



# Consumer Research into Rapid Charging

Conducted by PwC Strategy&, in association with  
Complete Strategy Ltd

Commissioned by National Grid

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# Important Notice

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# Executive Summary

**Consumers would feel more comfortable purchasing an EV knowing they had access to a rapid charging network**

We defined “range anxiety” as the perception of relative inconvenience of driving an EV that impacts buying decisions

We sought to distinguish between the experience of the car and the charging experience

- **EV car experience** – The extent to which buying decisions are influenced by drivers’ access to journey management software, by battery capacity and by the range of the EV.
- **Charging experience** – The extent to which (potential) buyers are influenced by:
  - The presence of a widespread interoperable charging infrastructure
  - Charging speeds.

We reviewed available research to test our hypotheses on rapid charging and range anxiety

We formulated two hypotheses and found a number of studies to be particularly relevant

- We formulated two hypotheses:
  - **Hypothesis 1** – The perceived inability to complete any journey in the UK as conveniently as in an internal combustion engine is a major barrier to EV uptake
  - **Hypothesis 2** – Rapid chargers are an effective method of improving perceptions that EVs can complete any journey in the UK as conveniently as an ICE.
- We reviewed 45 sources of research. These sources included surveys, articles, commercial, industry and government reports. We assessed the extent to which each study was relevant, applicable and reliable to testing these hypotheses.
- A number of studies were particularly relevant: Baringa, confused.com and the AA Populus Driving Survey.

We found that range anxiety is a key barrier to EV uptake and that a rapid charging network could help alleviate consumer range anxiety

Rapid charging has an important role to play ... although there are gaps in the research

- We found the research supported Hypothesis 1, with **nearly all surveys identifying range anxiety as a key barrier** to EV uptake.
- We also found that **a motorway rapid charging network could help range anxiety** for non-EV drivers with some of the sources reviewed confirming this.
- Research suggested that **reduced charging times** are the one charging infrastructure **improvement that EV users most desire**.
- **There is a significant gap in research into the attitudes of business drivers and fleet operators.** Little research has been directed at the business community and the research that is available does not score well on relevance or applicability.

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1. Introduction
2. What we did and our scoring criteria
3. Findings from our research
4. Gap analysis
5. Next steps
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# 1. Introduction

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# Our objective and key hypotheses

## Purpose of project

### Objective

1

#### Objective

Clarify whether **existing research** into **customer EV buying behaviour** provides **robust evidence** that the lack of a network of **motorway rapid chargers** is a barrier to uptake of EVs



### Hypotheses

1

#### Hypothesis 1

The perceived inability to complete any journey in the UK as conveniently as in an ICE is a major barrier to EV uptake

2

#### Hypothesis 2

Rapid chargers are an effective method of improving perceptions that EVs can complete any journey in the UK as conveniently as an ICE

### Research

1

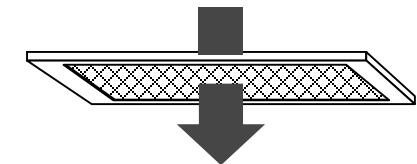
#### Hypothesis 1

Does existing research support Hypothesis 1?

2

#### Hypothesis 2

Does existing research support Hypothesis 2?



### Gap

Is there a gap in the existing research of EV buying decisions?

