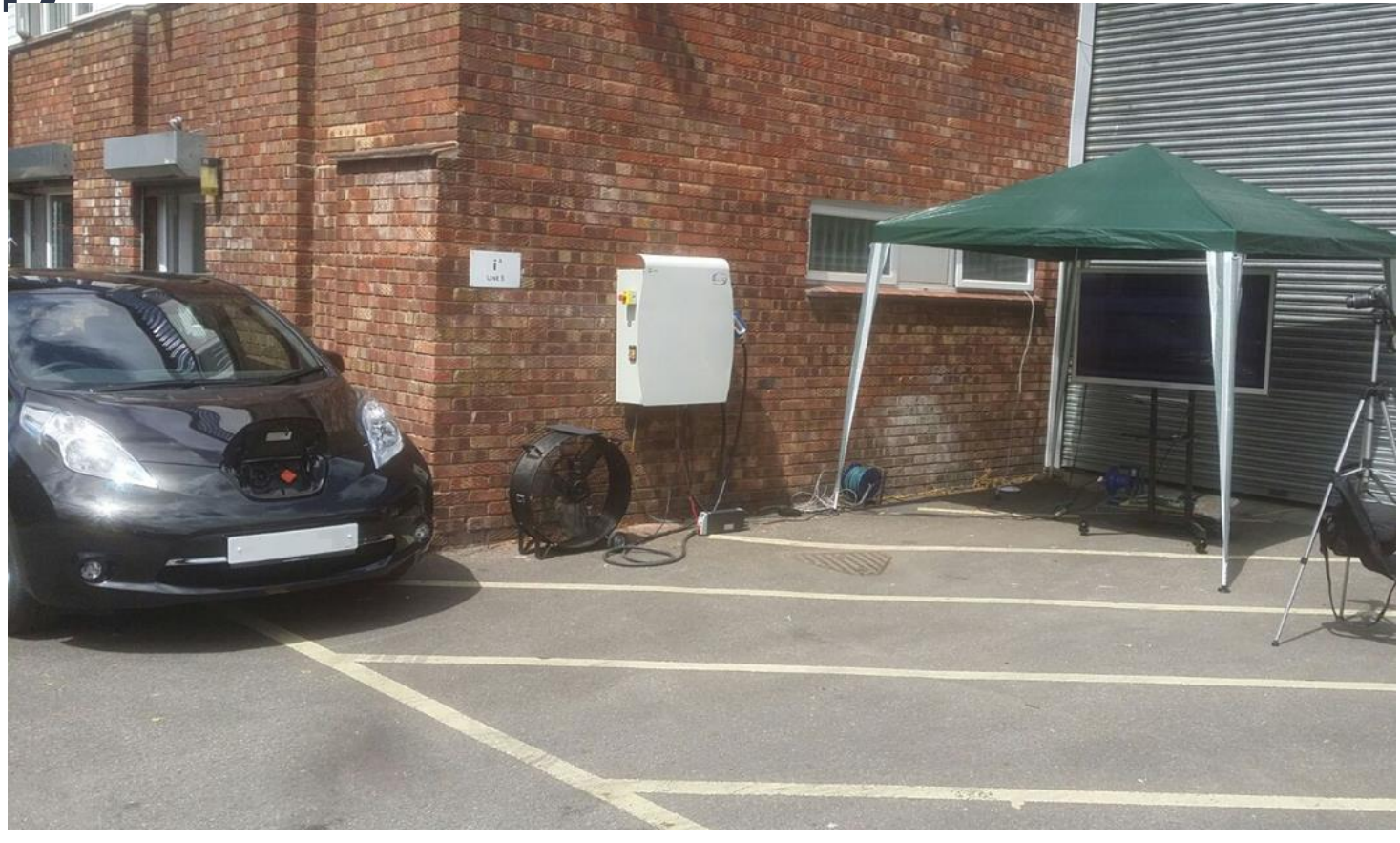


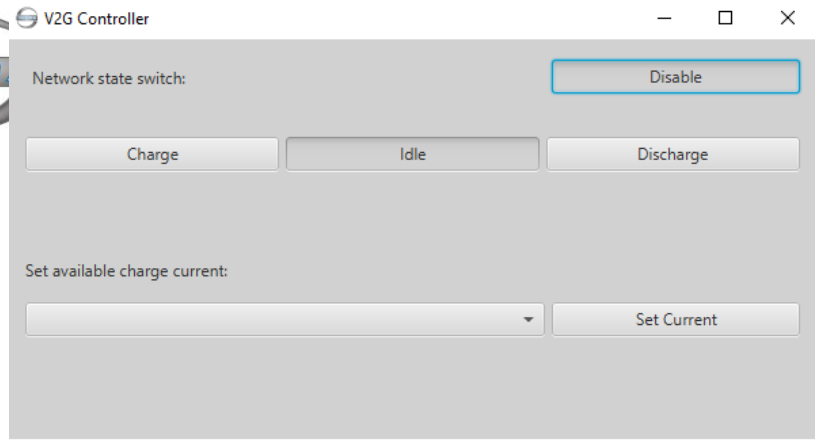


Our V2G Journey

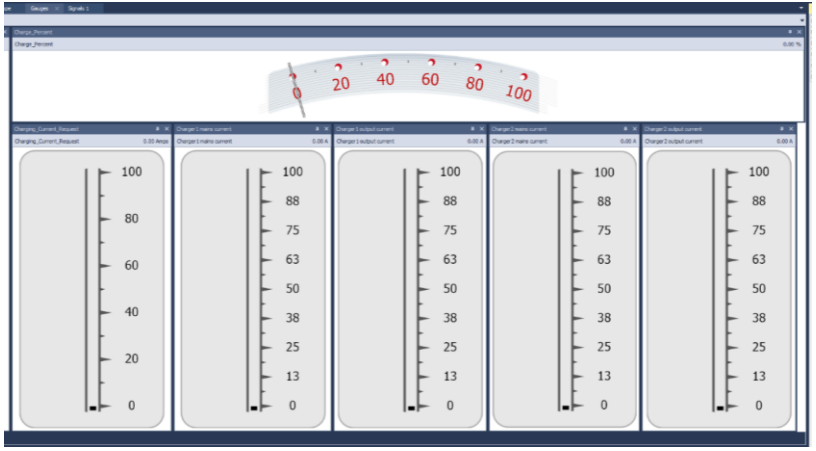


Mid 2017




V2G Controller
Network state switch:
Disable
Charge
Idle
Discharge
Set available charge current:
Set Current


V2G

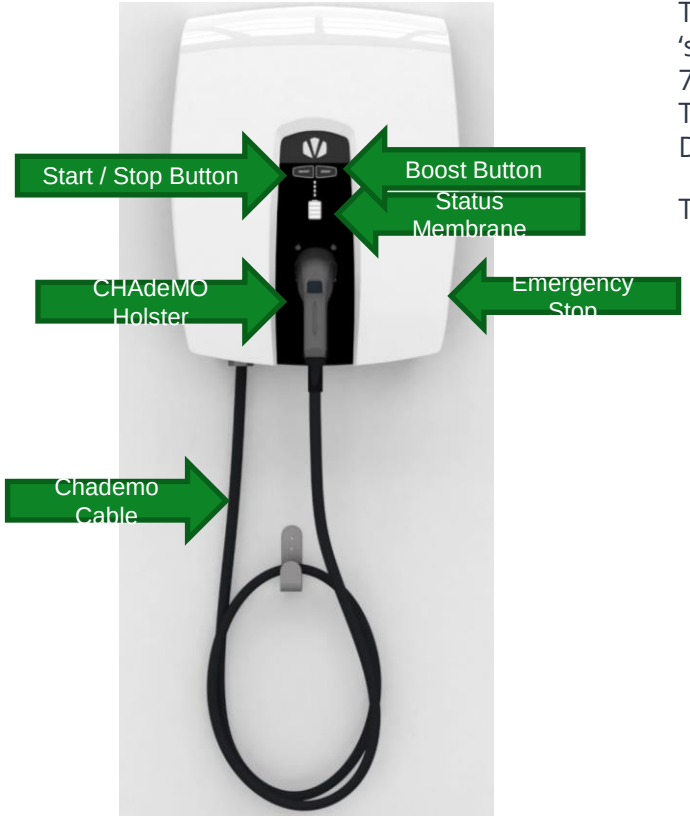

0
20
40
60
80
100
100
80
60
40
20
0
100
88
75
63
50
38
25
13
0

Development of V2G Hardware

- When we started in 2017…
  - Crane a unit onto a concrete pad!
  - >£15,000 unit cost

