

New EV Drivers: Overcoming Range Anxiety and Other Barriers

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Cenex

TSB ULCV Demonstrator Programme

Allied Electric Vehicles
Scottish Power
Axeon Batteries
Strathclyde University,
Glasgow City Council

Jaguar Land Rover (Tata), Smart,
Mitsubishi, Microcab
Eon Energy
Arup
Coventry and Birmingham City Councils
Aston and Coventry Universities

Ford
Scottish and Southern Energy
Strathclyde University

Smart UK
Nudge Advisory

Nissan, Smith Electric Vehicles, AVID,
Liberty Electric Cars, Peugeot
Gateshead Council
Future Transport Systems
Newcastle University (TORG)

BMW Mini-E
Scottish and Southern Energy
Oxford Brookes University

Delta Motorsport, Westfield Sports Cars
Ecotricity Cars, Lightning, AEA Technology,
Green Motion Eco Car Hire

Toyota
EDF Energy
MET Police, Transport for London, GCDA



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276,989 individual trips

1,559,144 miles travelled (2,508,663km)

51,659 charging events

Scottish and Southern Energy
Strathclyde University



Smart UK
Nudge Advisory

Toyota
EDF Energy
MET Police, Transport for London, GCDA



Participants

352 Drivers

212 Private; 140 Corporate

76% Men; 24% Women

23-71 years old (M = 46)

67% of PD paid monthly lease fee (M = £267)

82% > £41,000; 45% > £71,000; 25% > £101,000

85% Married or cohabiting

91% White

Data Collection Time Points

Pre-Trial 1 Week 3 Months

Questionnaire

Questionnaire

Interview

Interview

Interview

Who Drives EVs?



Who Drives EVs?



A man is shown from the chest up, sitting in the driver's seat of a car. His face is obscured by a black rectangular box. He is wearing a dark jacket over a light blue shirt. His hands are on the steering wheel. The background is a blurred outdoor scene.

Who Drives EVs?

General Car Enthusiast
Interest in New Technology
Being Among the First
Test the Practicalities
Protecting the Environment
Saving on Fuel Costs

A photograph of a man with a mustache, wearing a dark jacket over a light blue shirt, driving a car. His nameplate is redacted with a black box. The background shows a blurred outdoor scene.

Who Drives EVs?

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Being Among the First
Test the Practicalities
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Saving on Fuel Costs

Small #: Intend to “fully investigate” the capabilities

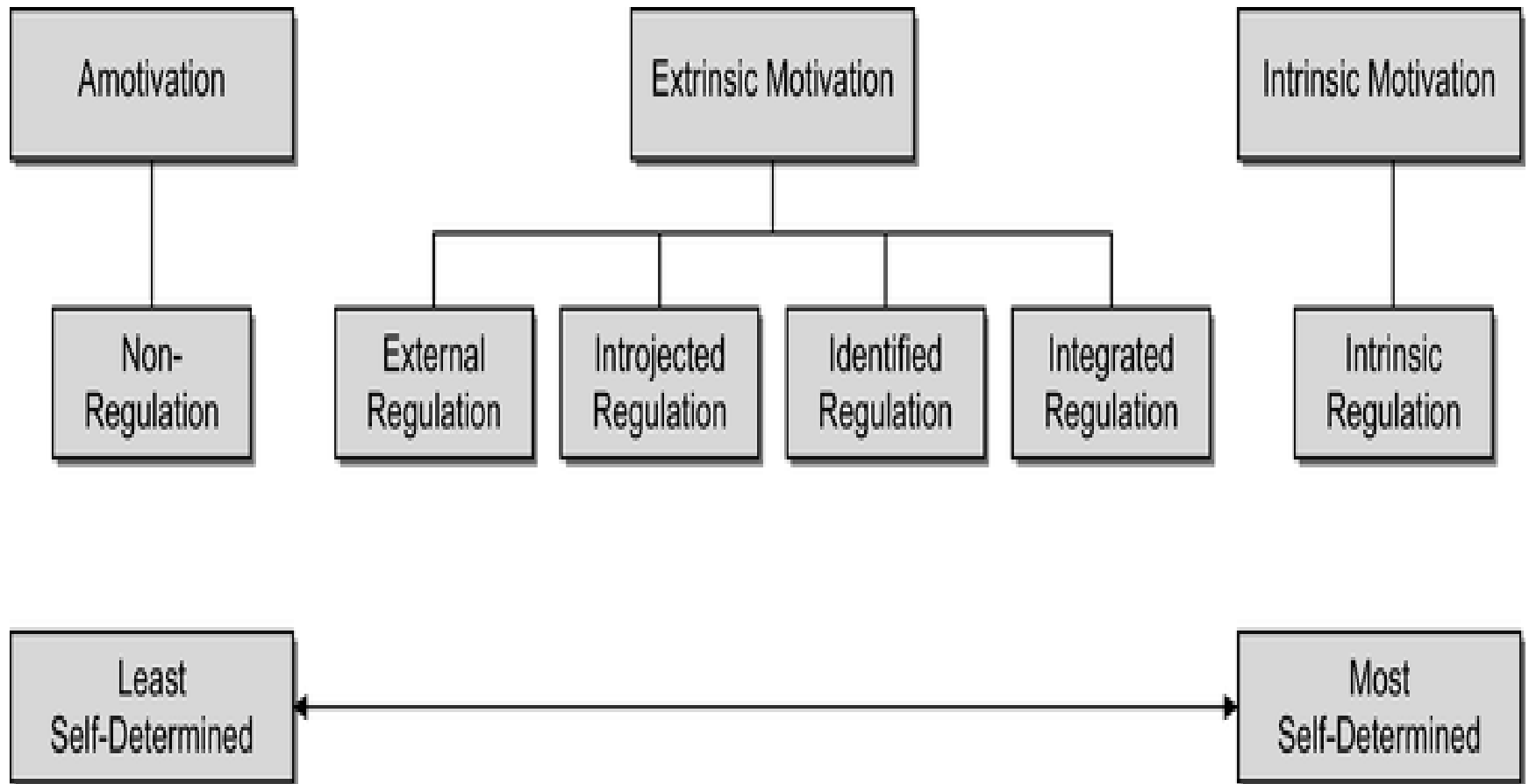
Corporate Drivers



Protecting the Environment
Identify with Company's Green Agenda
Endorse Renewable Energy

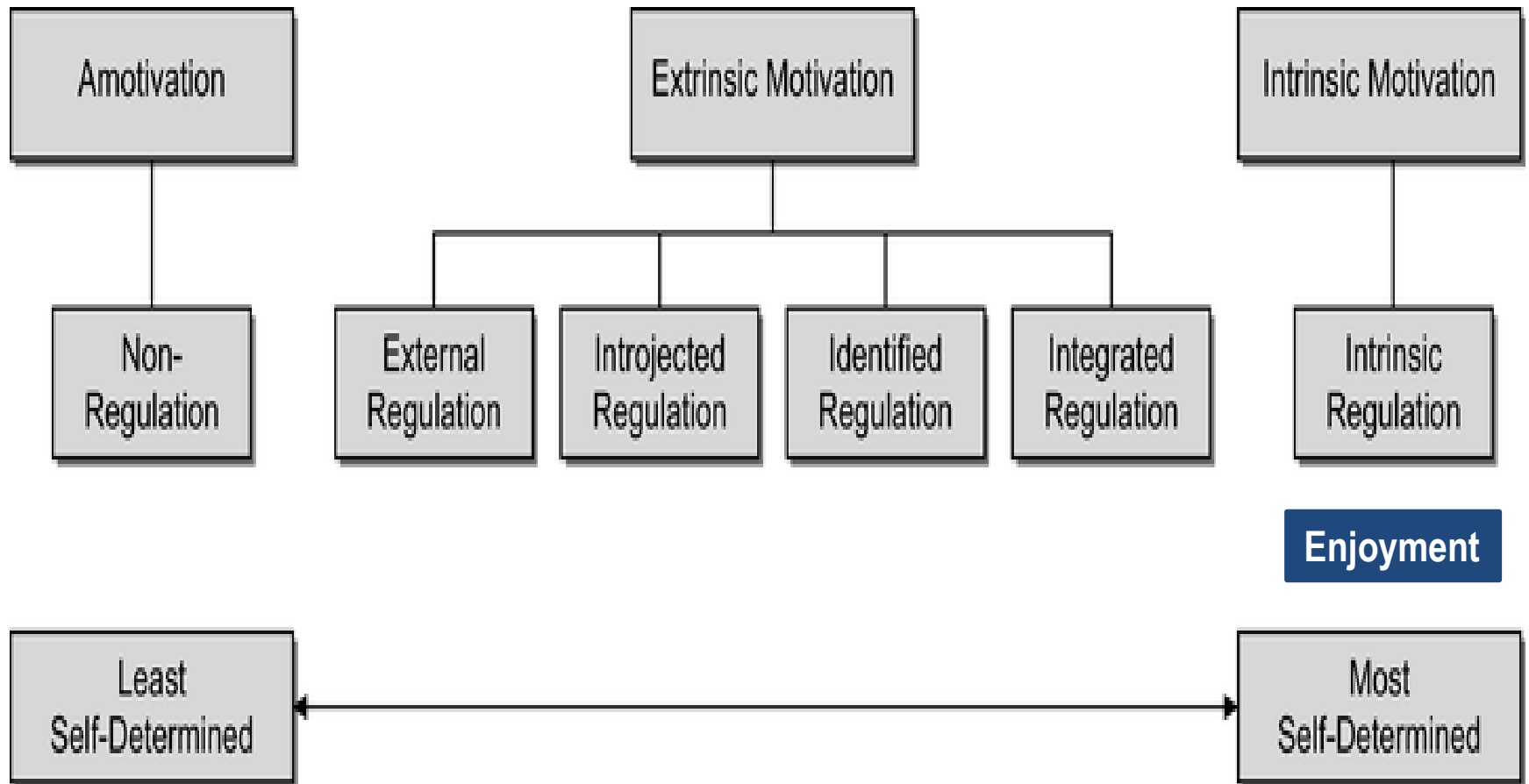
Self-Determination Theory

(Deci & Ryan, 2000)