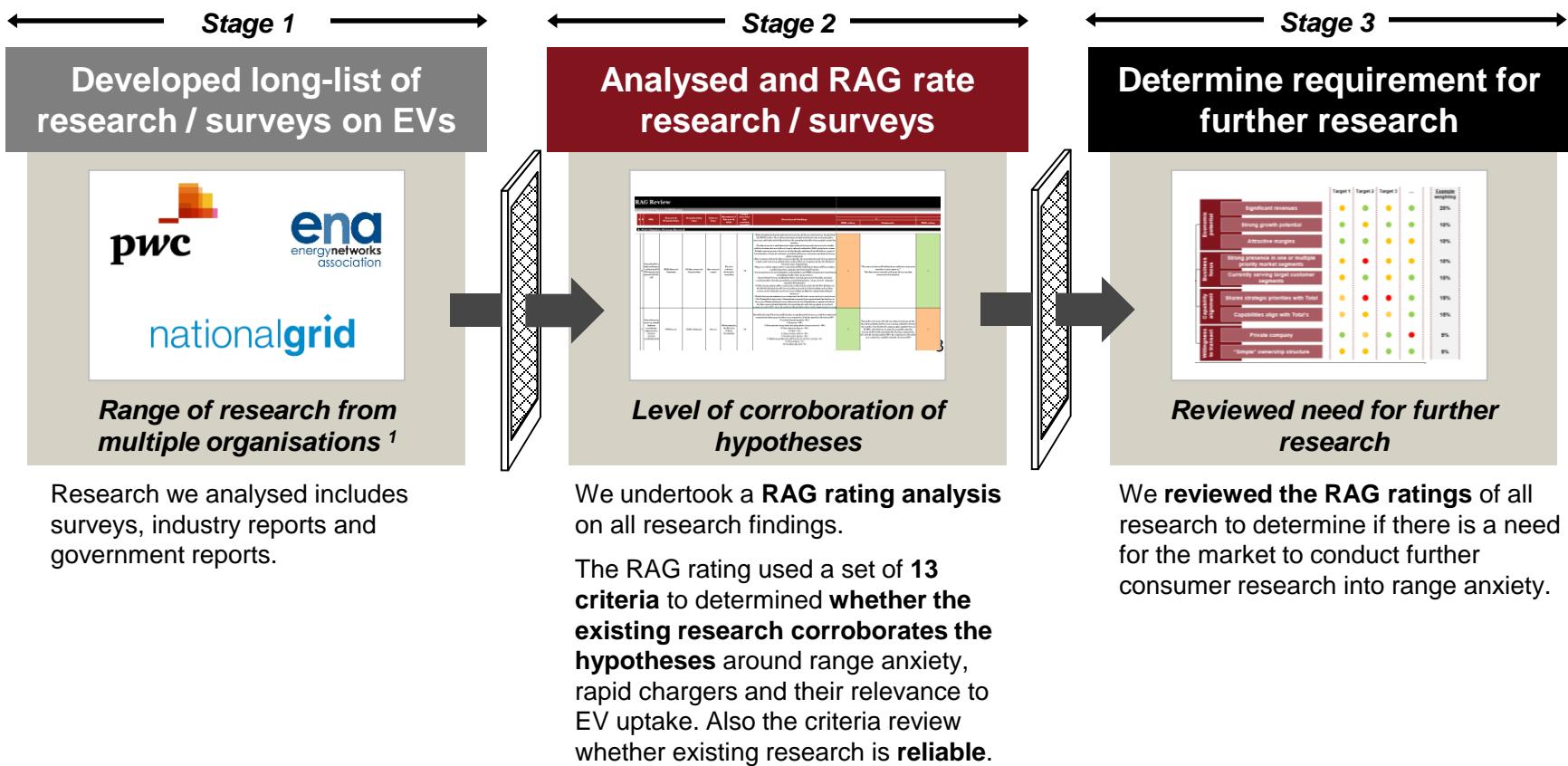
We reviewed a range of existing research to determine if there is a gap in the research on EV consumer behaviour.

## 2. What we did

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# We worked across three stages to analyse existing research and determine if any gaps exist

## Framework process



# We assessed the extent to which each research project was applicable to our two hypotheses

## RAG Framework

Scoring Factors		Red	Amber	Green	N/A
<i>RAG scoring (points assigned in framework)</i>		1 point	3 points	5 points	0
1)	Does the research have an appropriate definition for range anxiety?	No explicit reference of range anxiety	Range anxiety referenced in context of range limitations	Range anxiety referred to as a misperception	N/A
2)	Does the survey include rapid chargers?	No	N/A	Yes	N/A
3)	Does the research identify range anxiety as a major barrier to EV uptake?	No mention	Can be inferred but not explicitly stated	Explicitly stated	N/A
4)	Does the research identify any other key barriers to EV uptake?	Yes - multiple other reasons	Yes - one other reason	No other reasons	N/A
5)	To what extent is the research solely focused on range anxiety?	Low level	Medium level	High level	N/A
6)	Does the research identify rapid chargers as an effective method to reduce range anxiety?	No mention	Can be inferred but not explicitly stated	Explicitly stated	N/A
7)	Is this research UK specific?	No mention of UK	UK part of sample	Contains UK deep dive	N/A
8)	How recent is the research?	3+ years	3 > x >= 1 years	< 1 years	N/A
9)	How robust is the sample size?	0-99	100-299	300+	N/A
10)	How reliable is the publisher/survey source?	Online, untraceable source	EV player but possible conflict of interest or bias	Govt. organisation, major EV player or major market research firm	N/A
11)	Is the research segment specific (only B2C / only B2B focus)?	No focus	Only one of B2B/C	Both B2B/C	N/A
12)	Does the research provide varied data on different driver types?	No focus on different driver types	Some data on different driver types	Looks at all types of drivers e.g. school runs, fleet (van, lorry) drivers, taxis	N/A
13)	If this is a survey, how many of the "right type" of questions we would ask (see Appendix) have been answered (/9)?	Not RAG, mark /9	Not RAG, grade /9	Not RAG, grade /9	N/A