- By late 2018…
  - One man lift onto a wall bracket
  - <£2,500 unit cost

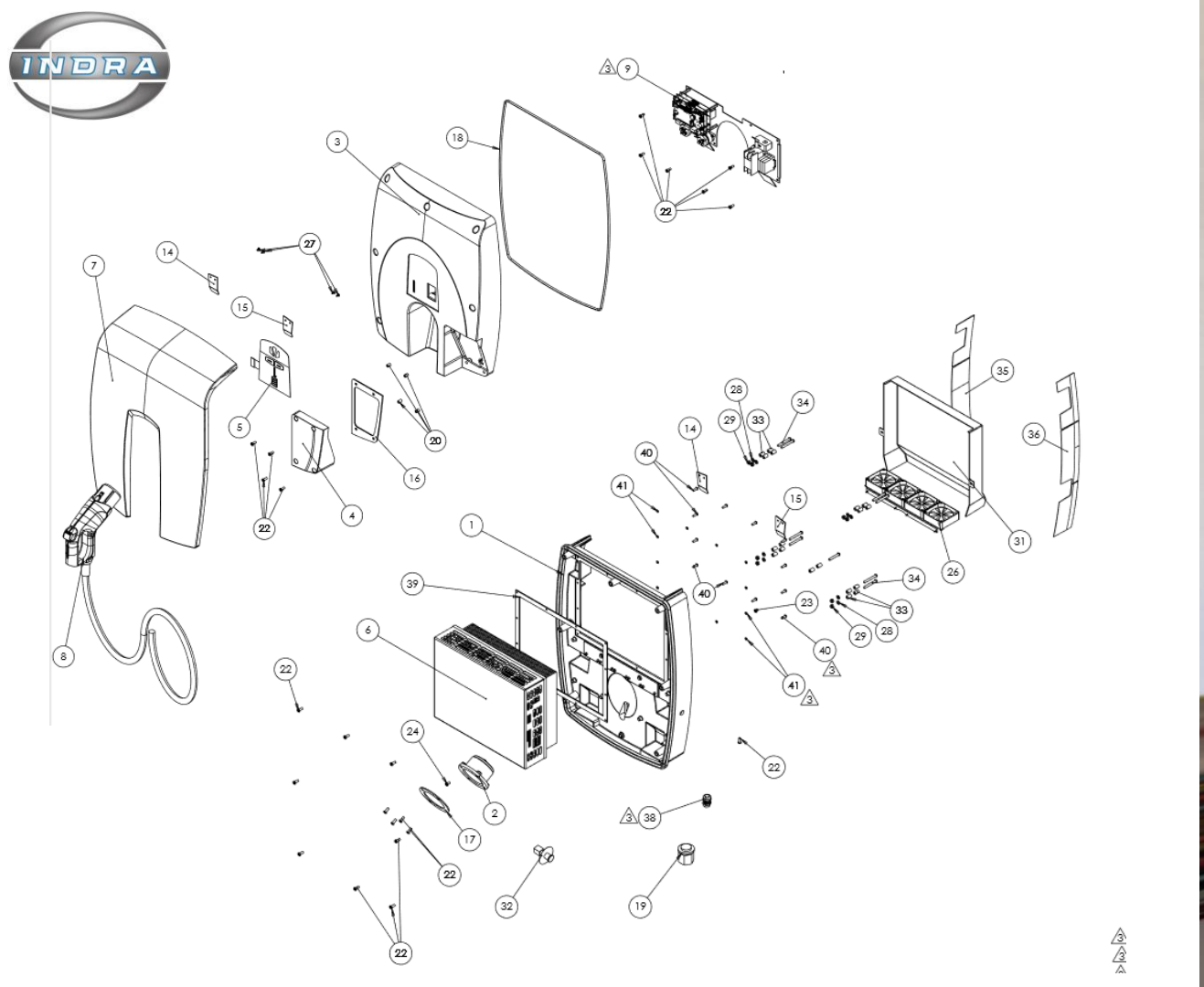
Indra’s Vehicle to Grid



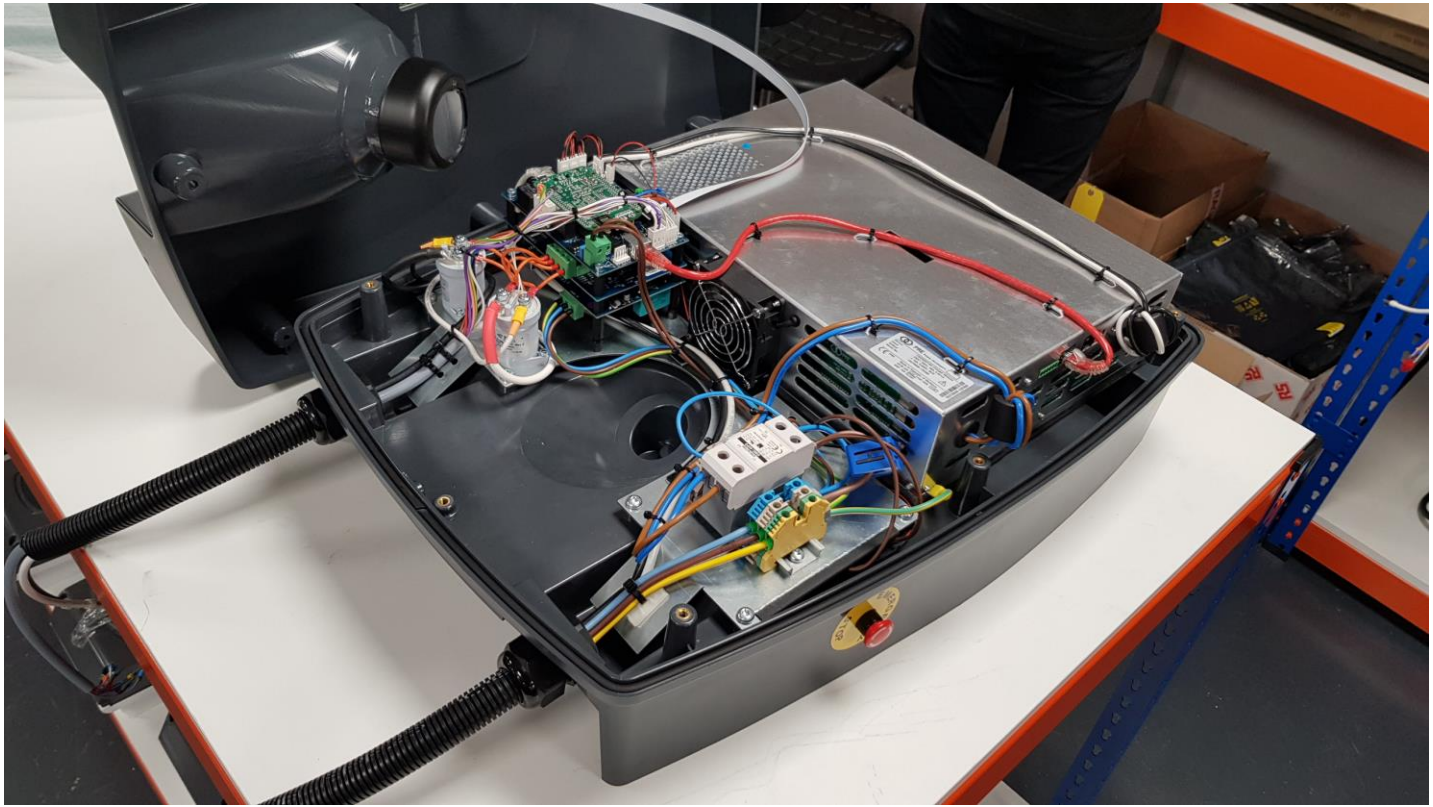
The INDRA Vehicle-to-Grid is a mode 4 , V2H (CHAdeMO) certified , ‘smart’, grid tied bidirectional electric vehicle charging solution at up to 7.5kW.
The world’s first bi-directional domestic charging solution.
Designed and manufactured by Indra in Malvern, UK

Technical Specifications

- CHAdeMO vehicle connection
- 6kW nominal Charge
- 6kW nominal Discharge
- UK residential (240V, 50Hz, single phase)
- Local smart charging
- Remote control using charging operator control platform
- Dimensions - 520mm x 210mm x 690mm
- IP65 protection rating


INDRA
Indra Renewable Technologies
181101 Smart Charger V3

Indra’s Vehicle to Grid solution



Development of V2G Hardware

- How did we reduce cost by **six** times!?
  - Use of Silicon Carbide in power electronics
    - Lighter
    - More efficient
    - Less waste heat (reduced cooling requirement)
    - Fewer heavy copper components
  - Design for manufacture
    - Build time reduced
  - Injection moulded plastics
  - Reduced power level from 10kW to 7.5kW (6kW with LEAF)
    - In line with existing charging speeds
    - In line with DNO approval
  - Economy of scale

The Challenges

- Hardware design frozen in late 2018
- Software updated over the air since. Typically quarterly

- Vehicle / CHAdeMO certification
- CE Certification
- DNOs…
- Grid Code changes G59/G83 to G98, G99, G100
- Install regulation changes
- Vehicle changes (40kWh LEAF)
- VPP (Kaluza) integration
- Scale production

Where else is the charger installed?

- Australia
- Taiwan
- Jersey
- Various Innovation projects in UK and Europe
- Private UK residences
- UK businesses

What’s next for Indra and V2G?

- CCS
- New optimisations
- Updated electronics
- Higher power, 3 phase and commercial variants.
- Smaller form factor

CCS

- CCS is now the de-facto charging standard for Europe
  - But not the best…
- Development project well underway
- 15118-20 standards delayed considerably
  - Originally promised draft in March 2020
  - No test/certification path
  - Still waiting for draft!….
  - Still awaiting compatible vehicles
- More vehicle partners sought

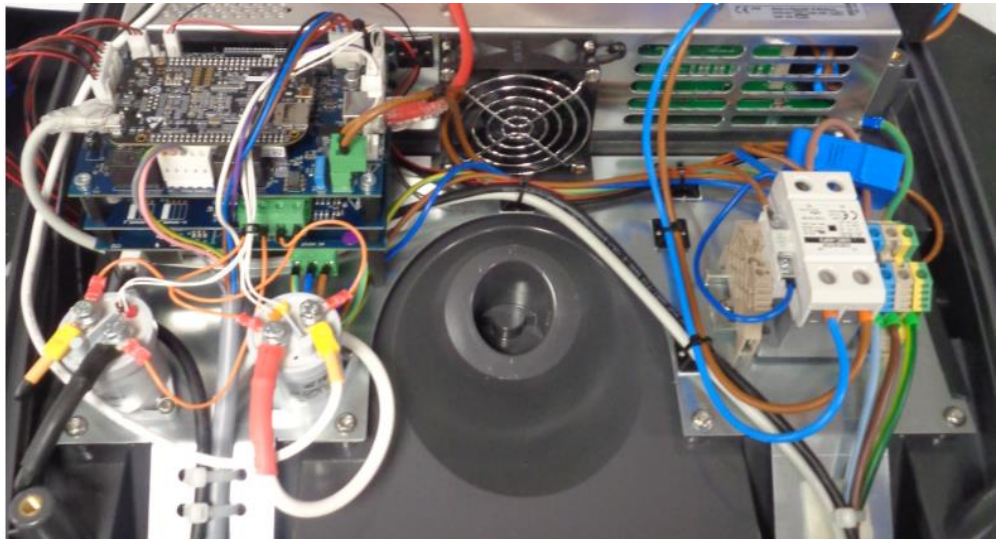
New Optimisations

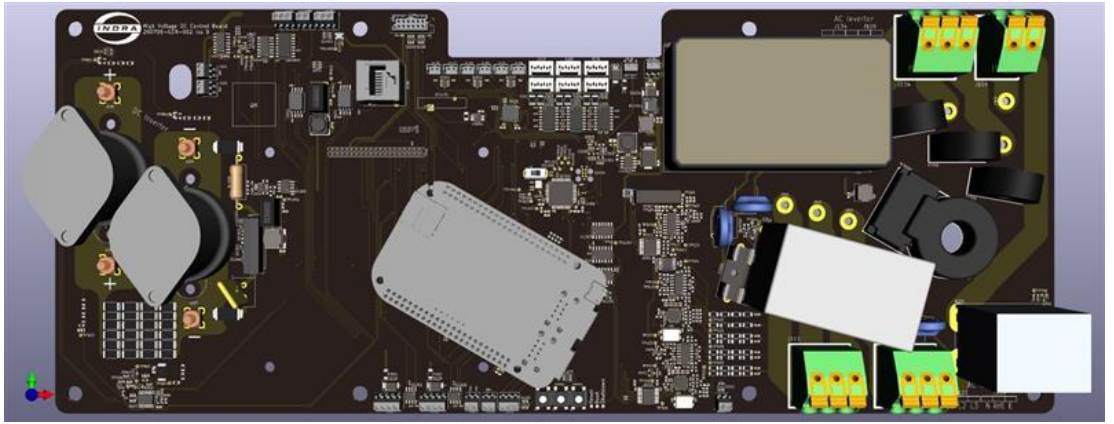
V2X encompasses the following technologies and optimisations. Other than islanded, the hardware can be identical.

- V2G - Grid tied hardware optimised by a virtual power plant (VPP) or aggregator. Often taking price and/or carbon feeds but also useful for trading, arbitrage, response services etc.
- V2H - Grid tied but optimised for local use - e.g. home solar storage (export match), load matching, time of use, etc.
- V2H2G – grid tied and optimised for V2H but with some V2G services made available to a VPP/Aggregator within constraints set by the user.
  This is not incidental use of a V2G system within the house
- V2B – Grid tied but optimised for a building or infrastructure (business, hospital, train station, etc). May be optimised by a local third part management system or integrated sensors.
- Islanded - not permanently grid connected, often implemented alongside V2G/V2H with additional controls to provide energy to the property in an outage for backup purposes.

Updated Electronics

- Improve reliability
- More testable
- Reduce costs
- Reduce build time
- Support new installation regs
- Support 3 phase
- Support CCS
- Support new markets





Thanks!


KALUZA
AN COMPANY
MARCH 2021
CONOR MAHER-MCWILLIAMS
HEAD OF FLEXIBILITY
KALUZA
FREE DRIVING: THE INTELLIGENT ENERGY PLATFORM UNLOCKING THE POTENTIAL OF V2G

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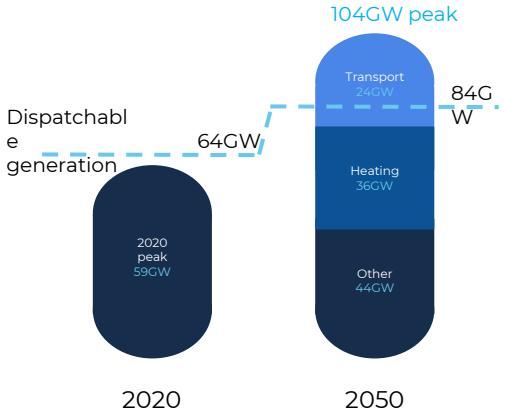
THE CHALLENGE

PEAK THREAT
REQUIRES MITIGATION



Source:
National Grid Future
Energy Scenario 2019

Addition of EVs, smart heating and home energy storage

INCREASING RENEWABLE PENETRATION IS CHANGING THE WAY THE **GRID** OPERATES

Growth in renewables

April
2014
London, UK

Installed Capacity
25 GW

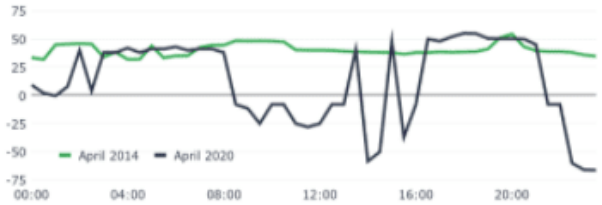
18

April
2020
London

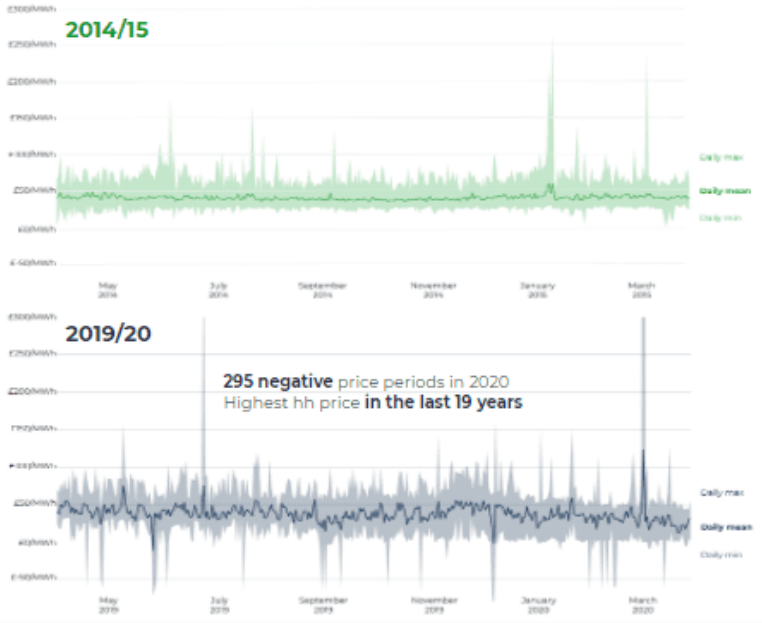
Installed Capacity
47 GW

21

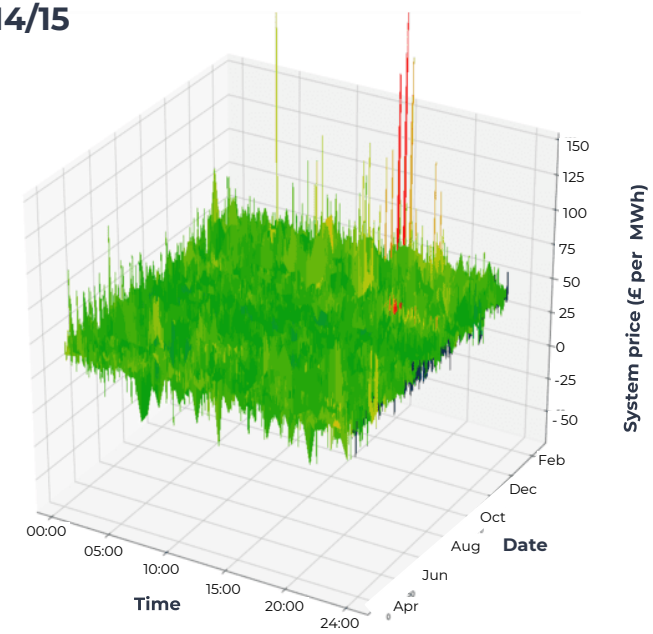
Drives price volatility (£/MWh)