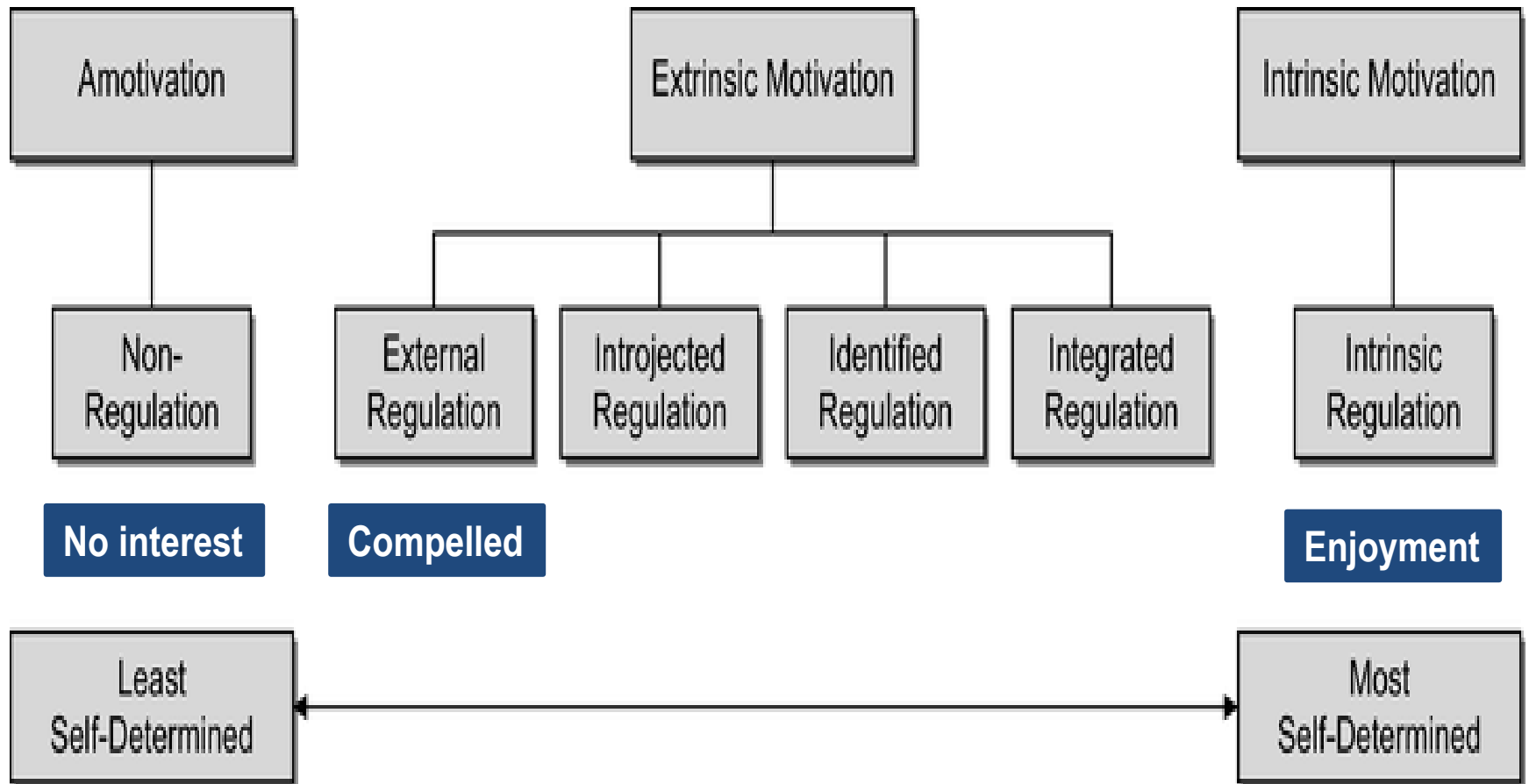
Self-Determination Theory

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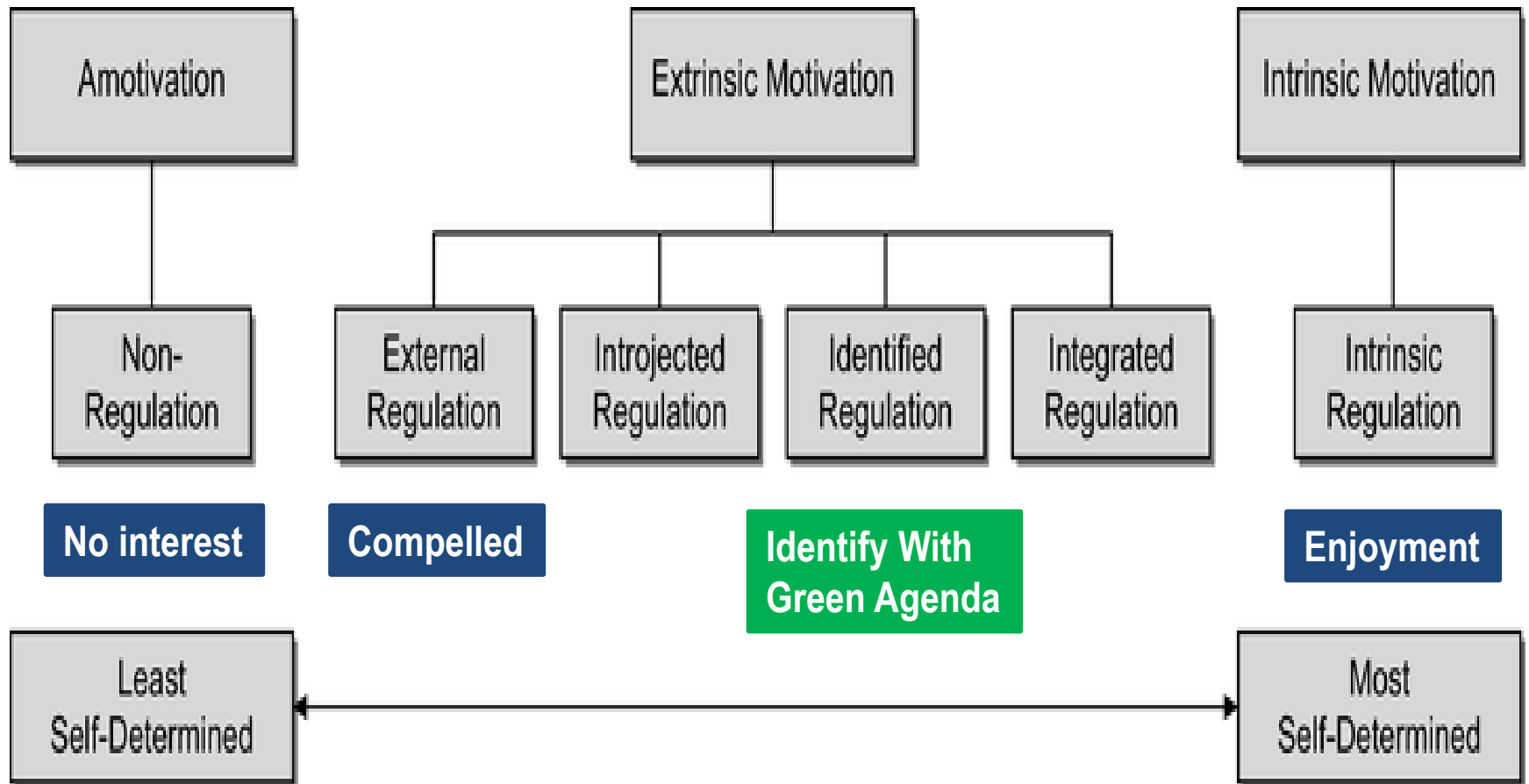
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Self-Determination Theory

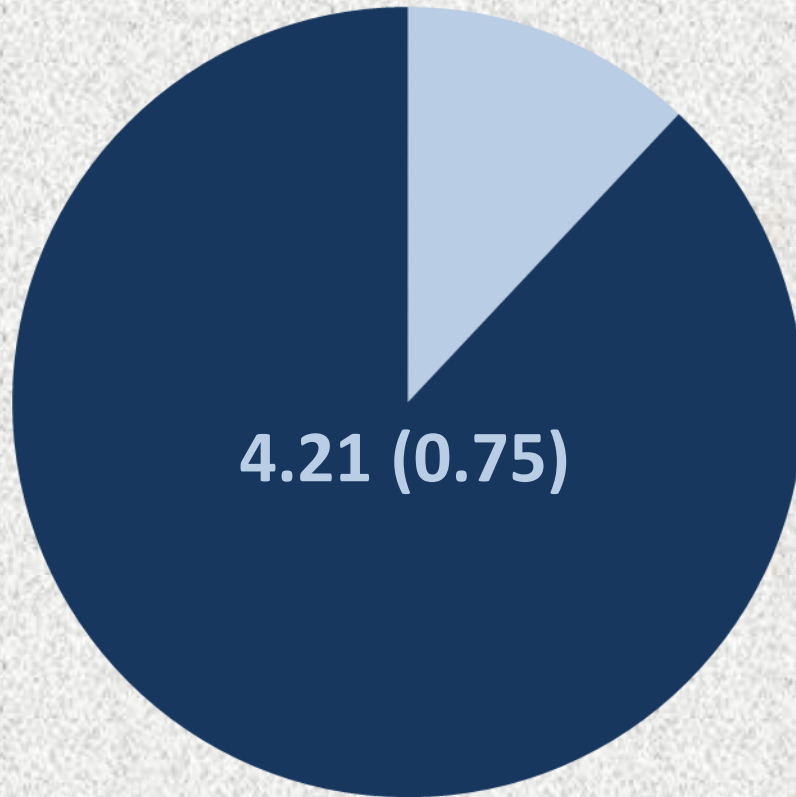
(Deci & Ryan, 2000)