# Our research covered sources produced by a range of organisation types

## Research organisations covered as part of research

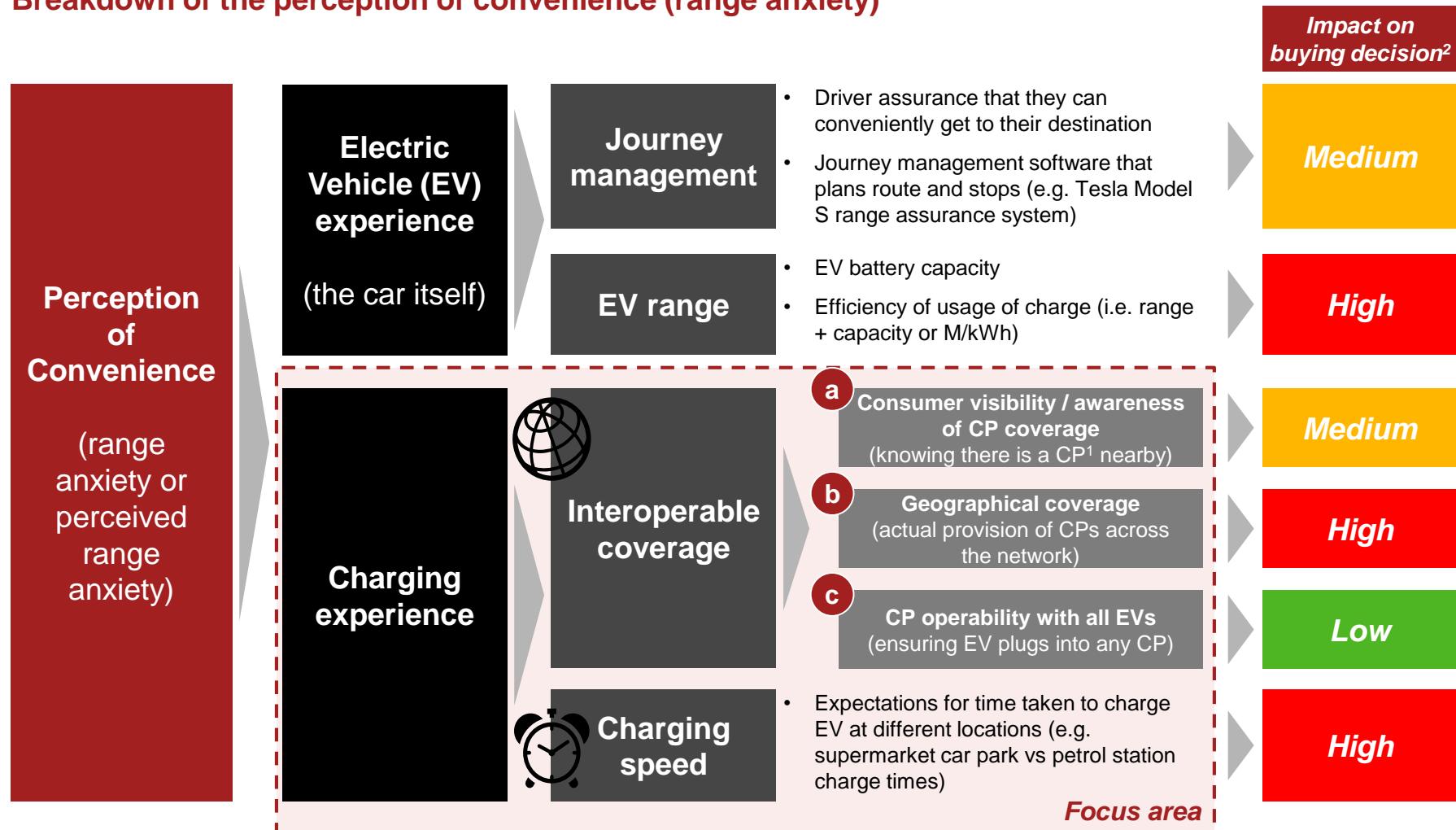
	Academic Institution			Media Organisation	
	Charge Point Operator			OEM / Car Manufacturer	
	Consumer Rights Group			Other Automotive Company	
	Energy Network Specialist			Road Association	
	EV Specialist			Trade Association	
	Independent International Organisation			UK Government Organisation	
	Market Research Firm			Utility Company	