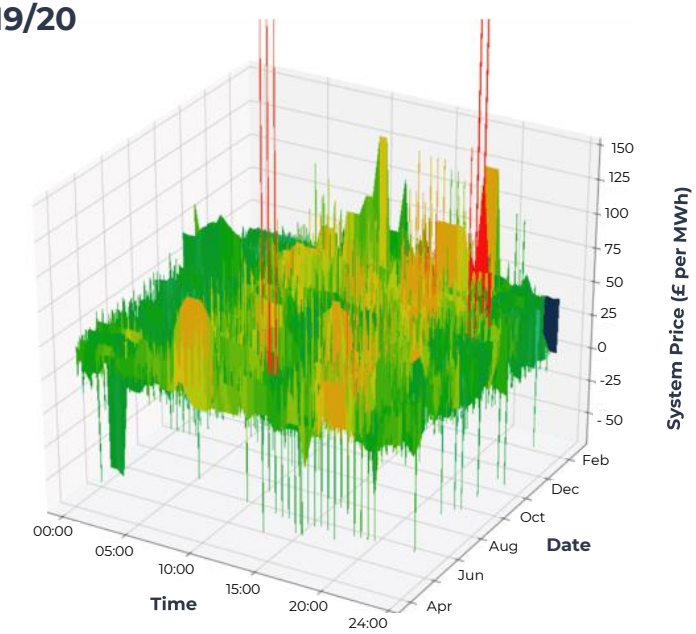
Wholesale price volatility increase



2014/15



2019/20



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THE OPPORTUNITY

FLEXIBILITY WILL SAVE UP TO **£7BN A YEAR** IN THE **UK** ALONE

Summary of starting assumptions for the baseline assumptions:

-£6.9BN

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THE WORLD'S LARGEST DOMESTIC V2G PROGRAMME


energy
Get a quote
Products
Moving home
About OVO
Help
Search
My OVO
OVO Vehicle-to-Grid Trial
Combining your Nissan EV and our V2G Charger could save you up to £570 a year¹
Our V2G Charger stores electricity in your Nissan electric vehicle battery when it's cheaper and more likely to have been produced by renewable sources², then sells energy back to the grid when it's in demand.
Sign up to OVO Energy, join the trial and you'll get a groundbreaking charger for free. You will also get a £75 credit on your OVO Energy bill and a payment of up to 30p per kWh of energy exported back to the grid.
Register your interest

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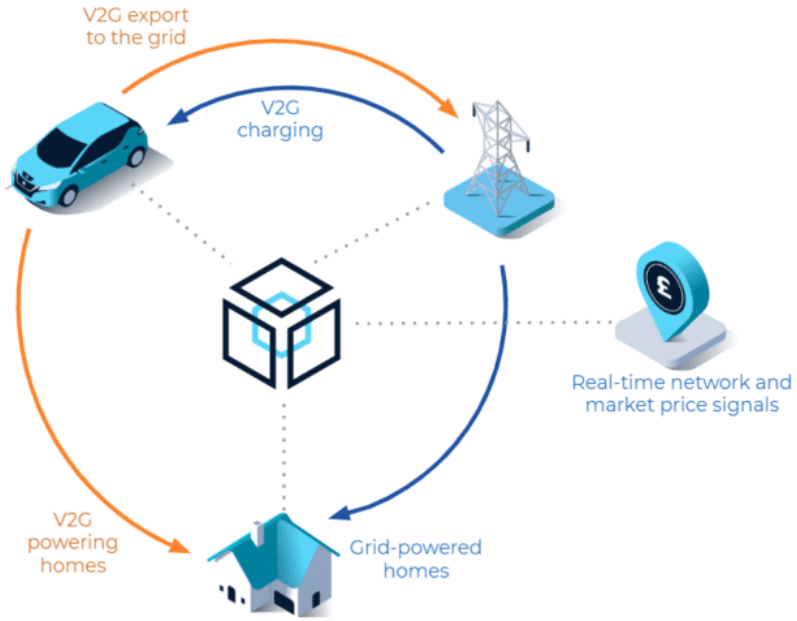
THE **FLEXIBILITY OFFERING**

V2G ON THE KALUZA PLATFORM



Kaluza takes real-time network and market price signals to optimise EV charging and discharging using machine learning algorithms.

Decisions are updated on a minute-by-minute basis, continually optimising the charging path.

KALUZA
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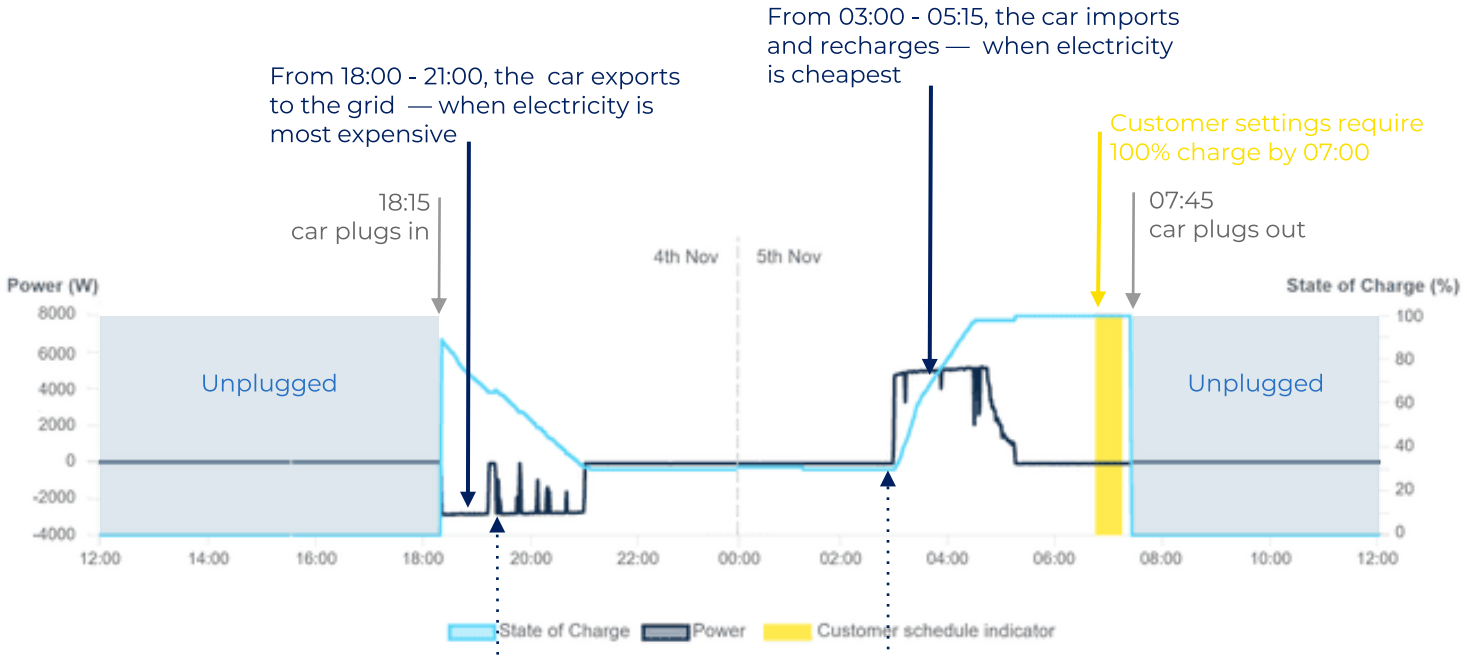
V2G IN ACTION

24 HOURS AS A V2G CHARGER



KALUZA

BEN.WHITE@KALUZA.COM

VALUE | NETWORK | PRICE RESPONSE | SIMULATION | OPERATIONS

V2G POWER CONSUMPTION

V2G STATE OF CHARGE

V2G CONTROL COMMANDS

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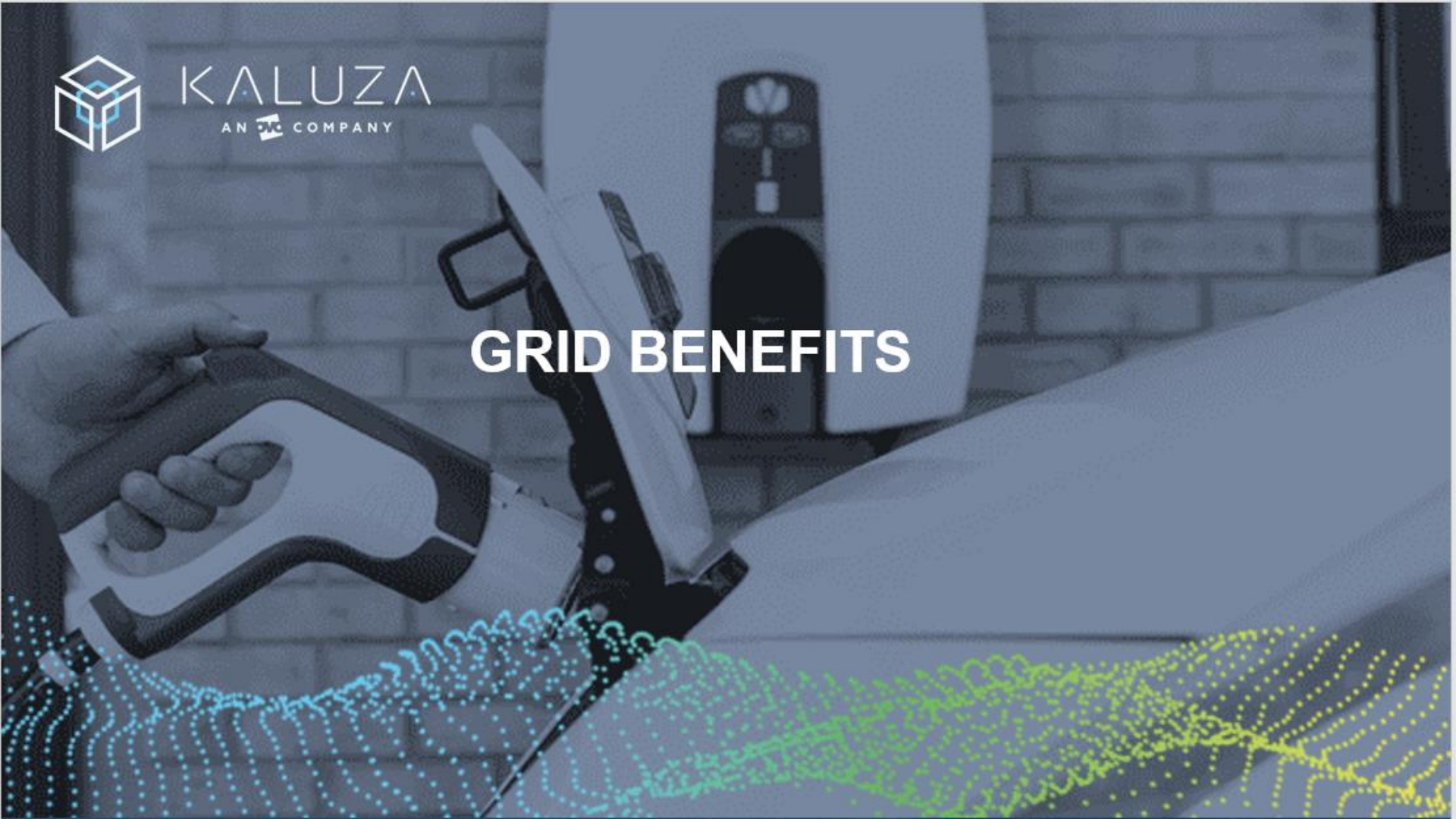
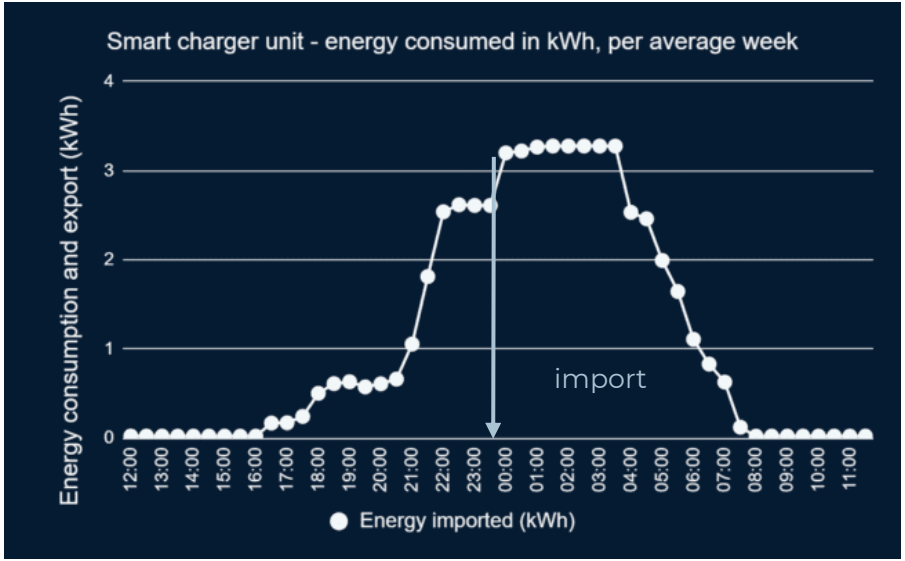
GRID BENEFITS

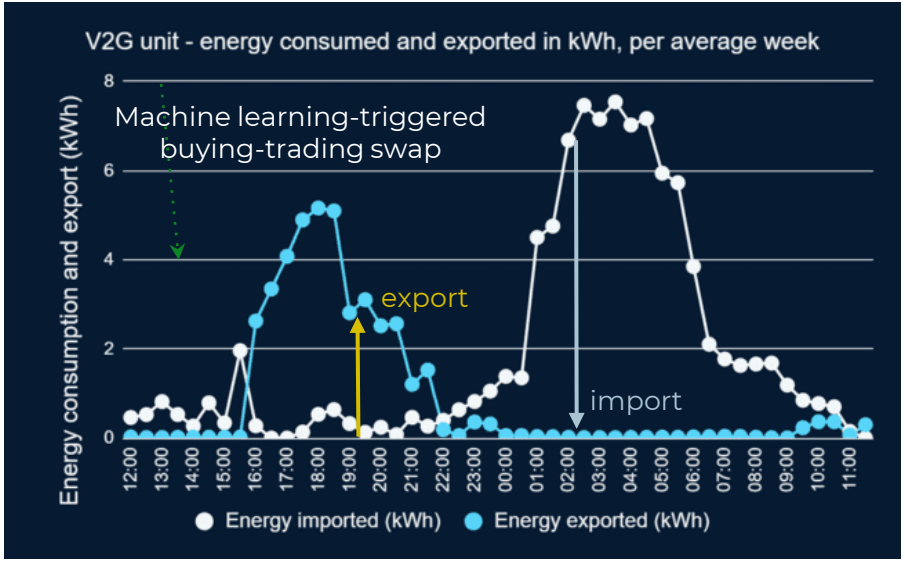


OPTIMISING TIMES OF ENERGY **IMPORT** AND **EXPORT** CREATES **VALUE**

Kaluza-optimised energy consumption for a Smart charger and V2G - over an average week.