Initial Adaptation

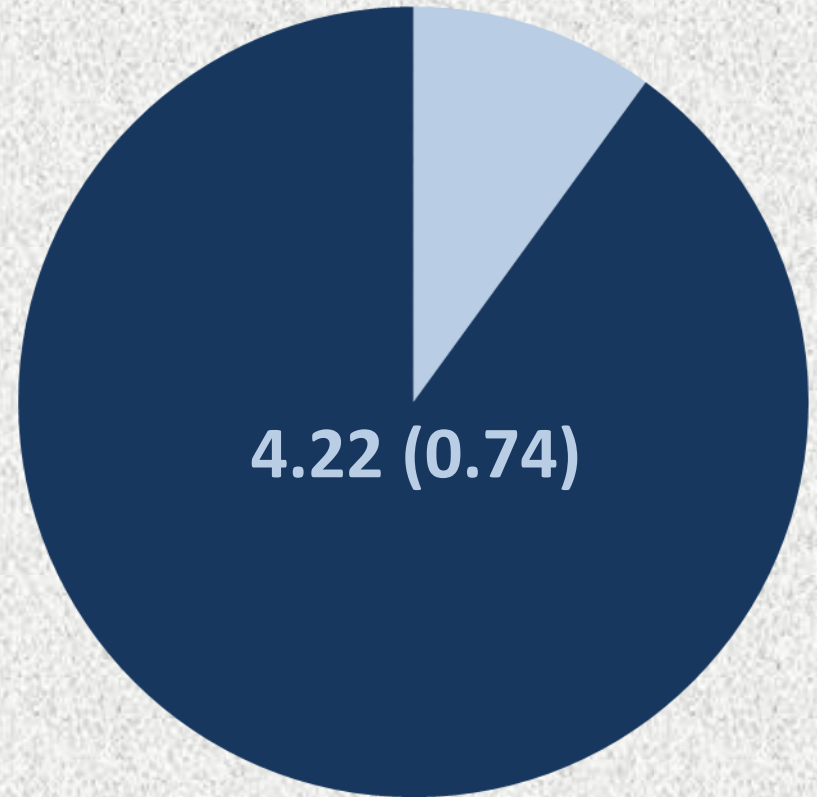
Learning to Use My EV Will Be Easy

88% Agreement



PD

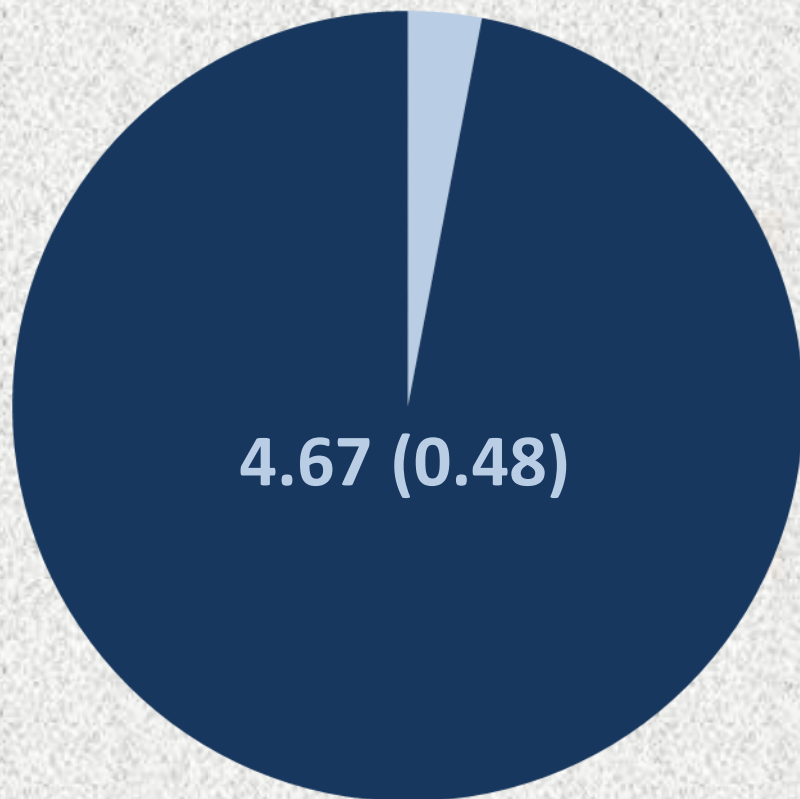
90% Agreement



FD

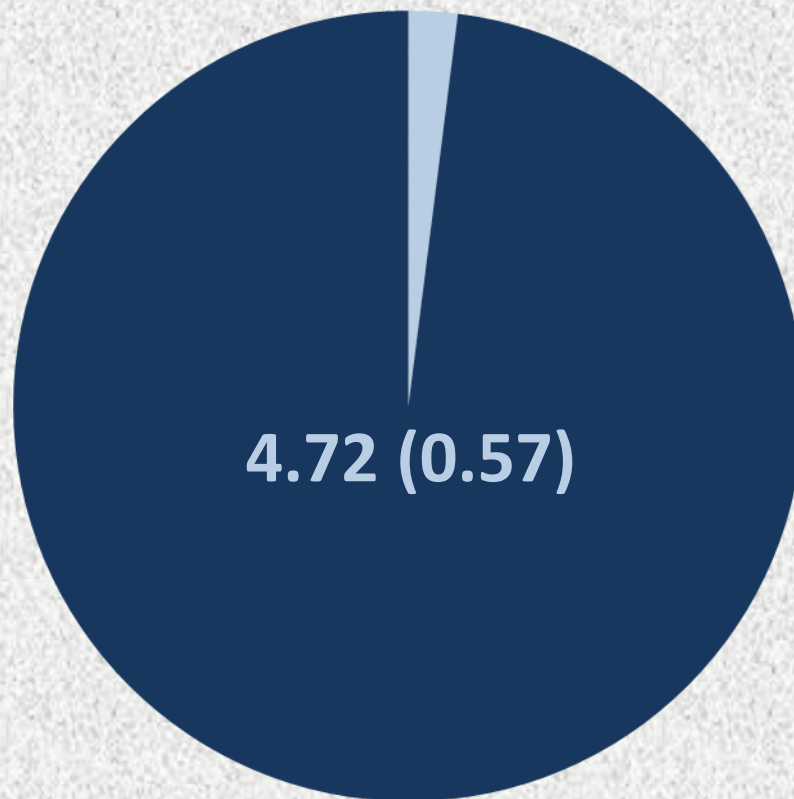
Learning to Use My EV Was Easy

97% Agreement



PD

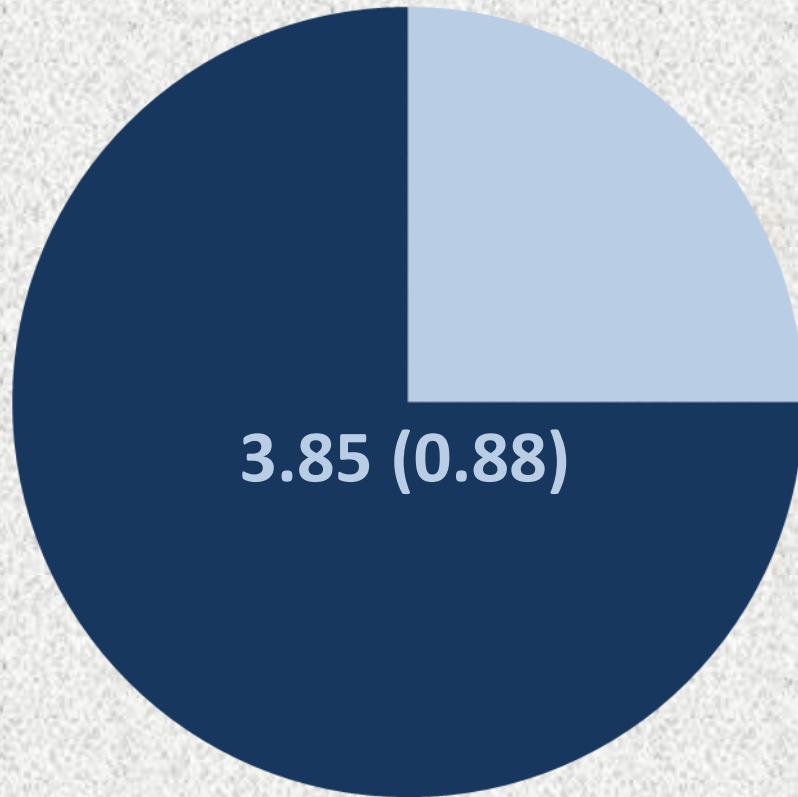
98% Agreement



FD

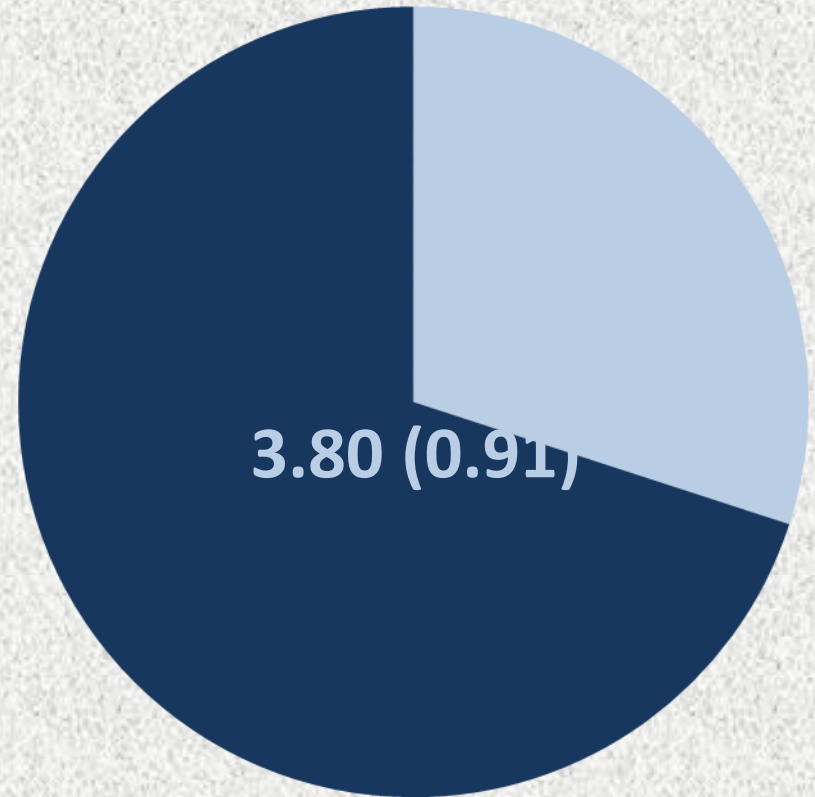
My EV Will Be As Easy To Use As My Normal Car

75% Agreement



PD

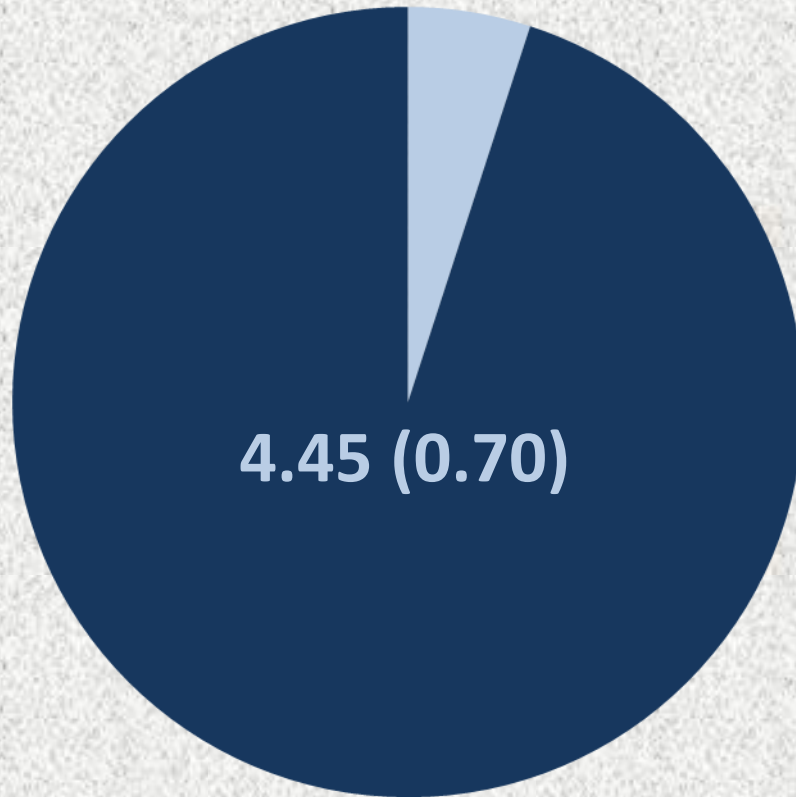
70% Agreement



FD

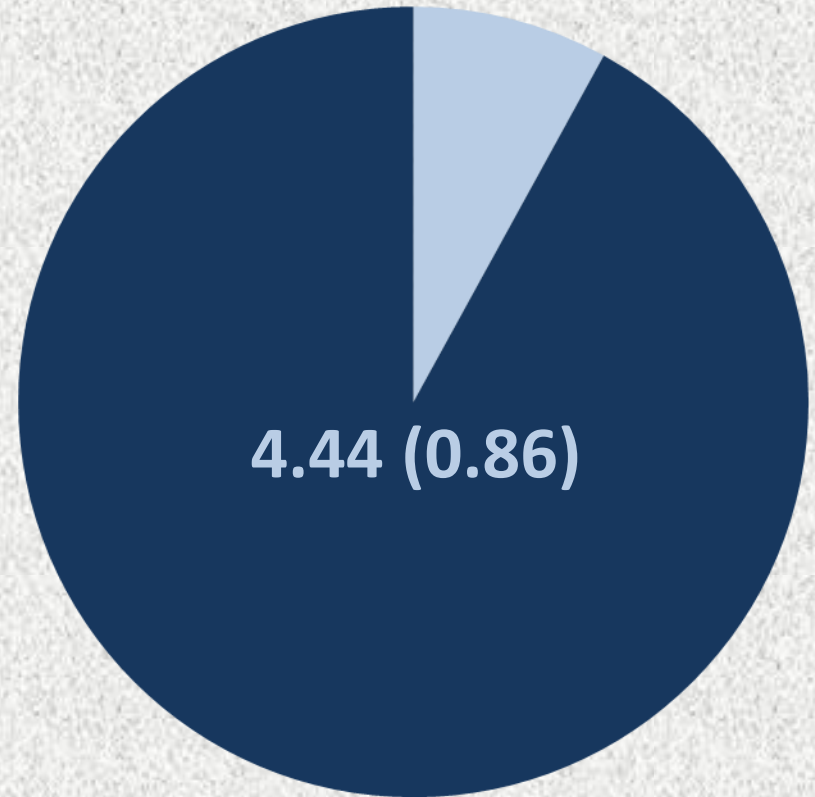
My EV Was As Easy To Use As My Normal Car

95% Agreement



PD

92% Agreement



FD



Typical EV Performance?

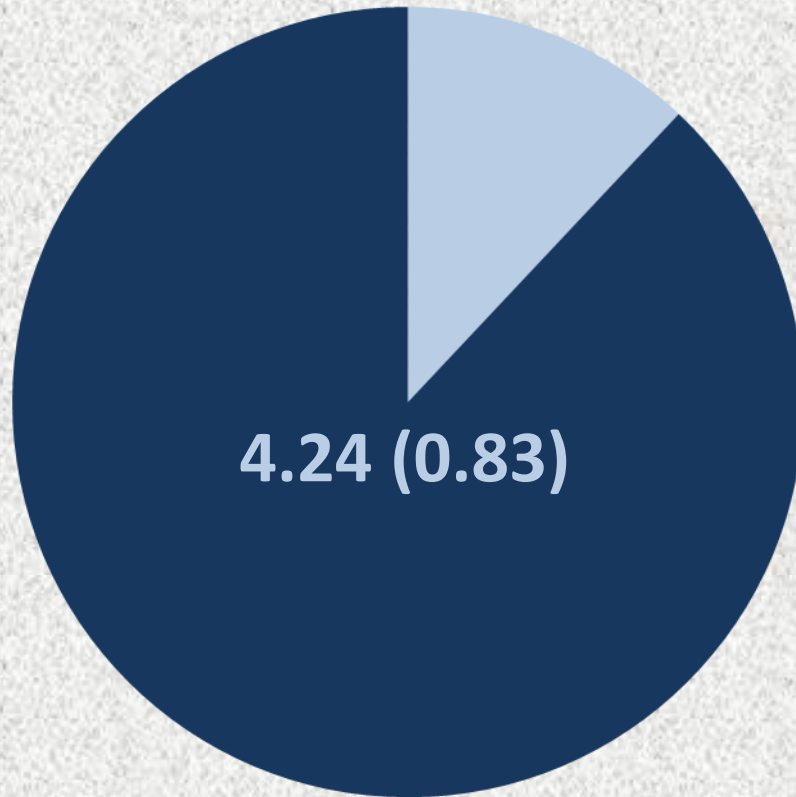
Superior Generation of EVs

**Performance
Acceleration
Handling**



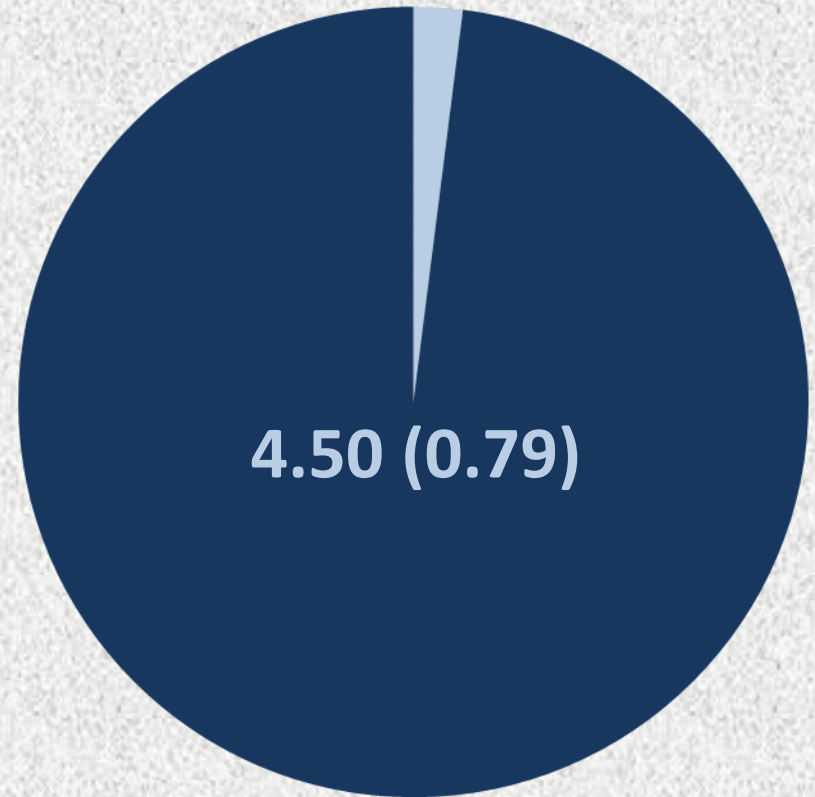
The Top Speed of My EV Was Sufficient

88% Agreement



PD

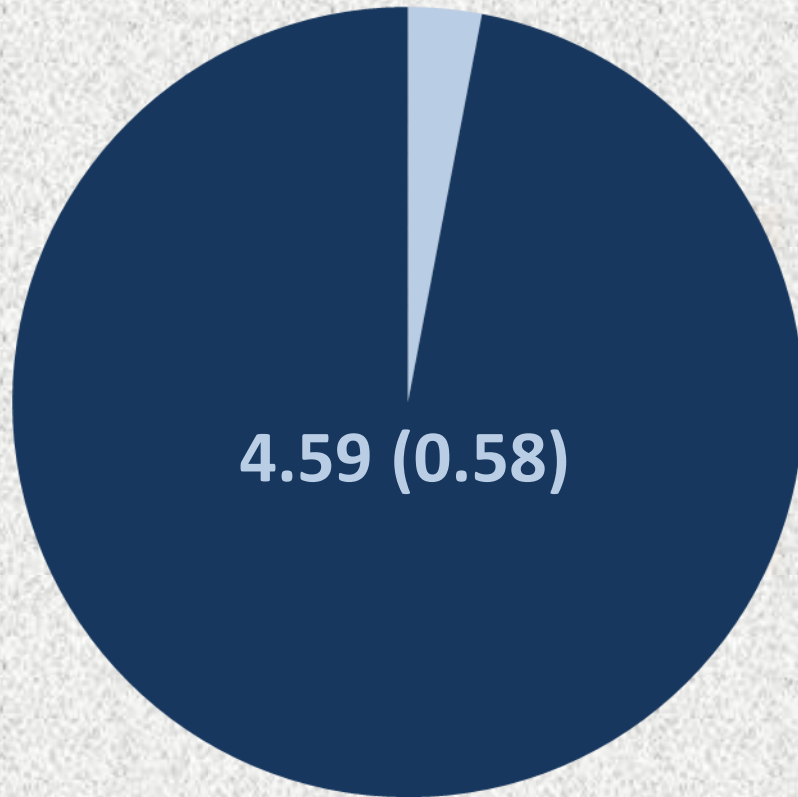
98% Agreement



FD

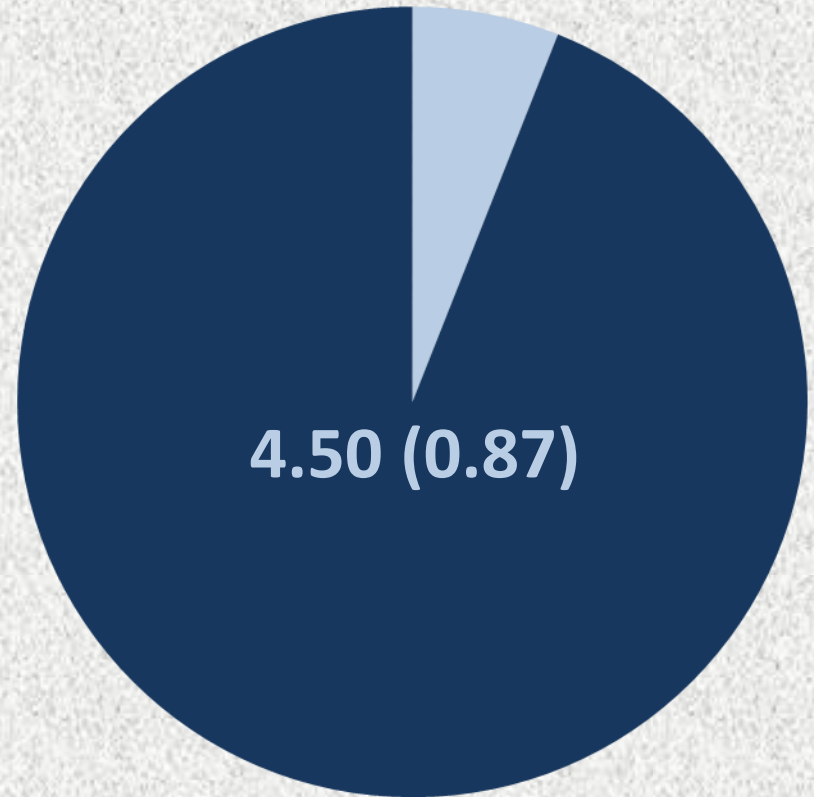
My EV Was Fun To Drive

97% Agreement



PD

94% Agreement



FD

Nature of EV Meanings?