Smart chargers are optimised to charge at the cheapest times in the day



V2Gs are optimised to charge at the cheapest times, and export at the most profitable times

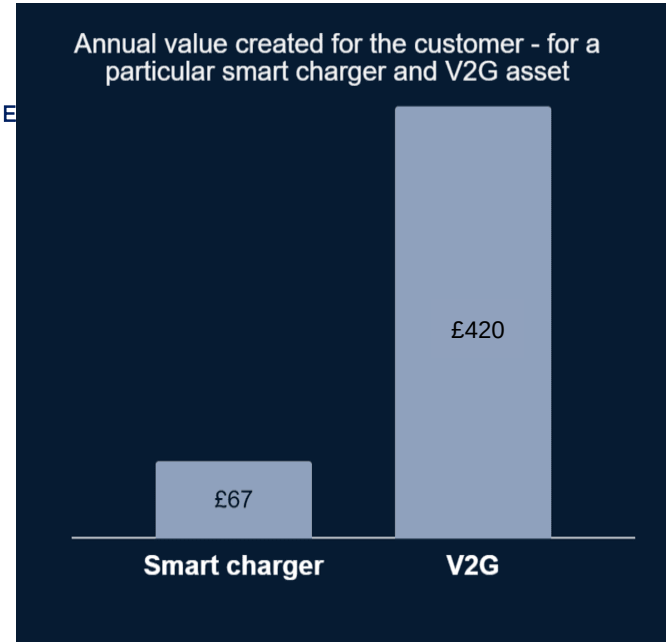
V2G VS SMART CHARGING

CONSIDERING A V2G AND SMART CHARGER, WITH SIMILAR NE
ENERGY IMPORT:

V2G: ~2.8 MWH

SMART CHARGER: ~2.9 MWH

NOTE: VALUE FOR IMBALANCE PRICE TRADING ONLY, NO ANCILLARY SERVICES REVENUES INCLUDED



* Value delivered for specific devices, with similar consumption profiles - neither is indicative of the maximum value attainable from either device type


KALUZA
Vehicle to Grid Chargers
UK
All devices
272
Plugged in
139
Importing
16
Exporting
82
Idle
41
Insights
Alerts
Insights for the last 30 days
Total exported
40,711 kWh
Carbon saved
3,842 kg
Export payments
£ 12,213
Export
Import
Plugged in vehicles (%)


KALUZA
AN COMPANY
KEY LEARNINGS

Customer insights

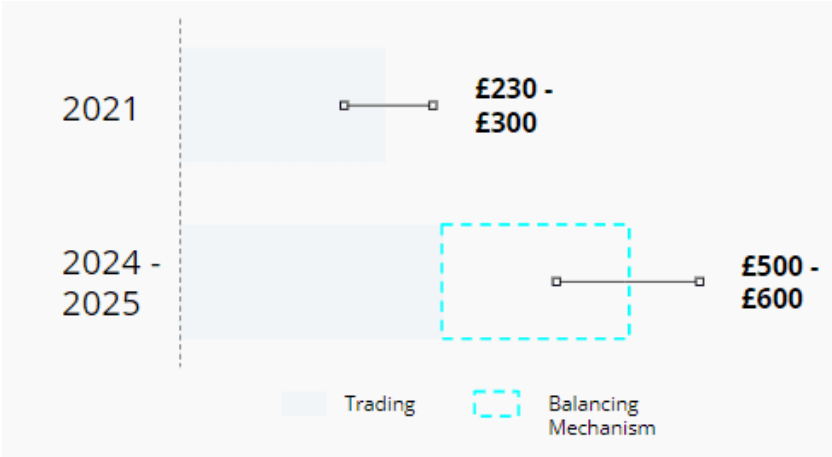
- The average customer imports **11.36 kWh** and exports **6.77 kWh** per day
- Customers plug-in to charge on average **18 times per month**
- 319 V2G connected EVs offer **0.38 MW** of capacity to support the grid at **peak times**
- Avg. customer earns **£60/month** and with some earning up to **£130/month**

Source: Kaluza Analysis and Cenex White Paper

Revenue from V2G is close to £300 for many customers, and will increase with growing price volatility and market access

V2G Value Modelling Based on Project Data

Kaluza Analysis

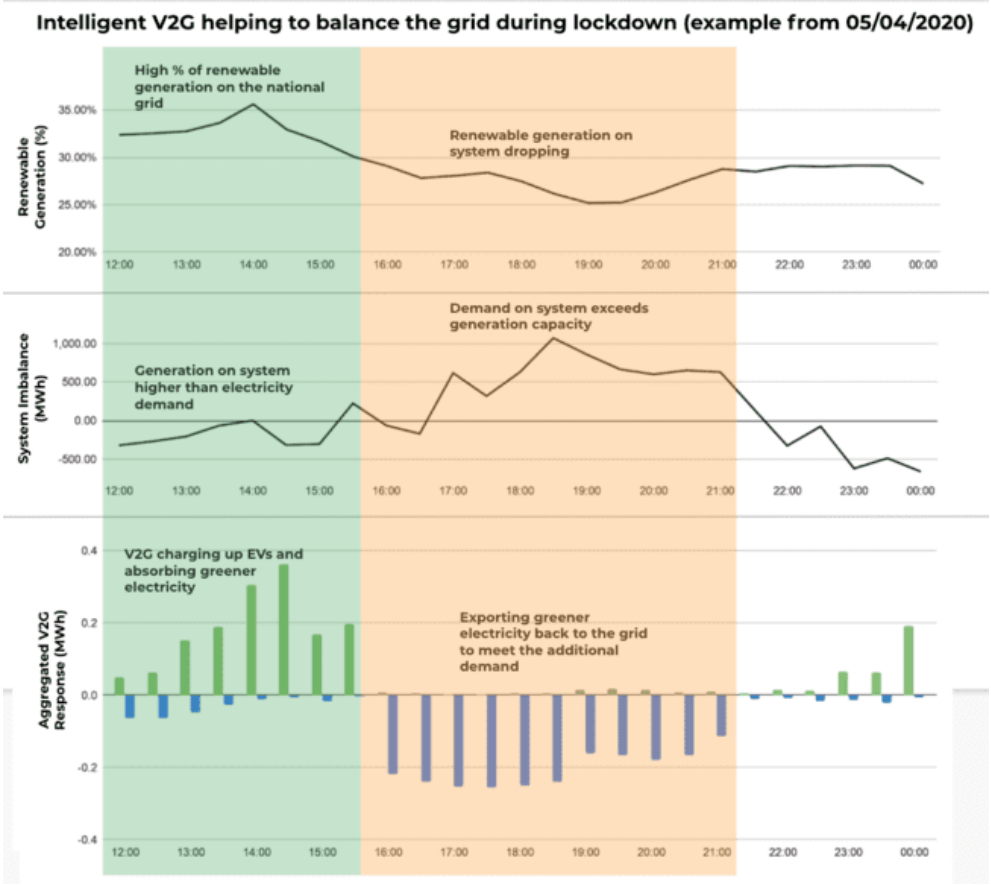


Source: Kaluza Analysis and Cenex White Paper

V2G helped to balance the grid over lockdown

Increases in V2G portfolio availability were observed across the day as more people were working from home.

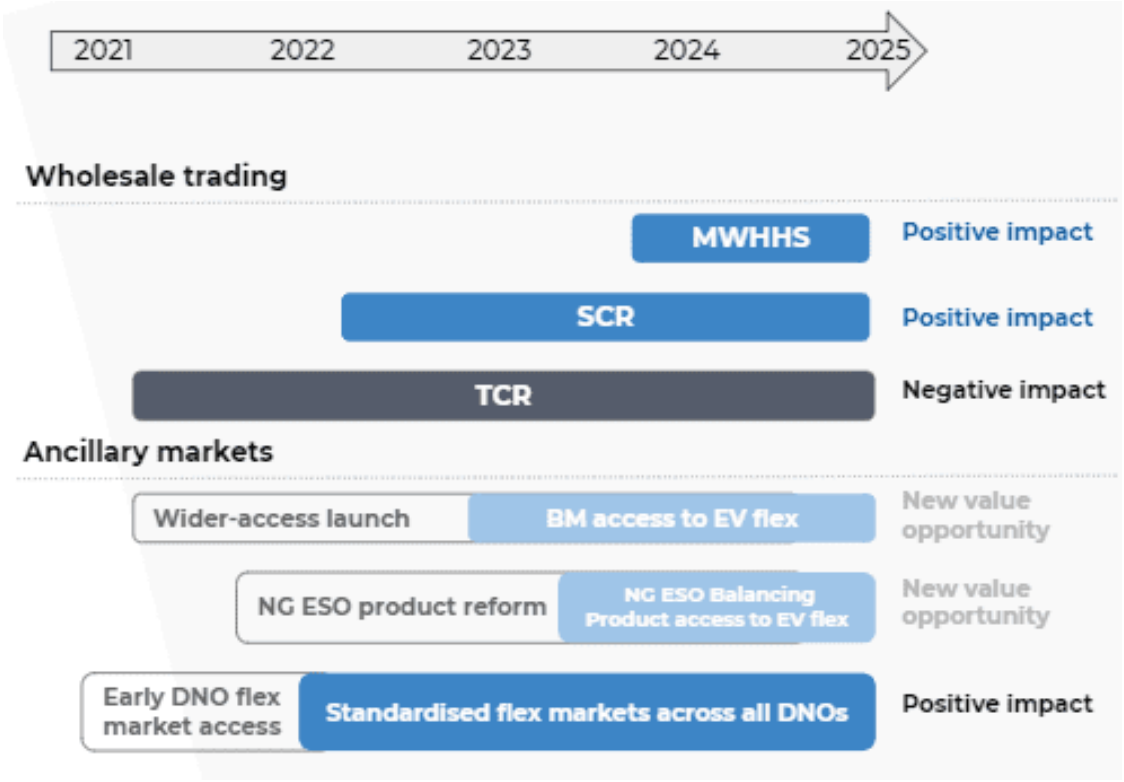
As a result, on some days we saw increases of **up to 30% in available flexible capacity** from the V2G portfolio compared with pre-lockdown portfolio availability patterns.