General stereotype has been -Ve

Nature of EV Meanings?

General stereotypes

seen

-ve

Outdated

Nature of EV Meanings?

General stereotypes

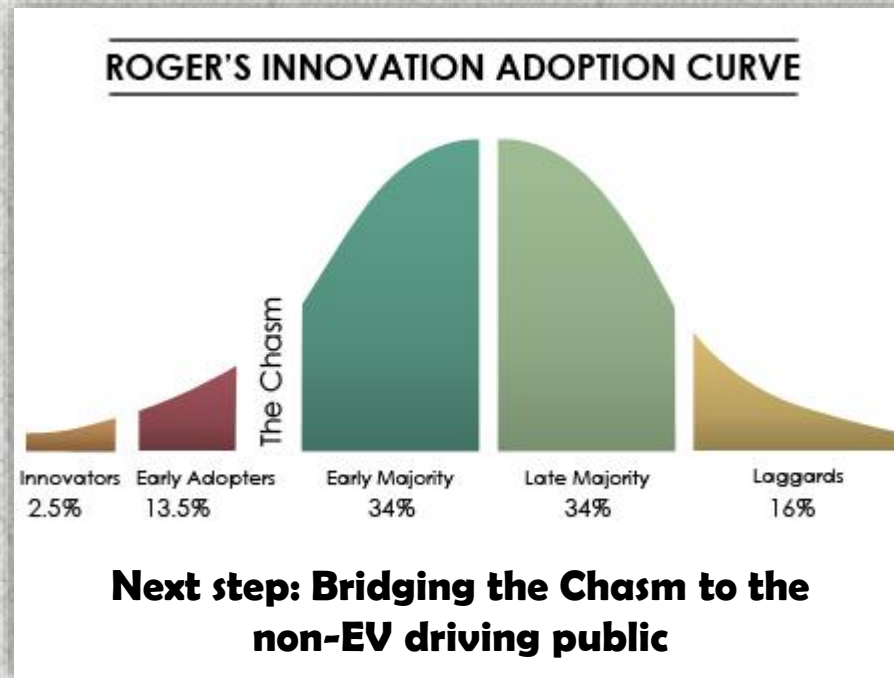
seen

-ve

Outdated

Burgess, King, Harris & Lewis. (2013) EV drivers' reported interactions with the public: Driving stereotype change? Transportation Research Part F, 17, 33-44.

Diffusion of Innovation

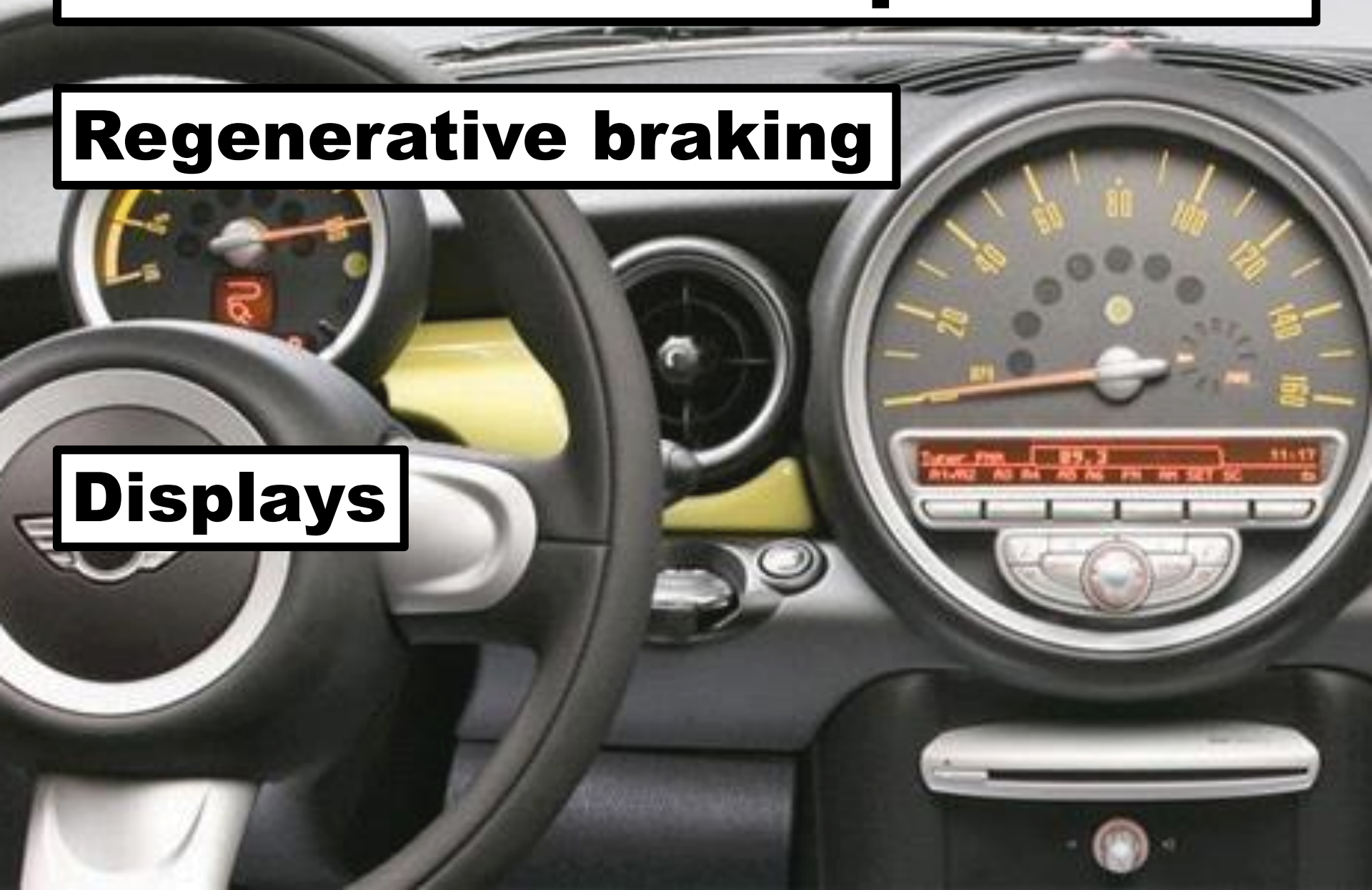


Often, exposure of mainstream to innovators/early adopters helps with diffusion and helps change cultural context & meanings surrounding new technology.

Ease of Use/Interpretation

Regenerative braking

Displays



Ease of Use/Interpretation



Regenerative braking

Positive feature, immediate, preferential use

Displays

Clear, understandable, visually arresting

Ease of Use/Interpretation



Regenerative

How Much?

Positive feedback

“No Idea”

potential use

Displays

Clear, understandable, visually arresting

Introduction to the Vehicle



Introduction to the Vehicle

All drivers quickly learn:

Drive competently

Use regenerative braking

Interpret displays



Introduction to the Vehicle

A white car with green accents and green wheels is parked in front of a brick building. A person is visible in the driver's seat. The car has a green stripe running along the side and green wheels. The background is a brick wall with a window.

All drivers quickly learn:

Drive competently

Use regenerative braking

Interpret displays

Primary Adaptation





RANGE

The background of the image is a reproduction of the painting 'The Scream' by Edvard Munch. It depicts a figure in the center with a pale, greenish-yellow face and wide, staring eyes, holding their hands to their cheeks in a gesture of shock or distress. The background of the painting shows a turbulent, swirling sea in shades of blue and green, with a yellow, hazy sky in the distance where a few small boats are visible.

RANGE

Social: Impede widespread adoption

Personal: Will suit my needs

The background of the slide is a reproduction of the painting 'The Scream' by Edvard Munch. It depicts a turbulent sea with dark, swirling blue and red waves under a pale, yellowish sky. Two small ships are visible on the horizon in the upper left.

Well, it will be just perfect because I'll charge it at night and it'll do exactly what I'll need for my daily commute *Driver 9*