Source: Kaluza Analysis and Cenex White Paper

Significant new revenue streams for V2G will become available from 2022-2023

Policy & Regulation Change Timeline



Source: Kaluza Analysis and Cenex White Paper

Q&A

partner@kaluza.com kaluza.com

V2G from an OEM perspective

Nissan Intelligent Mobility

V2G supporting the switch to EV and decarbonisation

- A key component of the residential electrical ecosystem
- A clear manifestation to consumers and business of the benefits of merging the electrical ecosystem and e-Mobility
- Driver of personal net zero and self sufficiency
- Will support EV take up through reduced TCO
- V2G related battery life/management improvement up to 9%, supporting case for improved RV and lower leasing costs*
- Should reduce grid upgrade cost impact on consumers energy bills over the long term

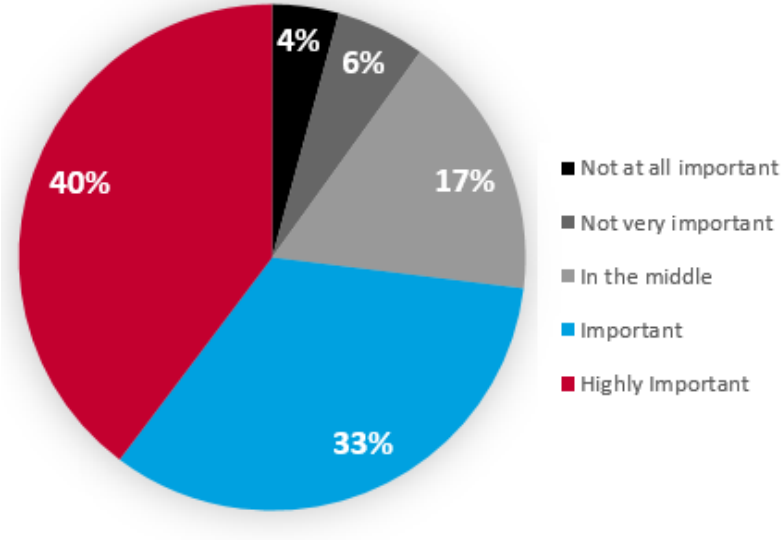
*A com

V2G an OEM brand differentiator

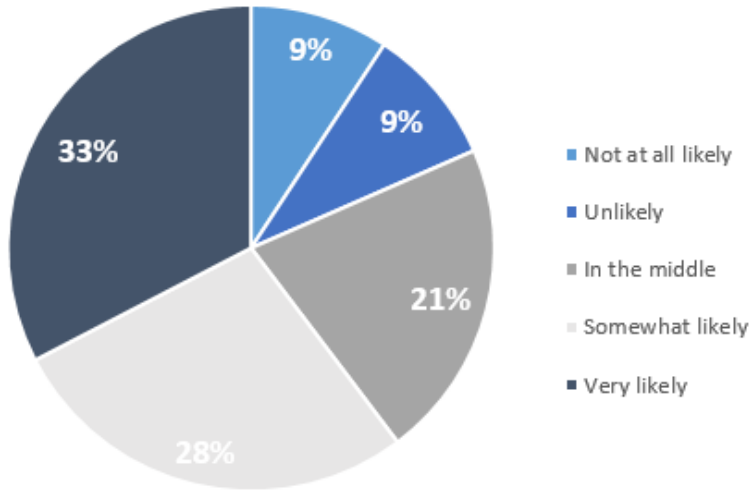
- A key pillar in Nissan's Intelligent Mobility – Intelligent Integration positioning
- Until V2G is ubiquitous, it is a strong brand differentiator for Nissan
- V2G even when widely available will still bring EV OEMs
  - Reputable expertise
  - Sustainability credentials
  - Enhanced loyalty mix

V2G an OEM brand differentiator

How important is it for you that your next EV purchase is V2G-capable?



If Nissan continues to be the only car manufacturer with fully electric V2G-enabled vehicles in the UK, how likely is it that your next EV purchase will be a Nissan EV?



Source: Sciurus triaist survey 2020

The short term challenges facing V2G

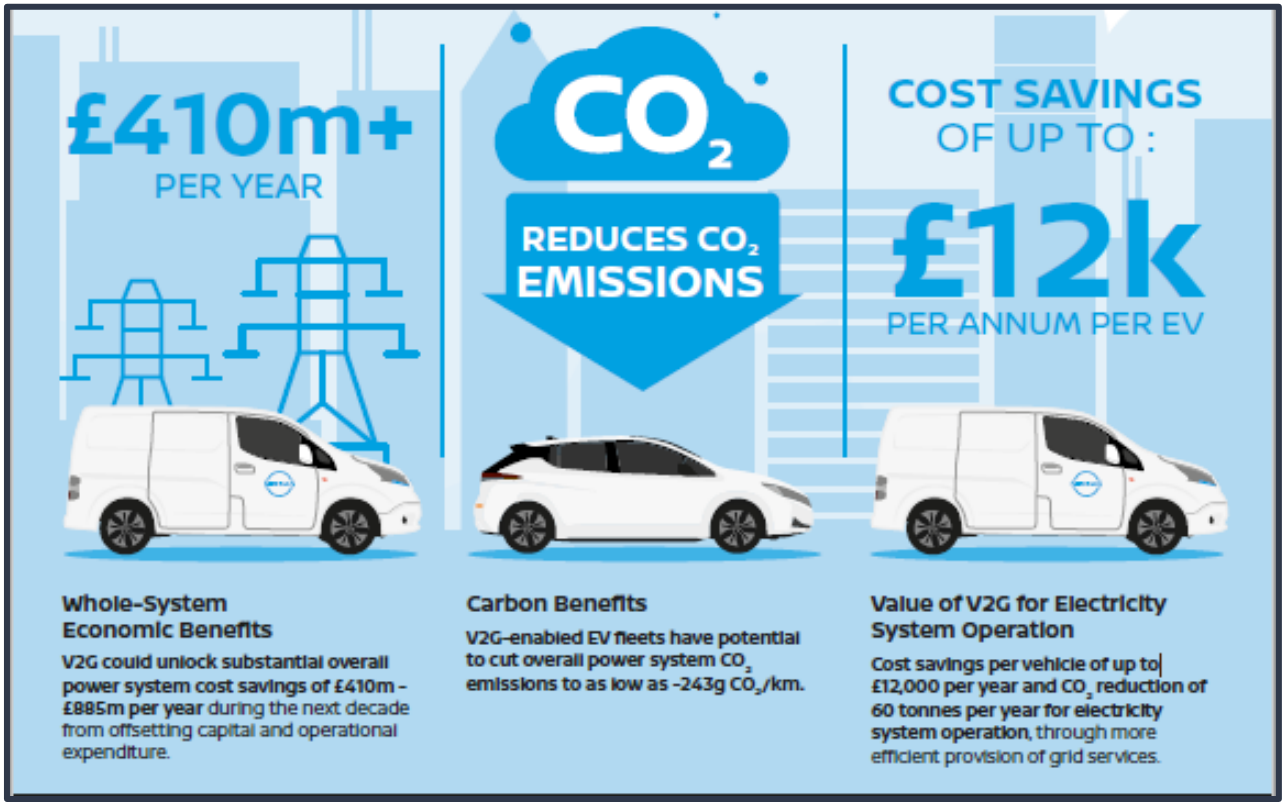
- ROI business cases exist in residential and fleet, but are weak
- Complexities around sharing benefits - aggregators, OEMs and end users
- Offerings devised through the lens of total account profitability; multiple product take up, enhanced customer loyalty, the halo of sustainability as well as arbitrage and grid revenues
- Grid services and the flexibility markets are evolving, DNO morphing to DSO but the grid revenue stack not yet aligned to optimise V2G
- Area bias - energy consumption patterns and differing levels of network stress, caused by Renewables penetration etc
- A nascent market, with low volume manufacturing thus expensive hardware at a time when uni-directional charging equipment is a long way down the cost reduction curve

Accelerating rollout will therefore require

- An improved grid revenue stack providing £700- £1200 per annum per charger
- A support mechanism that can provide consistent end user benefit across all UK
- Hardware and installation grants to minimise the cost differential between V2G and uni- directional kit, to help build market volume and to support ROI
- Reduced DNO costs - A fast track G99 approval process, and policy agreement on type testing by hardware model rather than by site basis
- P379 Meter splitting – introduce this market adjustment to facilitate end user recruitment

Supporting Dealerships, the human face of brands, on the journey to 100% EV sales

- Mass EV adoption will change dealership business revenue models
- EV are forecast to erode traditional aftersales and service revenues which need replacing
- V2G and the eco-system should be able to do some of this
  - Hardware sales and installation
  - Trail income from energy / grid services
  - Consultancy
  - Reasons to visit / enduring relationships
- V2G should support effective site power management and electricity cost minimisation, and
- Offset charger installations and grid connection costs



Source: The Drive Towards a Low Carbon Future White paper. Jan 2021

Thank you

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project sciurus

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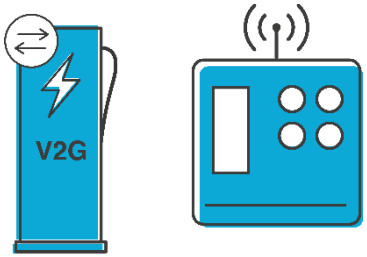
Trial Insights: Findings From 300 Domestic V2G Units in 2020

Greg Payne

Modelling & Simulation Lead

Introduction to Analysis

Data from each V2G unit on the trial has been collected and analysed.
Results from an online survey of participants was incorporated.
Data collected was run in our in-house model.
The importance of V2G customer archetypes was assessed.



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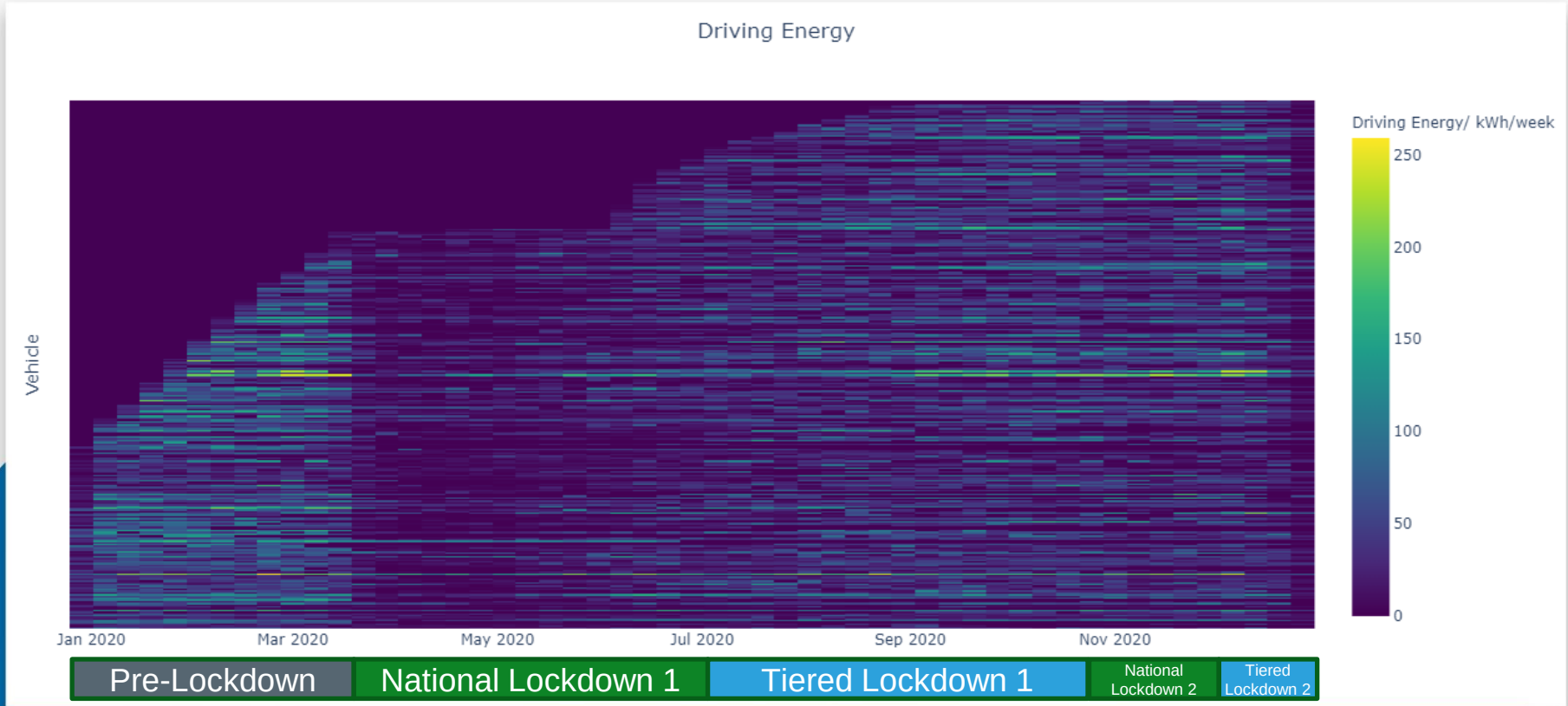
Driving Energy
Vehicle
Jan 2020
Mar 2020
May 2020
Jul 2020
Sep 2020
Nov 2020
Driving Energy/ kWh/week
250
200
150
100
50
0
Pre-Lockdown
National Lockdown 1
Tiered Lockdown 1
National Lockdown 2
Tiered Lockdown 2

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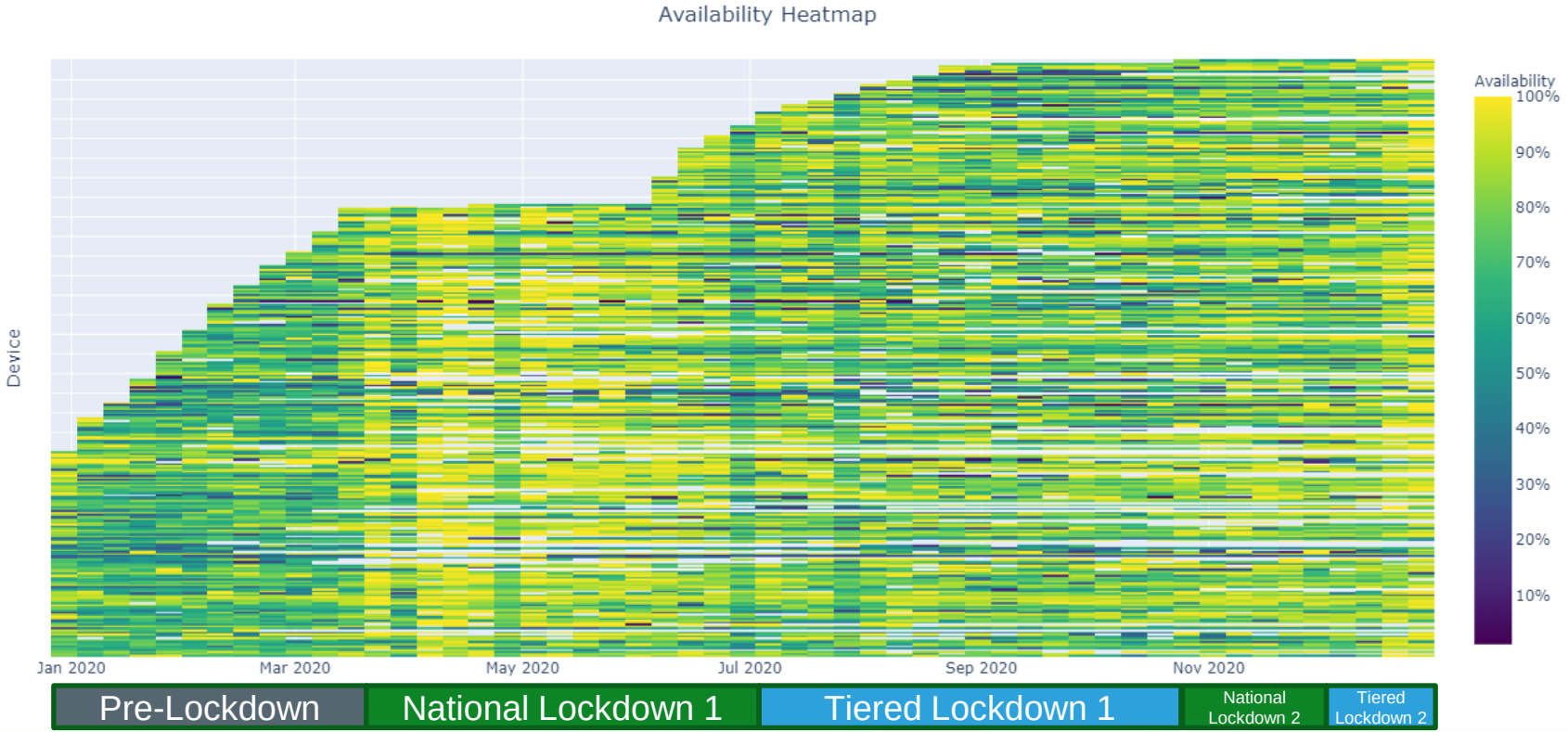
Availability Heatmap
Device
Jan 2020
Mar 2020
May 2020
Jul 2020
Sep 2020
Nov 2020
Availability
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
Pre-Lockdown
National Lockdown 1
Tiered Lockdown 1
National Lockdown 2
Tiered Lockdown 2

Plug-in Availability During Trial

Typical Domestic EV Plug-in Availability:

30%-40%

Trial Plug-in Availability:

56%

Lockdown Plug-in Availability:

70%

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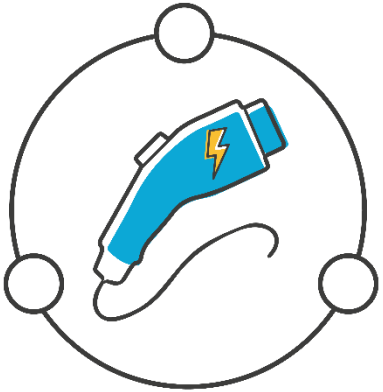
Participant Survey

Survey sent out during summer of 2020
Collected information on participants, how they used their EV and chargepoint
145 participants responded



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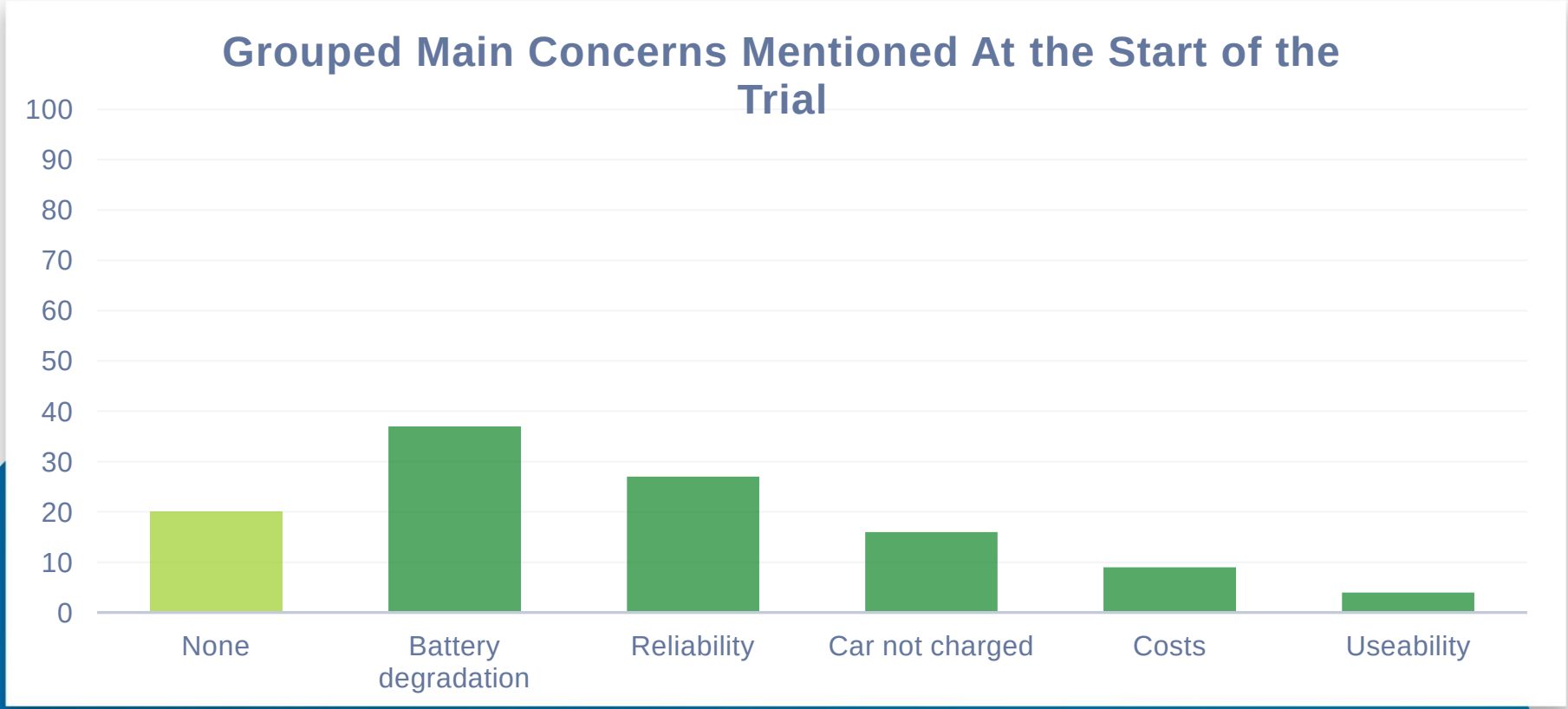
Grouped Main Concerns Mentioned At the Start of the Trial
100
90
80
70
60
50
40
30
20
10
0
None
Battery degradation
Reliability
Car not charged
Costs
Useability

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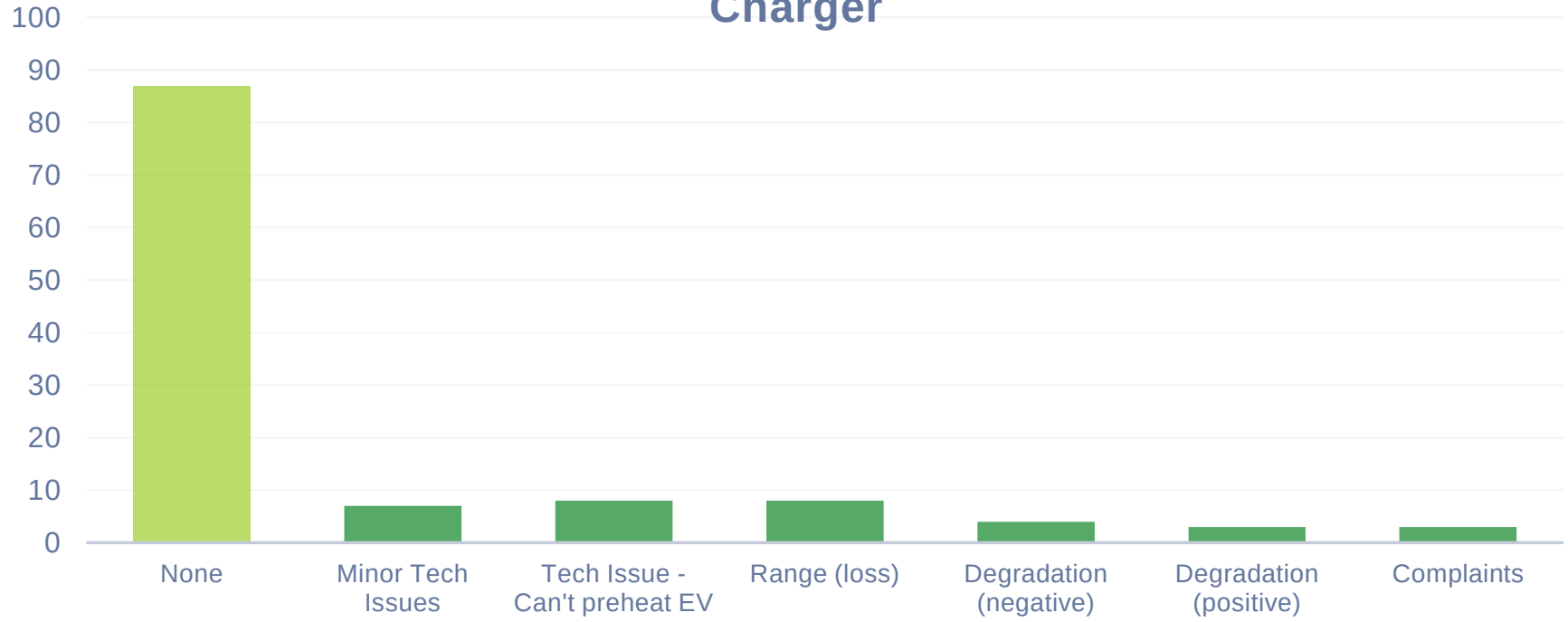
Grouped Main Changes to EV Noticed After Using V2G Charger



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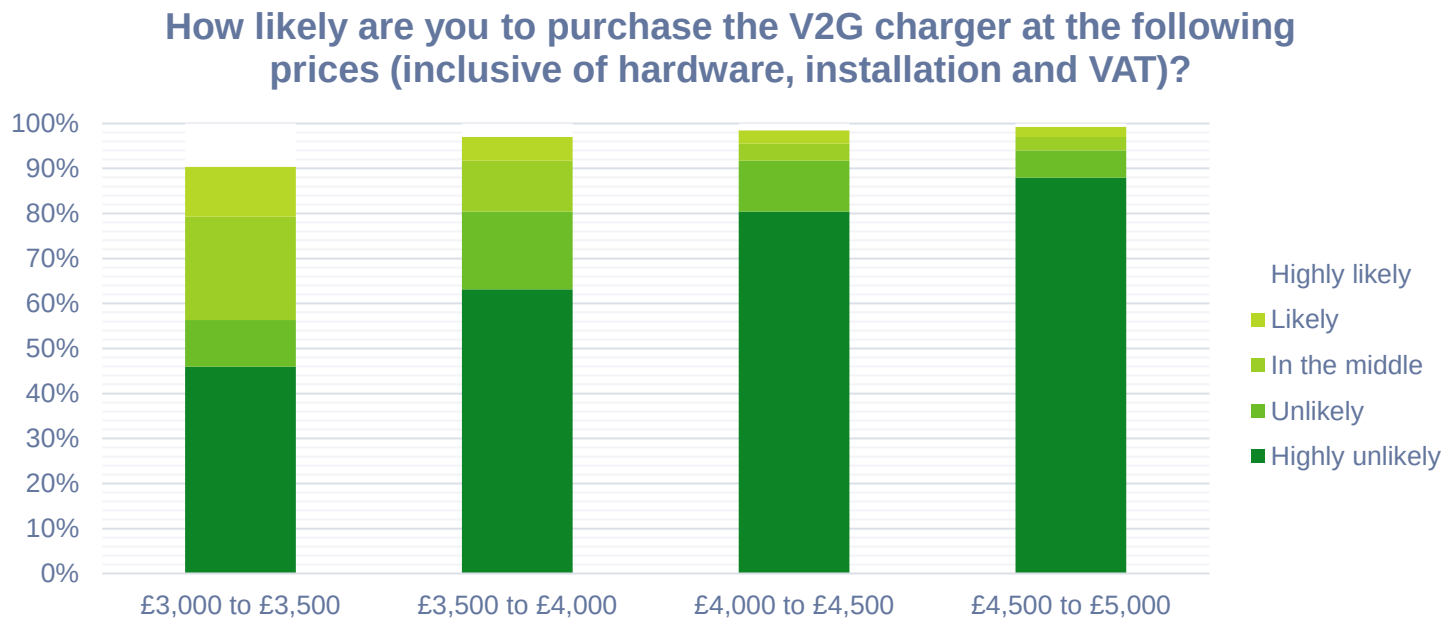
Purchase Cost of V2G is Still Too High



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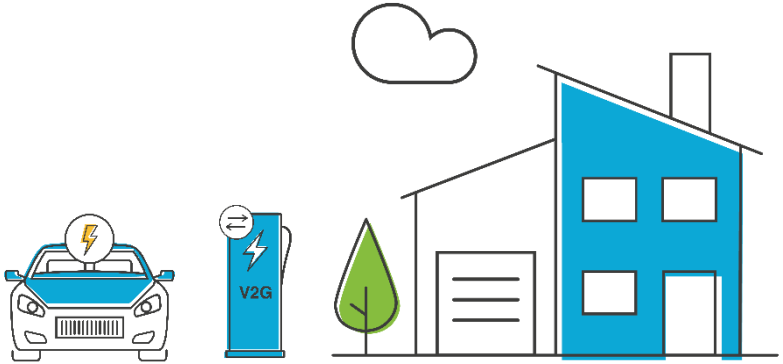
Modelling from Trial Data