Routine won't change *but*

Range: ▼ exceptional journeys

▲ cognitive load

Adequate and Ideal Ranges

Pre

Private

75

230

Adequate

Ideal

Fleet

100

170

0

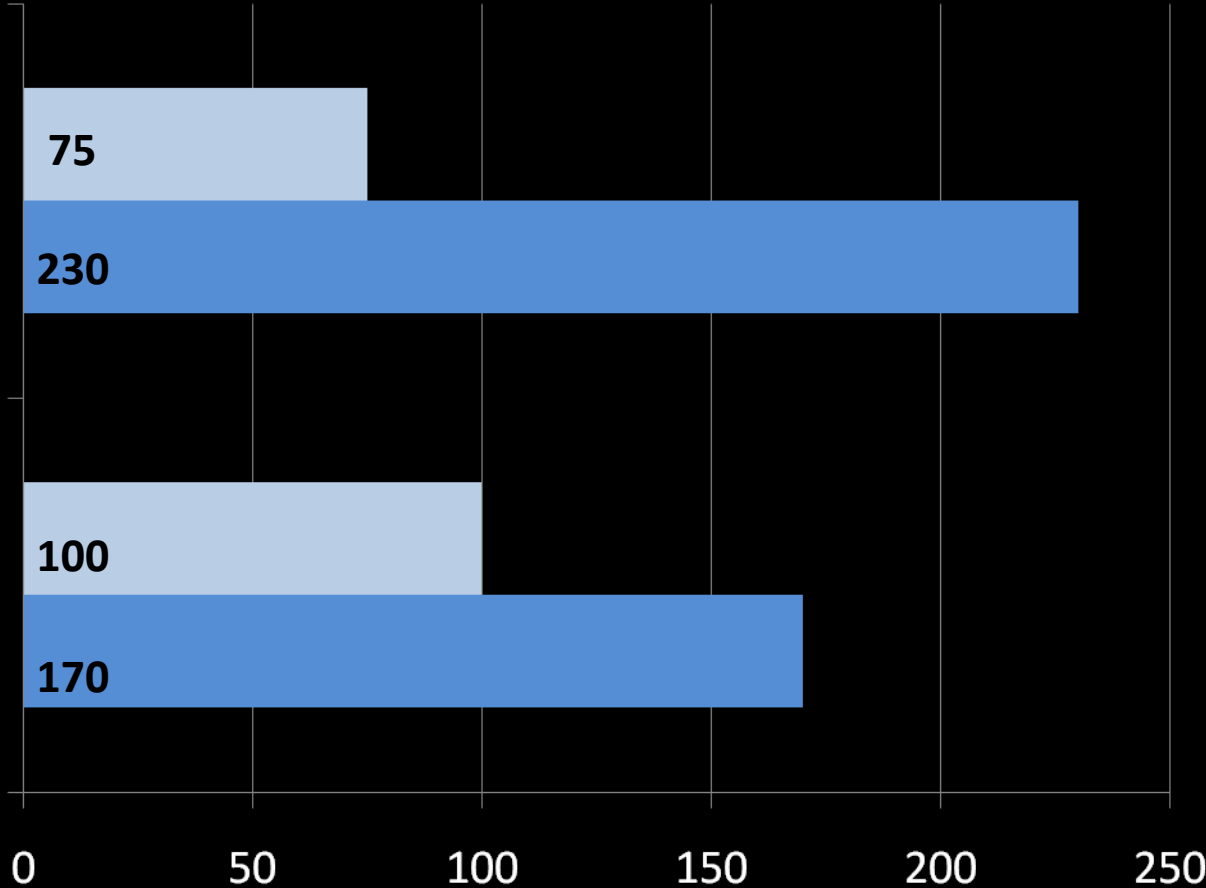
50

100

150

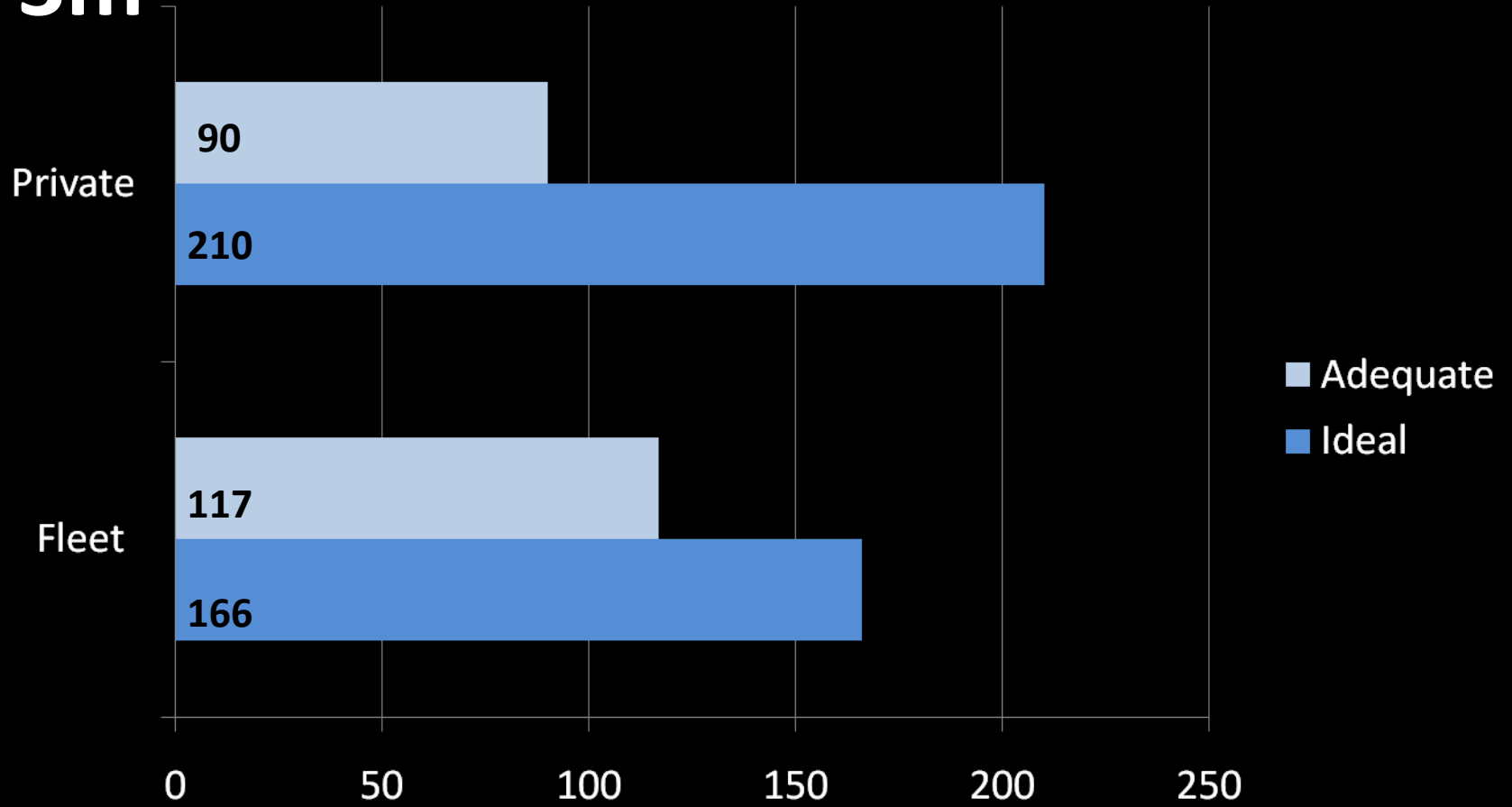
200

250



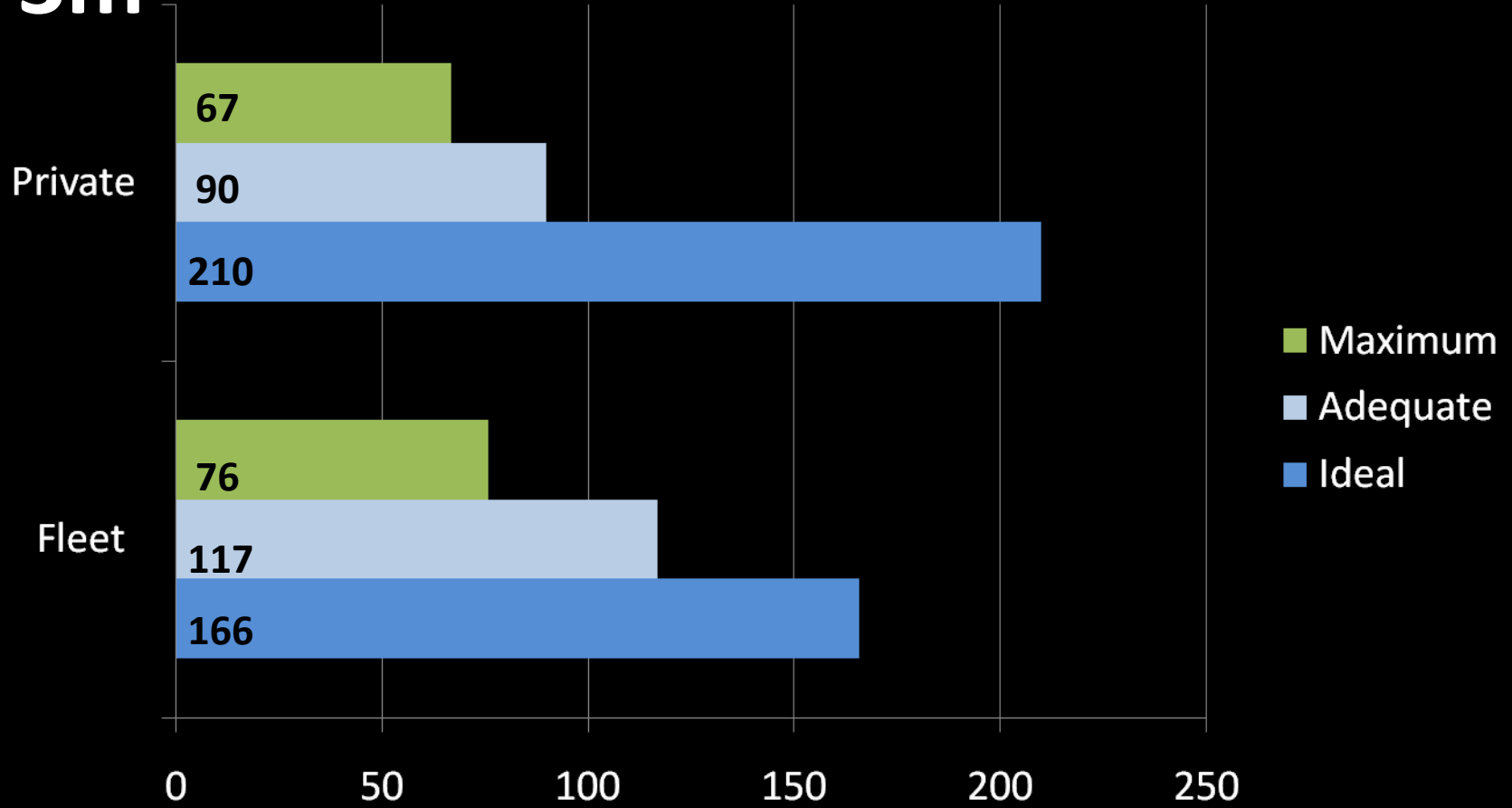
Adequate and Ideal Ranges

3m



Confidently Driving On One Charge

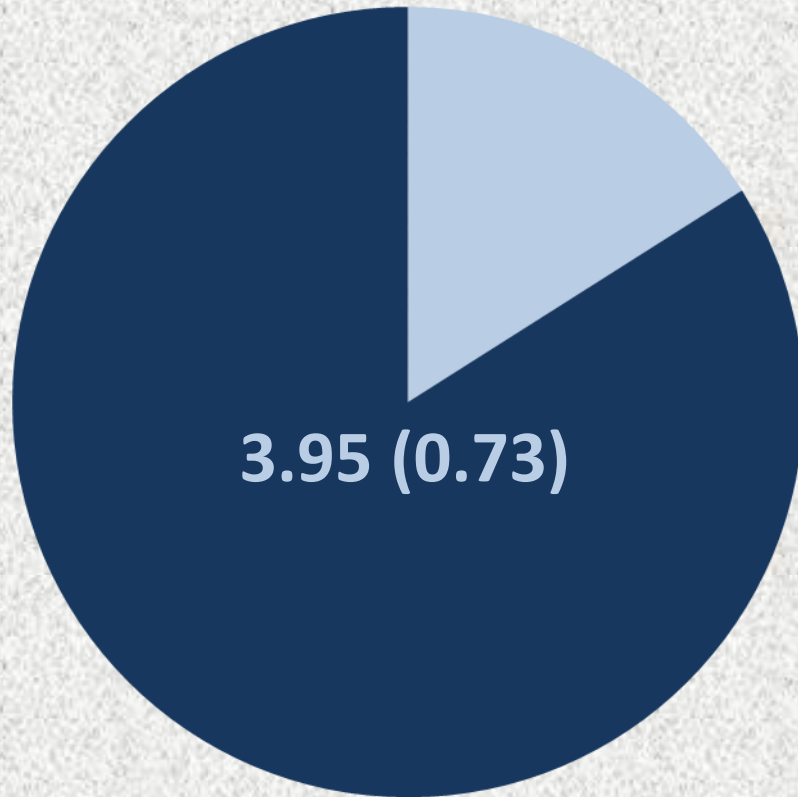
3m



Range Given By Manufacturer = 100 miles

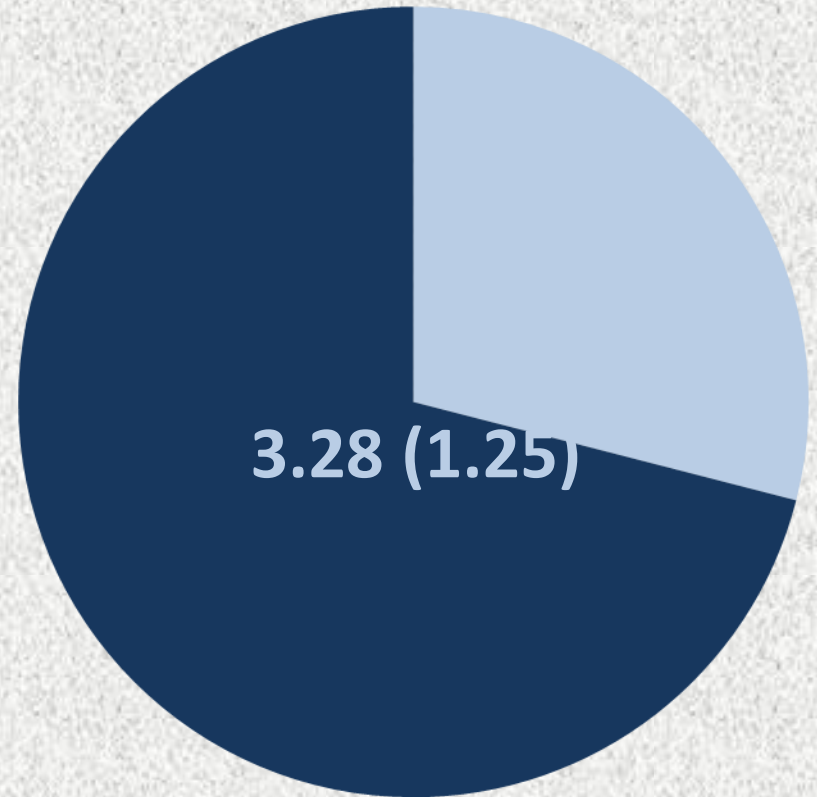
EVs Are Practical

84% Agreement



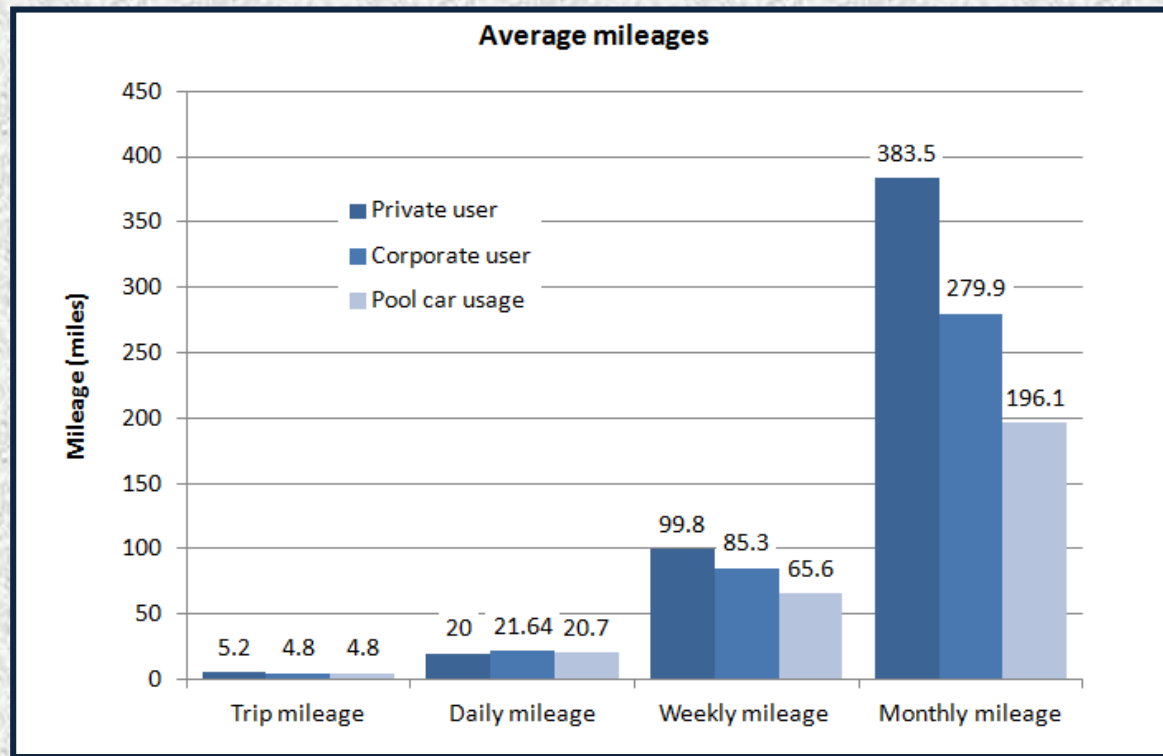
PD

71% Agreement



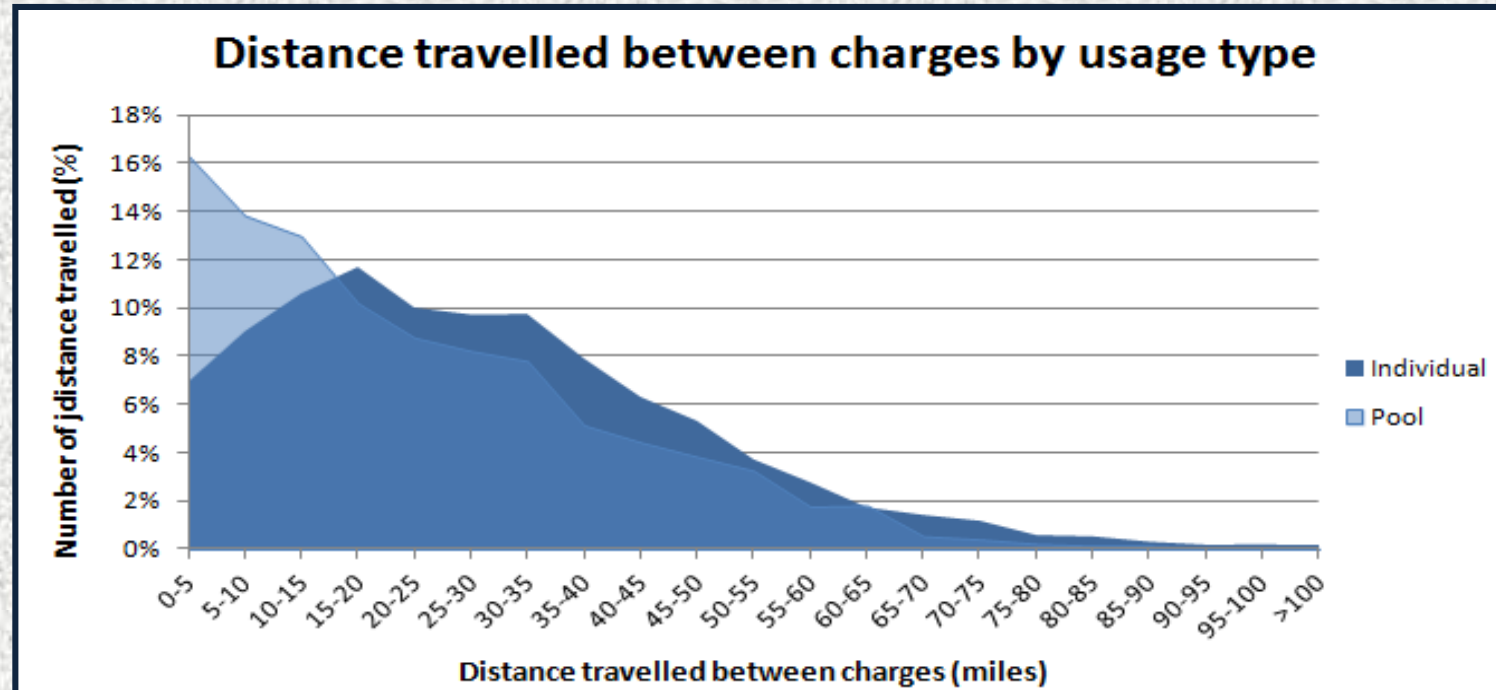
FD

Distances Travelled



National Travel Survey: M = 7 miles

Distance Travelled Between Charges



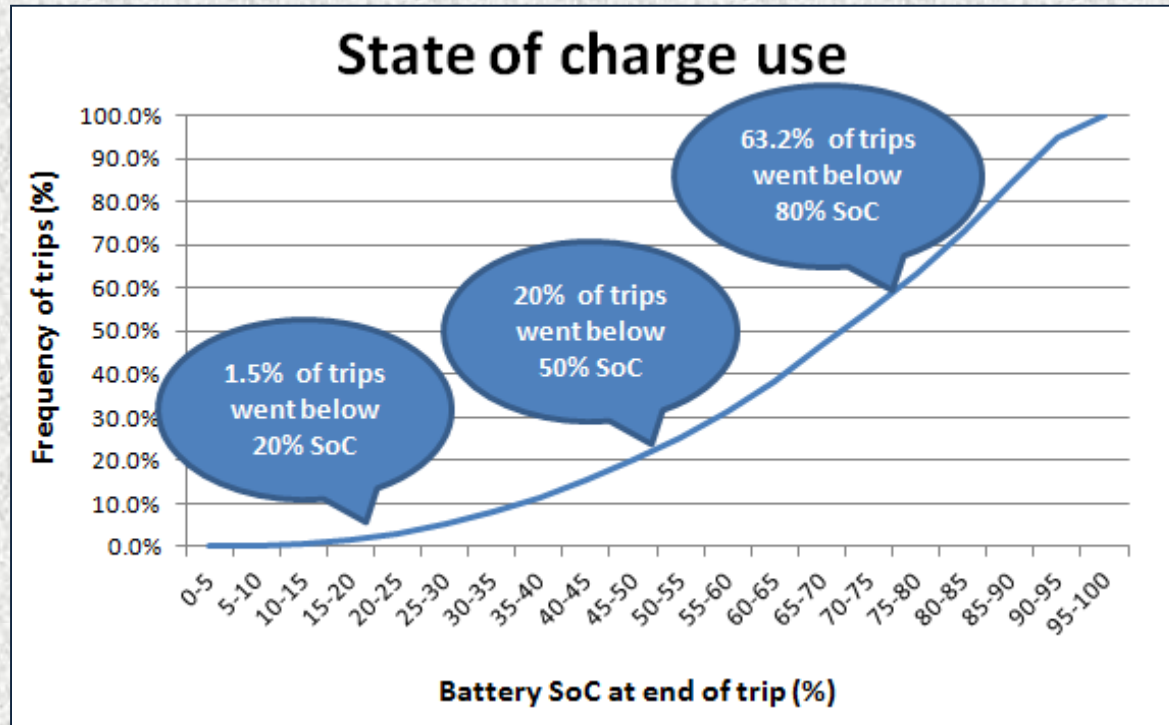
Distances between charges – but not overall distance - increases over time (15%)

Bunce, Harris & Burgess. (2014). Charge up then charge out? Drivers' perceptions & experiences of EVs in the UK. Transportation Research Part A, 59., 278-287

State of Charge Use

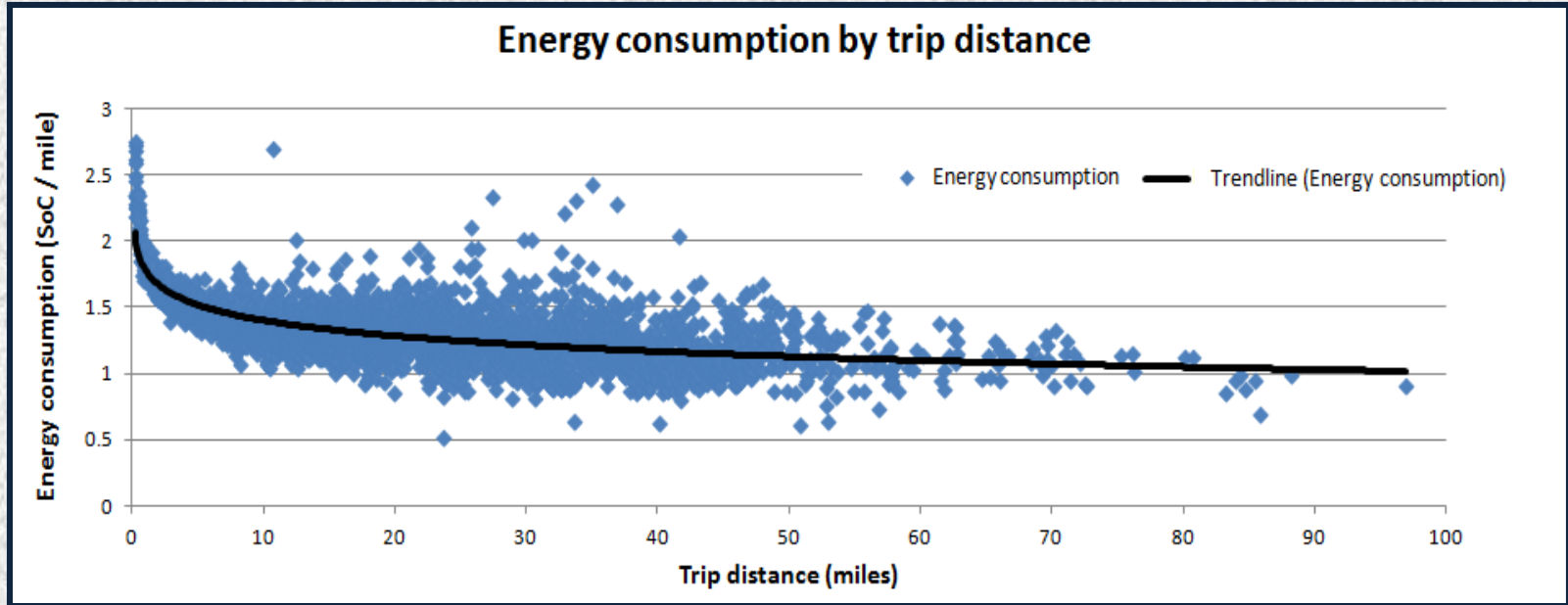
Average values	Mean average (SoC use)	75% of SoC use was less than...	Maximum SoC use
Trip	7.1%	8.85%	98.0%
Daily	27.2%	42.0%	189.8%
Weekly	120.7%	170.9%	628.1%

State of Charge Use



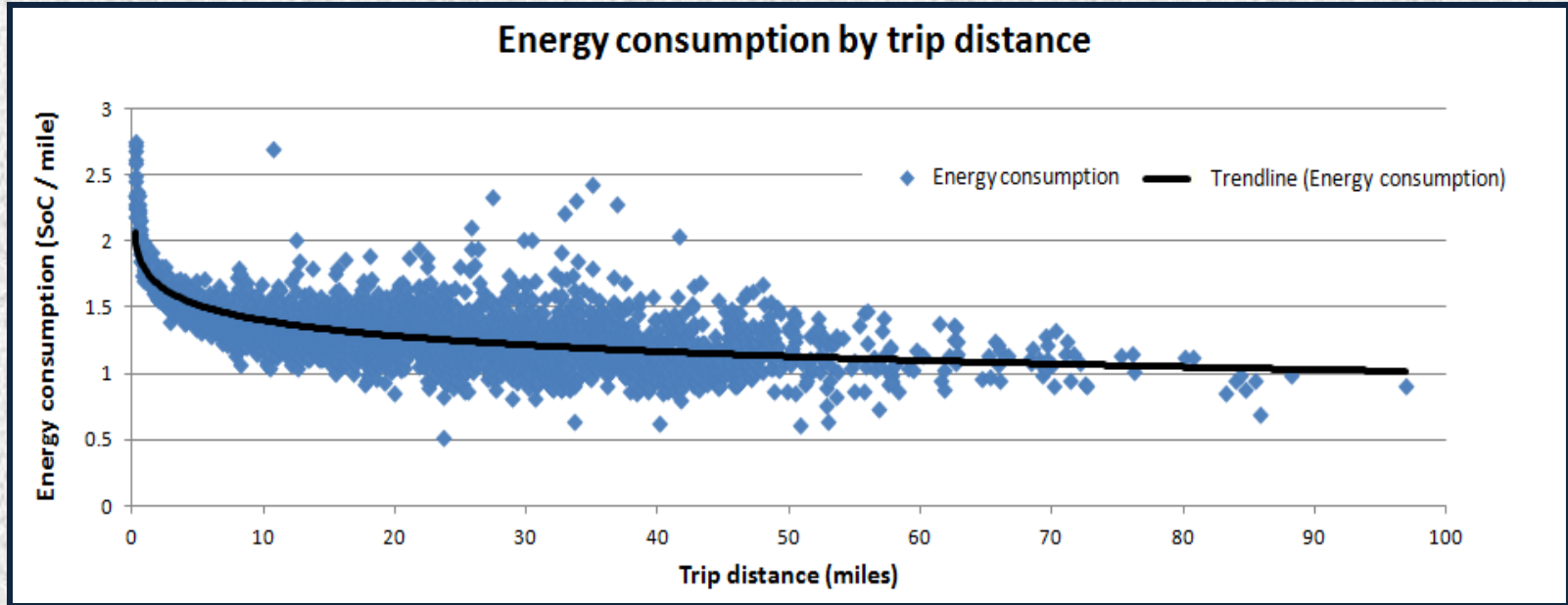
Private Drivers utilized lower SoC than Corporate Drivers