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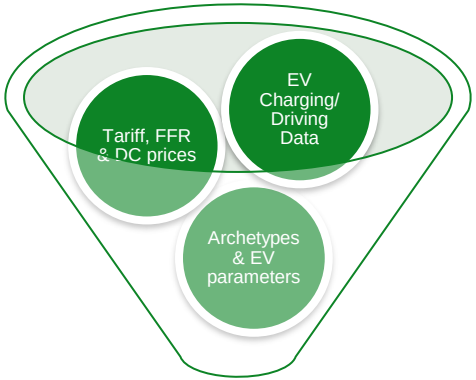
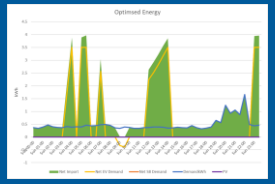
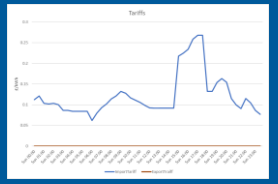
Modelling Approach



REVOLVE

Optimised Charging Schedules & Grid Service Participation





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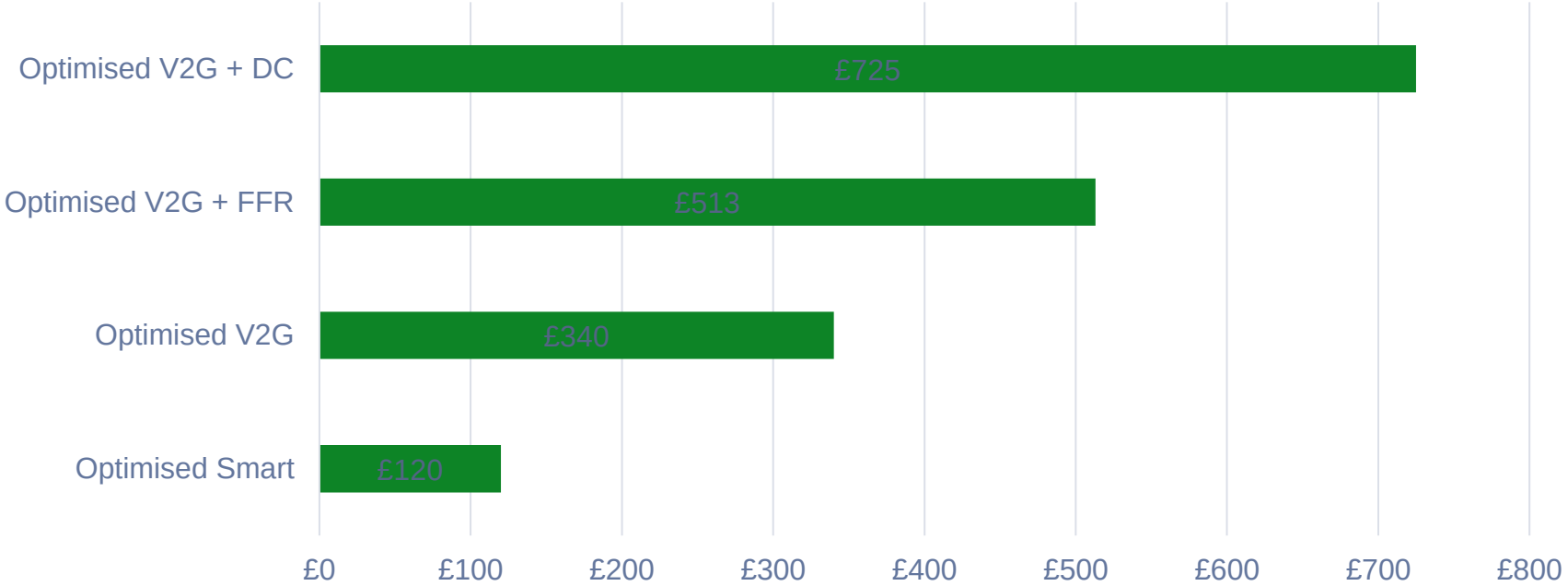
Annual Per Chargepoint Revenue



Note: Against a HH settled unmanaged charging baseline

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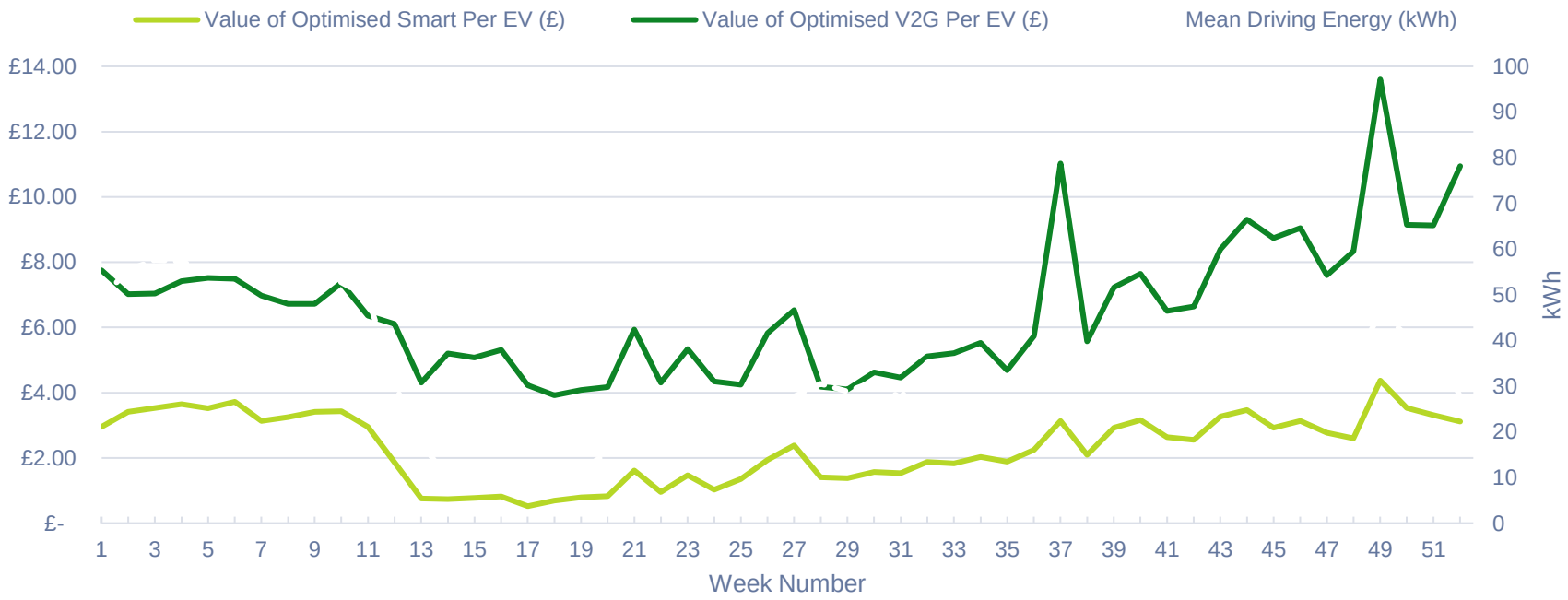
Weekly Value of Optimisation During 2020



Note: Spot market price spikes occurred in weeks 10, 37 and 49

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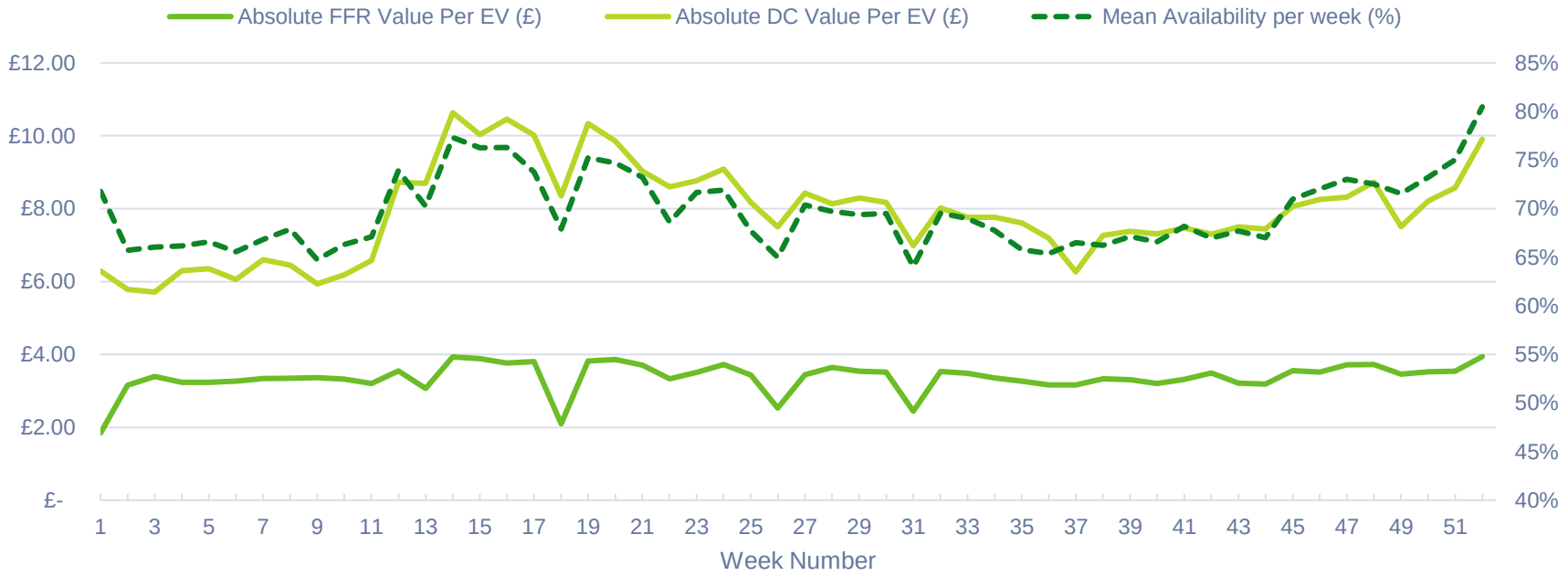
Weekly Value of Grid Services During 2020



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Future Changes To Revenue

- Targeted Charging Review will remove time of use based TNUoS charges in April 2022
- DUoS export rates for domestic premises will become shaped from April 2021
- The Net Impact: ~ 50% reduction in tariff optimisation income for V2G

- However, emerging balancing services (e.g. DC), and wider access to the Balancing Mechanism could form additional income.

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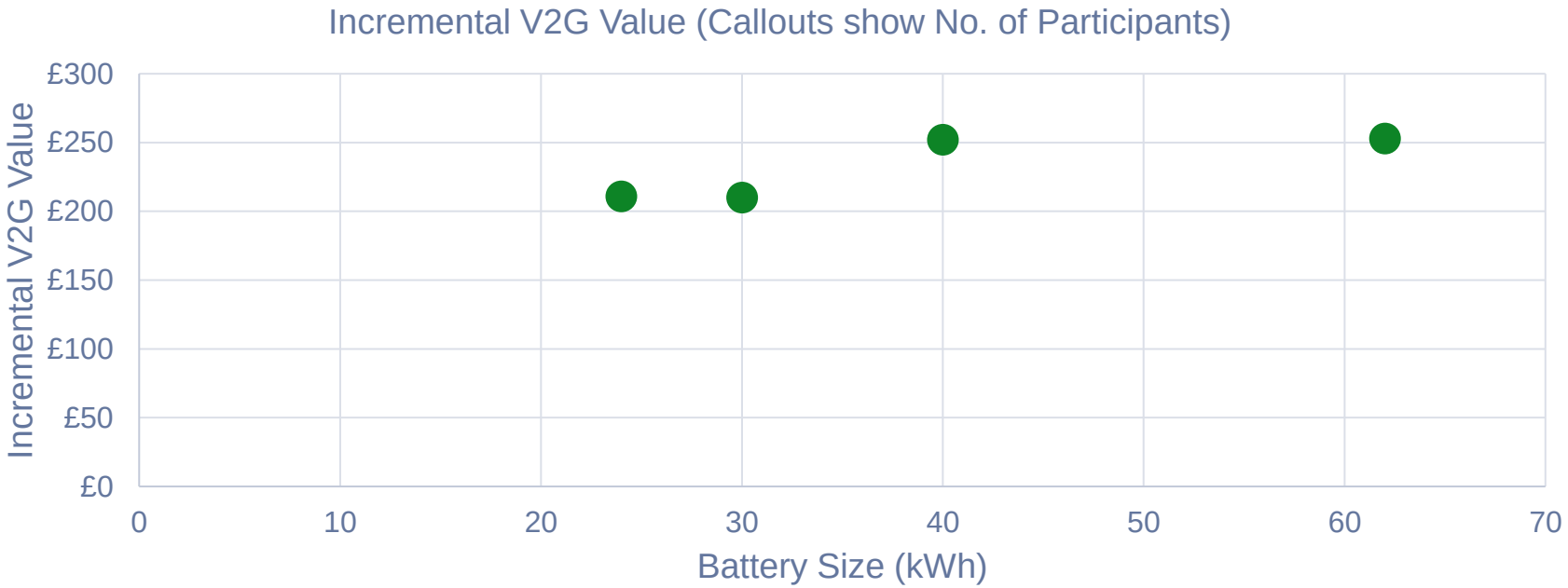
Does Size Matter?