Energy Consumption



Average consumption was 1.5% SoC per mile = theoretical range of 67 miles

Energy Consumption



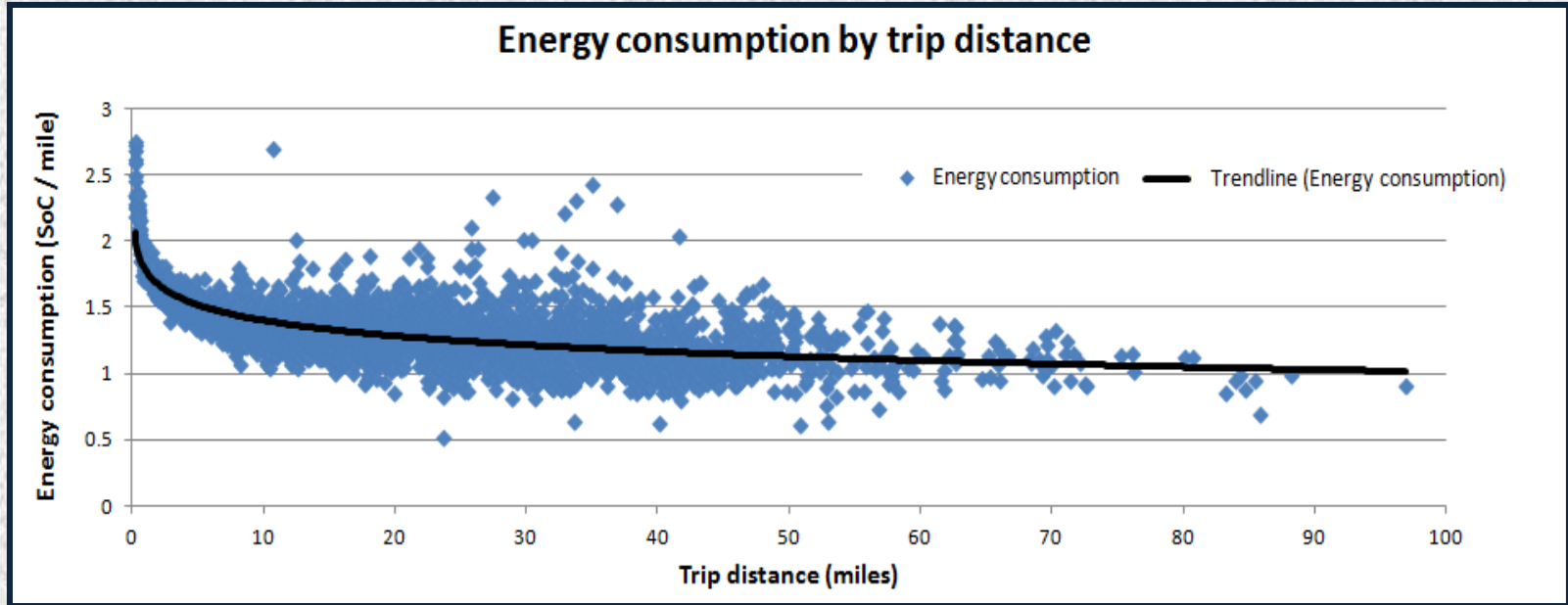
Fits their life/needs

Direct replacement for majority of journeys

No need to alter driving behaviour

Mansbridge, Burgess & Harris (forthcoming). EV drivers overcome range anxiety prior to their first trip.

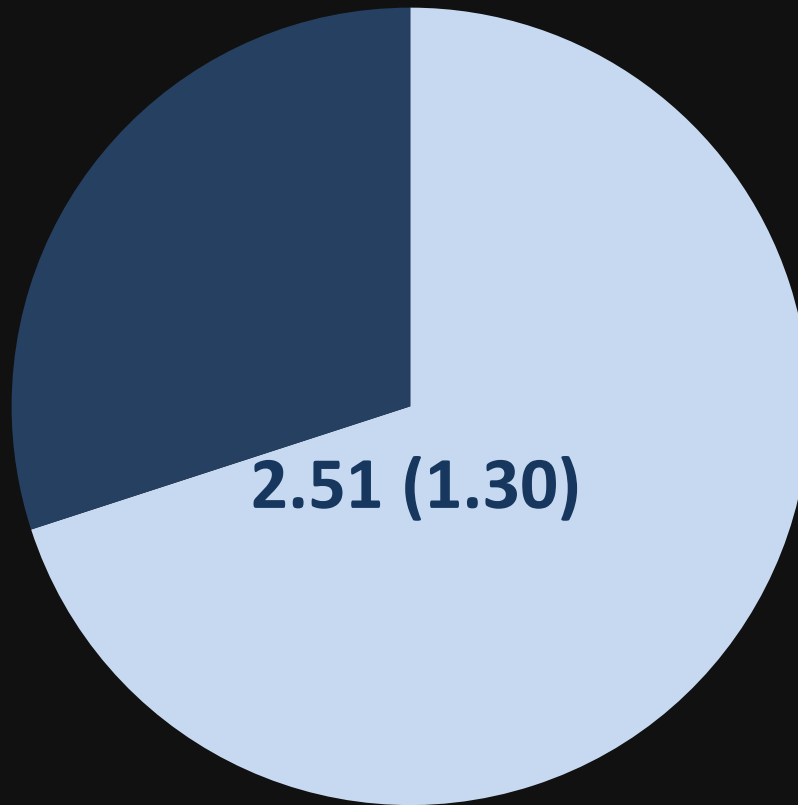
Energy Consumption



I'm driving it quite sportily. I'm not trying to eek the range out. It's not a consideration, driving carefully *Driver 27*

I Deliberately Attempted to Exhaust The Range

30% AGREEMENT



1 Week Post Pick-Up

Drivers Challenging Range Limits



1 Week Post Pick-Up

Drivers Challenging Range Limits

Consequence: **Recognise how regen, route selection, and style inter-connect & enable them to exert control**



1 Week Post Pick-Up

Drivers Challenging Range Limits

Consequence: **Recognise how regen, route selection, and style inter-connect & enable them to exert control**

I've often been presented with a really sad picture of only having 8% left, and I have 20 miles to do. And doing motorway travelling it's very difficult to adapt your style, but when you actually go off from the motorway you can still travel about another 20 miles on that 8% *Driver 4*

1 Week Post Pick-Up

Drivers Challenging Range Limits

Experience: **Understanding of inter-connectivity
of different factors on EV performance**

Shows drivers as active decision makers



1 Week Post Pick-Up

Drivers Challenging Range Limits

Experience: **Understanding of inter-connectivity
of different factors on EV performance**

Shows drivers as active decision makers

ONLY achieved by those who challenge the range



1 Week Post Pick-Up

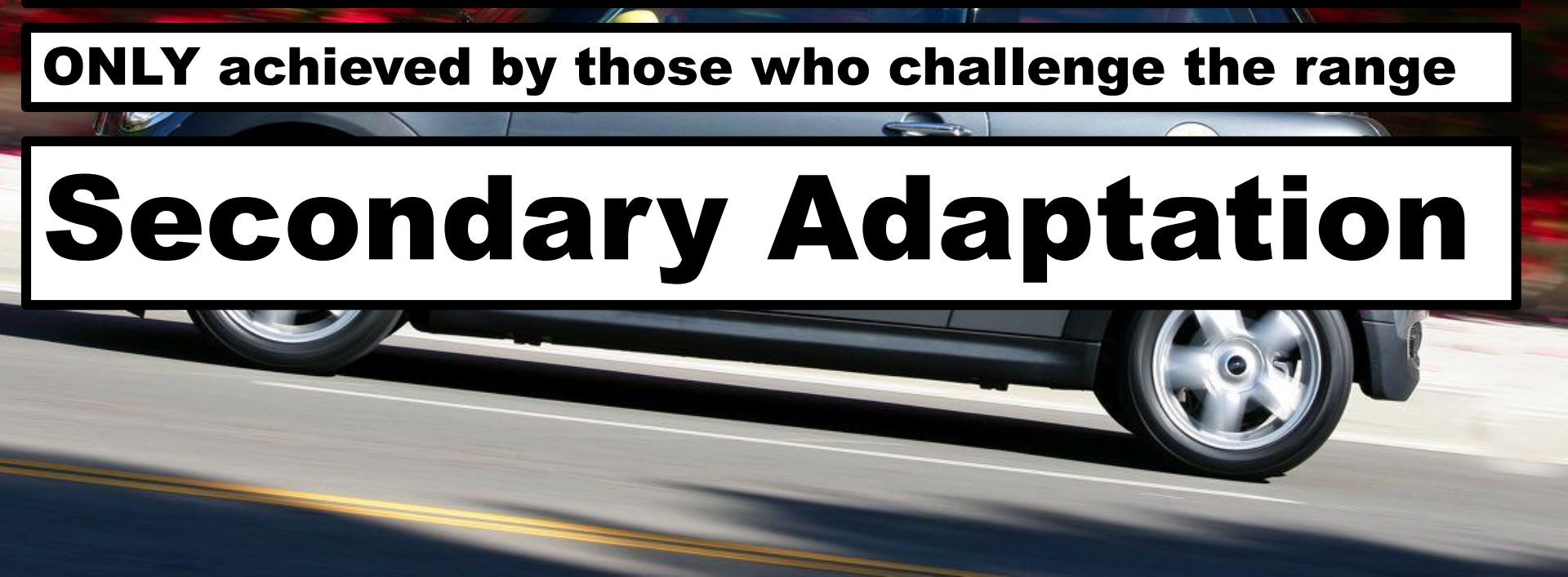
Drivers Challenging Range Limits

Experience: **Understanding of inter-connectivity
of different factors on EV performance**

Shows drivers as active decision makers

ONLY achieved by those who challenge the range

Secondary Adaptation



1 Week Post Pick-Up

Drivers Challenging Range Limits

Experience: Understanding of inter-connectivity
of different factors on EV performance

Shows drivers as active decision makers

ONLY achieved by those who challenge the range

Regen:

How Much?
“No Idea”

MINI

A silver luxury car, possibly a Jaguar, is parked on a city street. The car is shown from the rear three-quarter view, highlighting its distinctive taillights and multi-spoke alloy wheels. The background features a modern building with large glass windows and some greenery.

3 Months

Adaptive Consequences of Short Journeys

Unusual/unpredictable journeys within range?



3 Months

Adaptive Consequences of Short Journeys

Unusual/unpredictable journeys within range?

I had a very clear perception of how we were going to use the car: mostly for the week for commuting and for some shorter journeys within town and around town *Driver 40*

3 Months

Adaptive Consequences of Challenging Range





3 Months

Adaptive Consequences of Challenging Range

Secondary Adaptation not simply a result of personal disposition – Can also result from a critical incident

Accounts of ‘inter-connectivity’ were ALWAYS associated with 1st hand experience of range threatening to run out



3 Months

Adaptive Consequences of Challenging Range

Data Logger Analyses:

**Longest single trip:
Secondary > Primary**

Could be that Primary drive more trips for the same State of Charge, but Secondary Adaptors also drive further between charges than Primary Adaptors, $p = .006$

Finish Line



Finish Line

End of Trial: Price, Maintenance & Support Become Major Issues



Finish Line

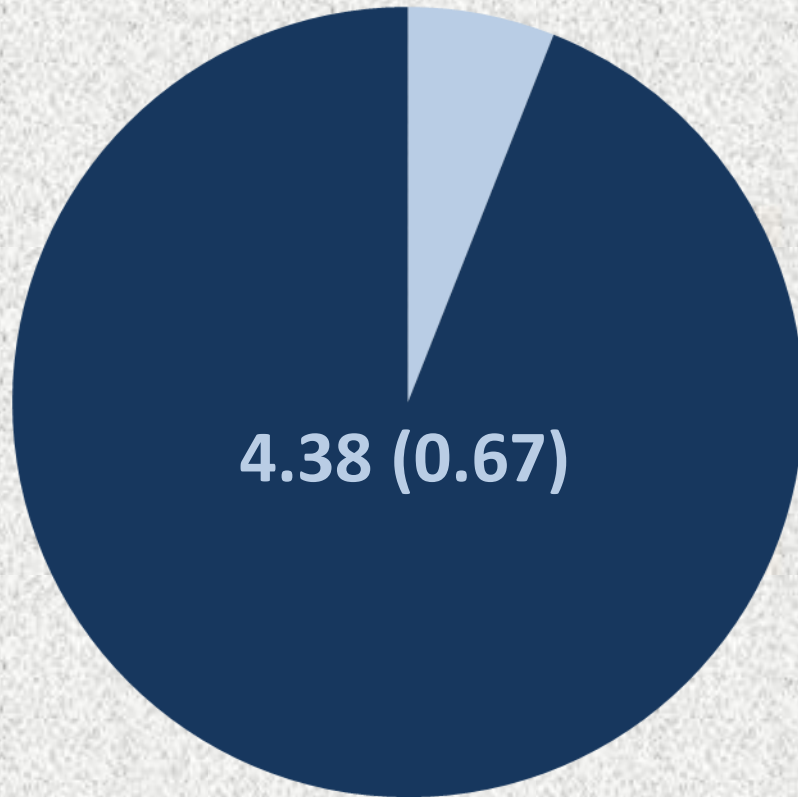
End of Trial: Price, Maintenance & Support Become Major Issues