Note: Incremental V2G value is the value of the V2G optimisation above the Smart optimisation

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Domestic V2G Archetypes

Cenex previously produced a portfolio of V2G customer archetypes.
See our public report "Understanding the True Value of V2G" 2019.

First Generation EV Owner

This is someone in their 50's or 60's who is an early adopter of technology. They already have PV on their home, and now an off-street V2G charger. They are very energy conscious and would like to maximise battery life. The car is an early EV, used for commuting in the day but spends most of the rest of the time plugged in at home.

Technology Progression

BEV
PHEV
N/A

Key Information:

V2G Location:	Home
No. of EVs using charge point:	1
V2G Availability:	40-60%
Potential no. in the UK:	1k-10k

Primary User		Usage	
Age Range:	40-60	Parking Pattern:	Predictable
Income Bracket:	Varied	Type of trips:	Short/Medium
Employment Status:	Employed	%age of plugged-in time used for charging:	20-40%
Vehicle Ownership Type:	Owned		
Battery Life Conservation:	High	Charging Location:	Mostly at this location
Primary Motivation:	Environmental	**Location**	
Vehicle		Building ownership type:	Owner
Battery Size:	Small	On-site renewables:	Yes
Type of vehicle:	Midsize car	Parking Location:	Varied

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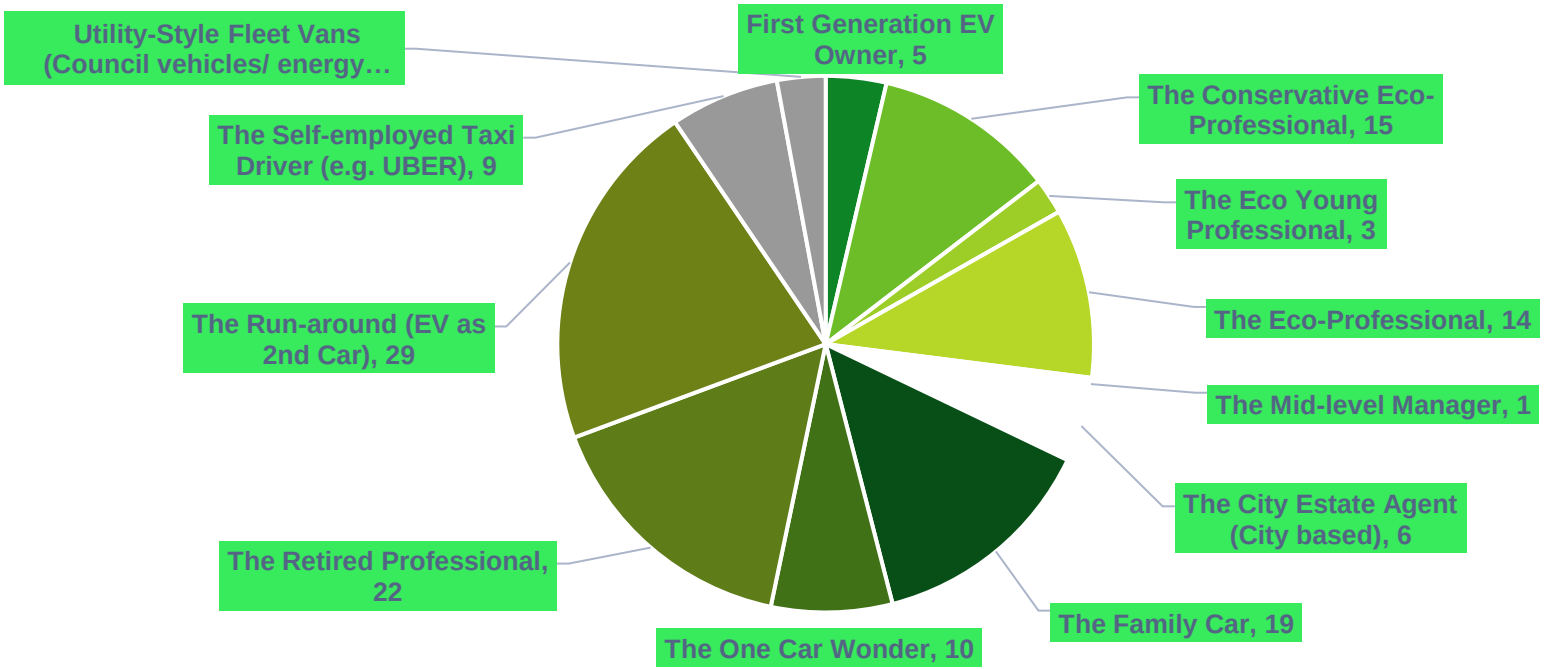
Archetypes of Survey Respondents



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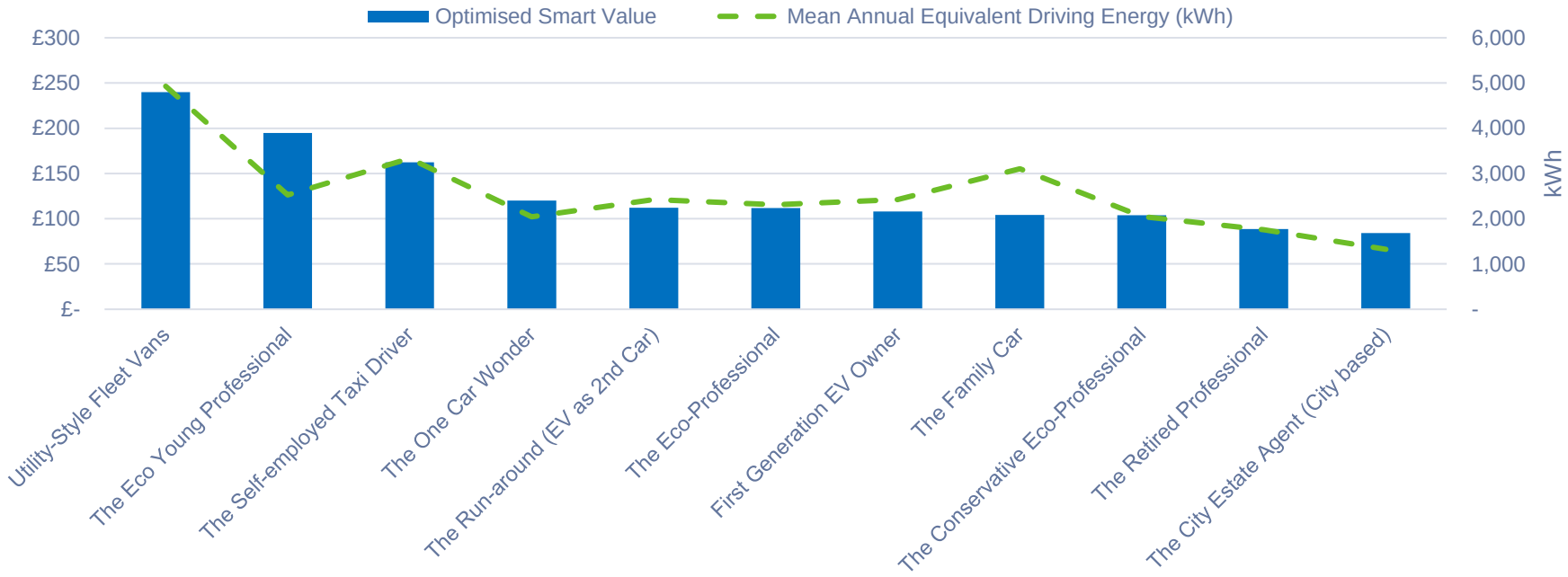
Value of Archetype for Smart Charging



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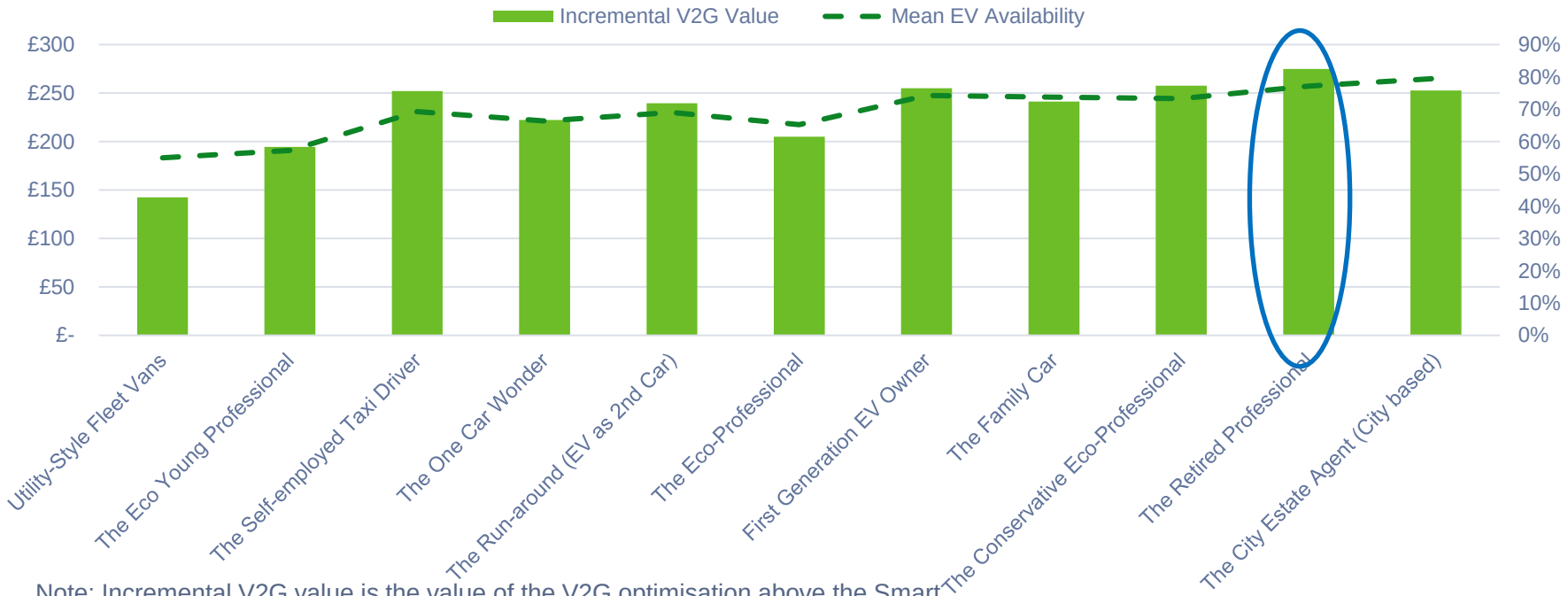
Value of Archetypes for V2G



Note: Incremental V2G value is the value of the V2G optimisation above the Smart optimisation

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Final Thoughts

In the trial we demonstrated significant plug-in behaviour change, and alleviated the majority of participants concerns.

In the future reductions in V2G hardware costs need to continue, and additional revenue streams sought to mitigate impact of TCR

To make the most of domestic V2G, propositions should target the right customer archetype with a sufficiently sized EV battery, using a solution that is able to capture value from grid or balancing services and wholesale price spikes.

Project Sciurus: Achievements from the world's largest V2G trial

project sciurus

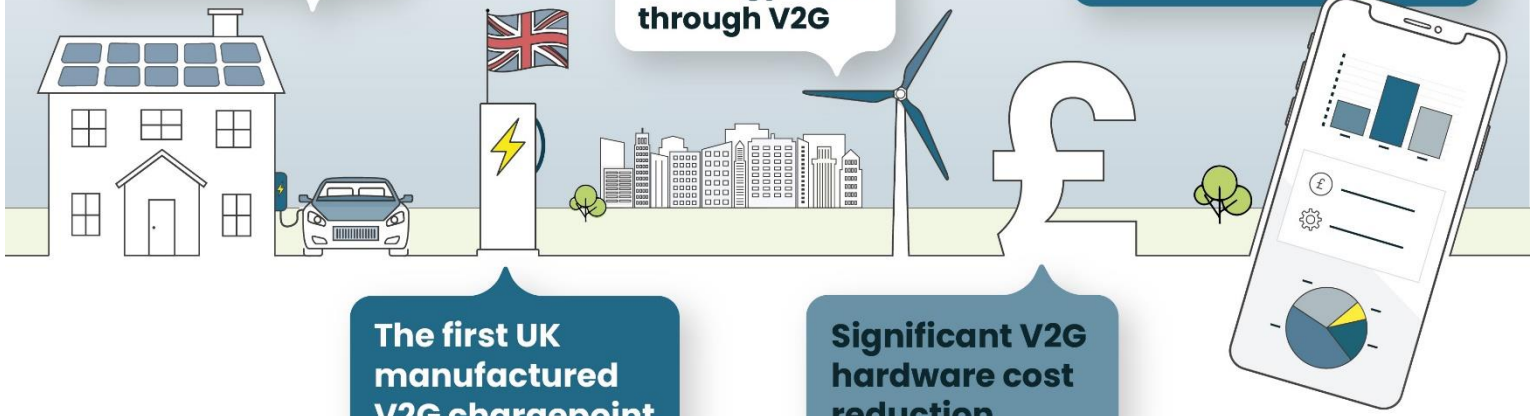
>320 V2G Units installed in homes throughout the UK

Simple customer proposition

Platform to aggregate and optimise V2G units

>750MWh of energy offset through V2G

Customer App keeping the customer in control of charging



The first UK manufactured V2G chargepoint

Significant V2G hardware cost reduction

Funded by the Department for Business Energy and Industrial Strategy (BEIS) and the Office for Zero Emission Vehicles (OZEV), in partnership with Innovate UK.

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Thank you for listening

Greg Payne

Modelling & Simulation Lead