Drivers strongly endorse the cars



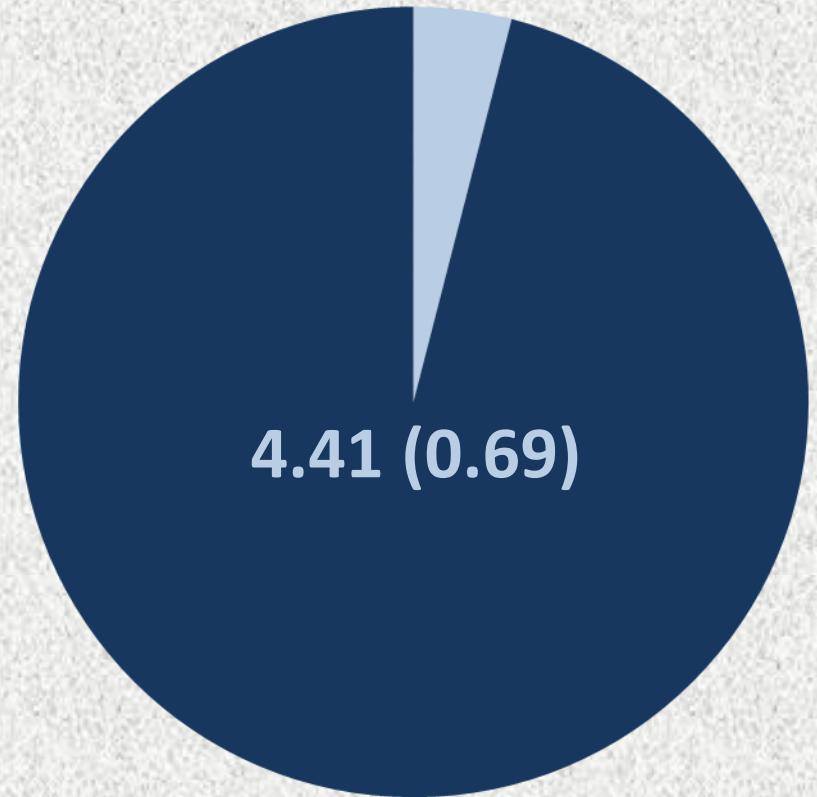
I Would Recommend EVs To Others

94% Agreement



PD

96% Agreement



FD

Finish Line

End of Trial: Price, Maintenance & Support Become Major Issues

Drivers strongly endorse the cars

Secondary Adaptation: Higher level of expertise



Finish Line

End of Trial: Price, Maintenance & Support Become Major Issues

Drivers strongly endorse the cars

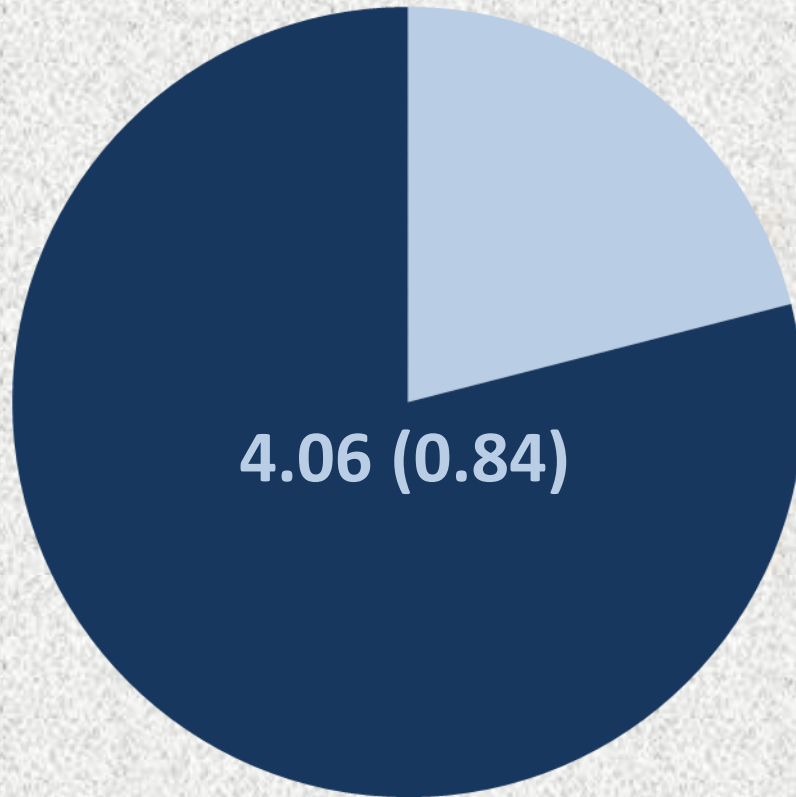
Secondary Adaptation: Higher level of expertise

Driving an EV like an ICE without challenging range and without consideration of unique features of EVs does not facilitate higher levels of adaptation and leaves drivers with lower expertise



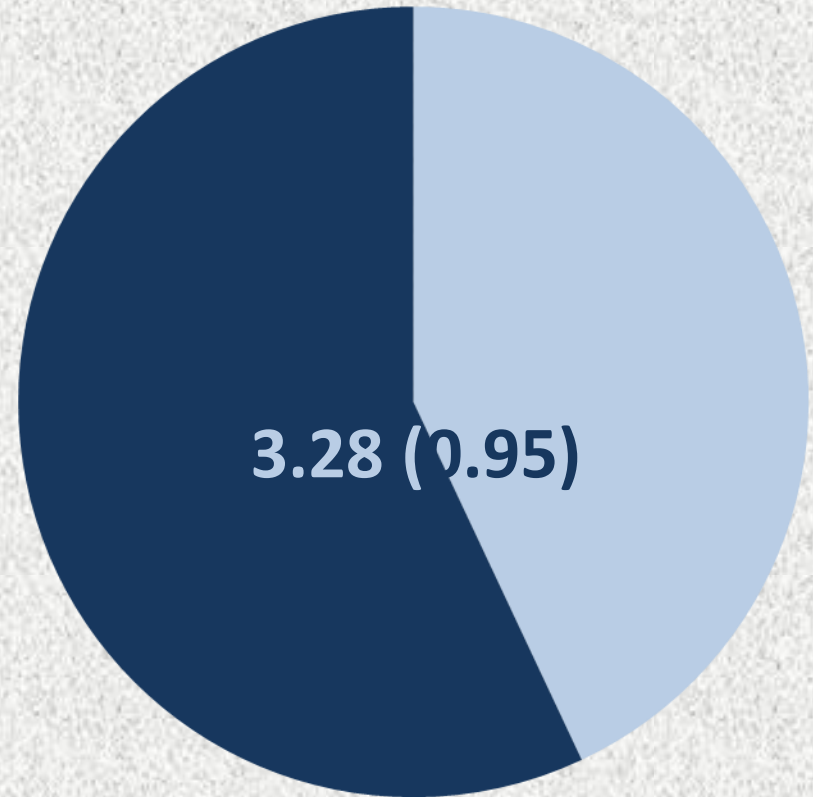
I Received Enough Training To Use My EV Effectively

79% Agreement



PD

57% Agreement



FD

Finish Line

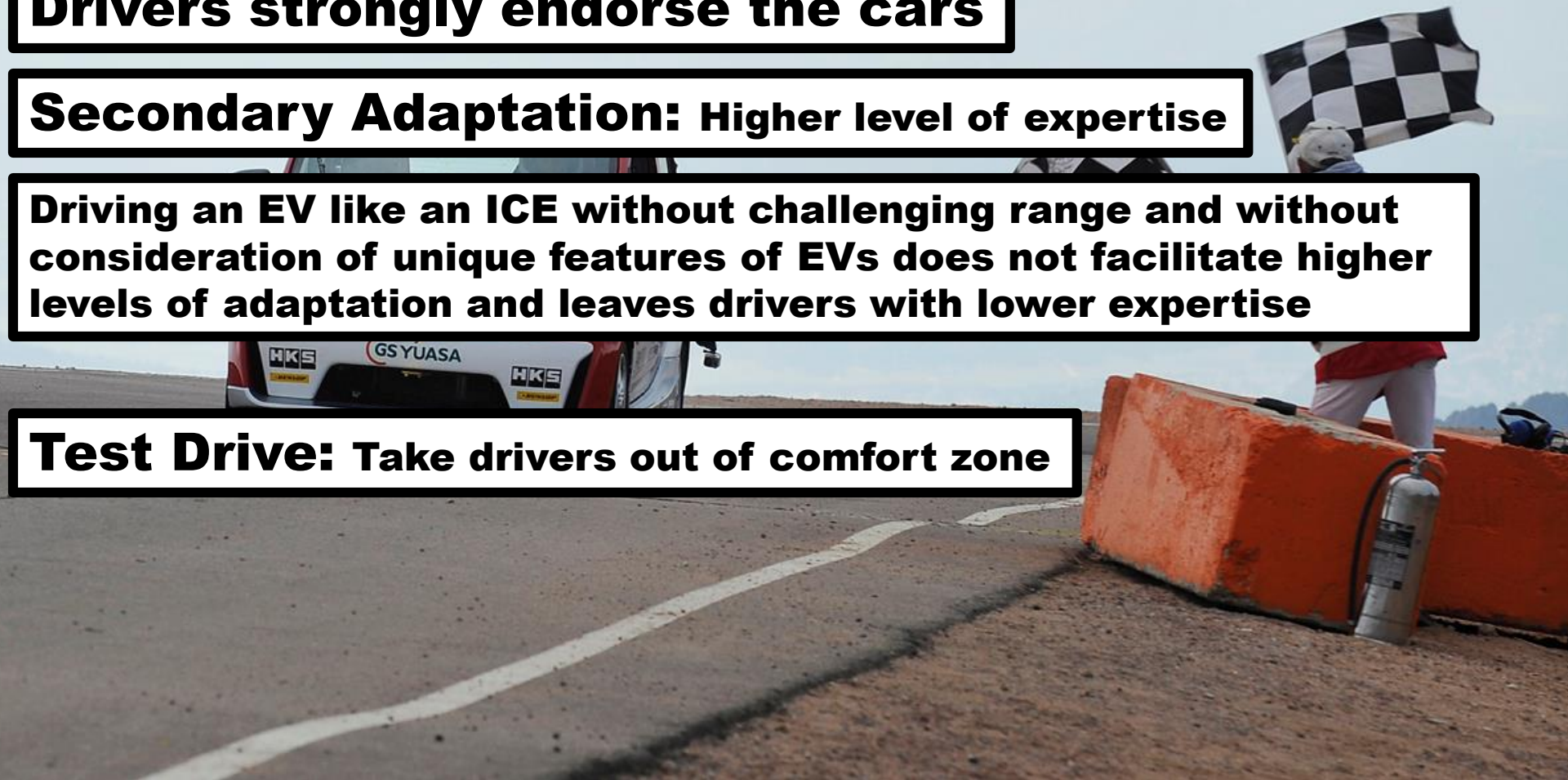
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Test Drive: Take drivers out of comfort zone



Finish Line

End of Trial: Price, Maintenance & Support Become Major Issues

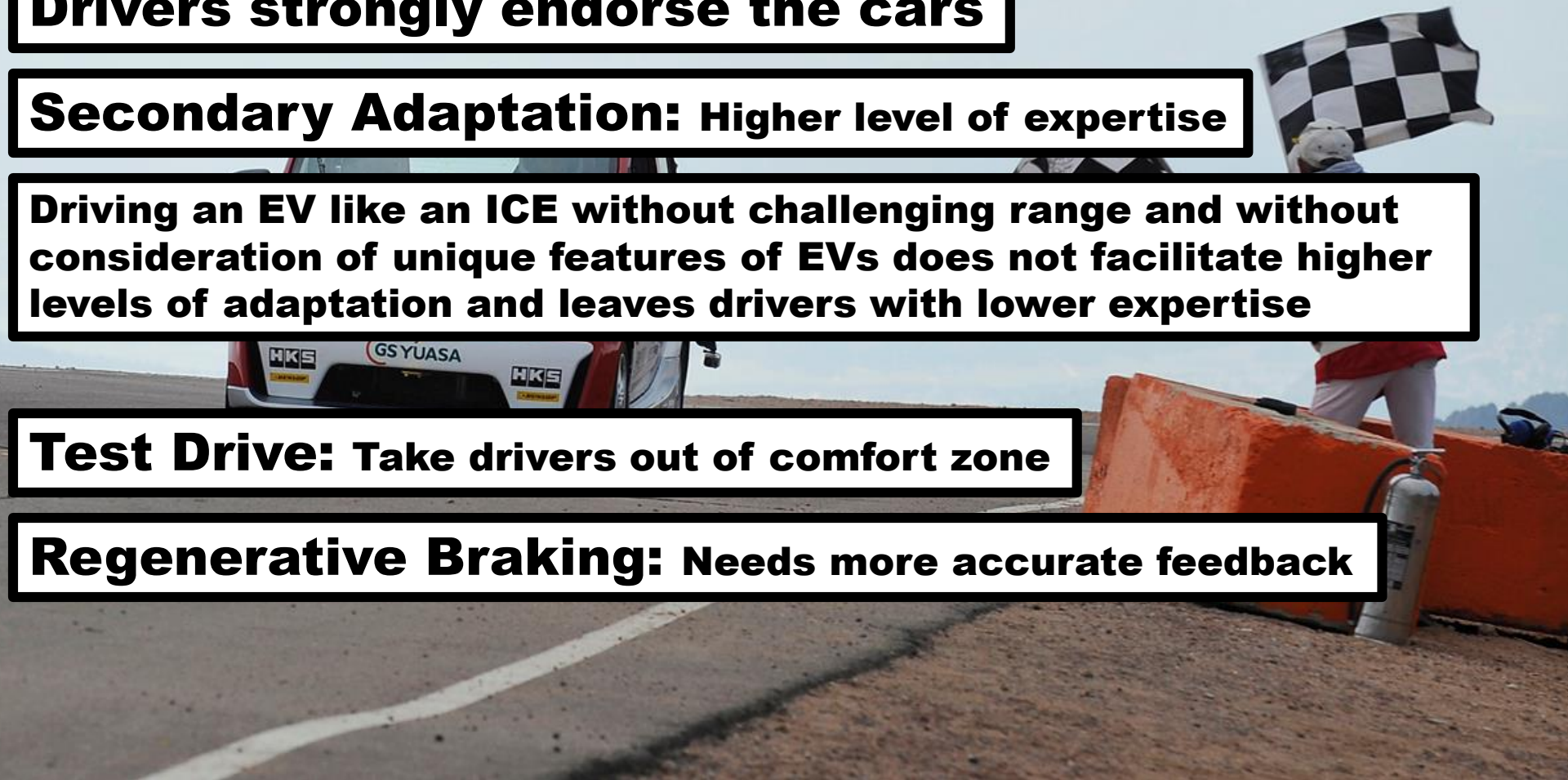
Drivers strongly endorse the cars

Secondary Adaptation: Higher level of expertise

Driving an EV like an ICE without challenging range and without consideration of unique features of EVs does not facilitate higher levels of adaptation and leaves drivers with lower expertise

Test Drive: Take drivers out of comfort zone

Regenerative Braking: Needs more accurate feedback



Finish Line

Viable in Daily Life?



Finish Line

Viable in Daily Life?

Yes!





Office for Low
Emission Vehicles



Office for
Low Emission
Vehicles

Driving the Future Today
A strategy for ultra low emission
vehicles in the UK