## 3.1 Summary of key range anxiety research findings

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# We defined range anxiety as a perception of EV driving convenience that impacts buying decisions

## Breakdown of the perception of convenience (range anxiety)



# And our findings showed that range anxiety is a barrier but rapid charging is one of several solutions

## High level results of our analysis from the 45 sources we reviewed

Hypotheses	Results of our research	What consumers say
<p><b>1</b></p> <h3>Hypothesis 1</h3> <p>The perceived inability to complete any journey in the UK as conveniently as in an ICE is a major barrier to EV uptake</p>	<p><b>Proven</b></p> <p>Hypothesis 1 was proven, with perceived range anxiety, whether a consumer myth or a real issue, a universally acknowledged barrier to EV uptake for non-EV drivers</p>	<p><b>EV owners<sup>1</sup>...</b></p> <ul style="list-style-type: none"><li>do not consider range anxiety an issue for themselves<sup>2</sup></li><li>cite environmental motivations as the main driver behind their adoption of BEVs<sup>2</sup></li></ul> <p><b>Non-EV owners...</b></p> <ul style="list-style-type: none"><li>cite a lack of geographical coverage of charging infrastructure (in relation to perceived range anxiety) as a major barrier<sup>3</sup></li><li>have a number of other concerns in purchasing an EV of equal, if not greater importance, including high EV sticker price, a lack of model choice and availability of vehicles<sup>4</sup></li></ul>
<p><b>2</b></p> <h3>Hypothesis 2</h3> <p>Rapid chargers are an effective method of improving perceptions that EVs can complete any journey in the UK as conveniently as an ICE</p>	<p><b>Proven</b></p> <p>The research indicates that the presence of rapid chargers would go some way to addressing the concerns of existing and potential EV owners.</p>	<p><b>EV owners<sup>1</sup>...</b></p> <ul style="list-style-type: none"><li>say that improved charging times would improve their EV charging experience the most<sup>2</sup></li></ul> <p><b>Non-EV owners...</b></p> <ul style="list-style-type: none"><li>identified improved geographical coverage of charge points as the most effective solution to perceived range anxiety with 15 of 45 sources reviewed confirming this<sup>4</sup></li><li>suggest that rapid charging could also alleviate range anxiety, however fewer sources reviewed (7 of 45) identified this as the most or one of the most effective methods<sup>5</sup></li></ul>

# With our three top scoring sources showing rapid chargers could alleviate elements of range anxiety

Key:  Out of scope

Barriers	AA	AA Survey	Confused.com	Confused.com Survey	Baringa ZapMap® ZapMap 2018 <sup>1</sup> Survey
<b>1 EV Cost and Availability</b>					
i. High sticker price (upfront cost) ii. High running costs (e.g. high cost to charge, high cost of specialised parts, expensive battery repair) iii. Lack of availability of vehicles		<b>83% of respondents claim price is one of their top 3 concerns</b>	<b>59% of respondents claim high stick price is a factor discouraging them from EV purchase</b>	<b>55% say the cost of buying an electric car is too high</b>	
<b>2 EV Battery Range and Battery Life</b>					
i. Current average battery range is c.250 miles (vs. 400-mile ICEs) ii. Short battery life is a barrier to development of second-hand market, which will delay uptake		<b>43% of respondents demand a “real world driving range” of at least 250 miles</b>	<b>“Concerns around the availability of charging points [are] tied to... the range of an electric car”</b>	<b>48% say inability to travel sufficient distance on one charge is a main barrier</b>	
<b>3 Charging Infrastructure</b>					
i. Interoperable coverage a. Lack of consumer visibility / awareness of CP coverage (knowing there is a CP nearby) b. Lack of geographical coverage (6999 locations in the UK today <sup>7</sup> ) c. Lack of CP operability with all EVs  ii. Charging speed	<b>Range Anxiety</b>	<b>80% of respondents claim a lack of CPI coverage is one of their top 3 concerns</b>  <b>79% of respondents claim a lack of rapid chargers at motorways for long distance driving is one of their top 3 concerns</b>	<b>72% of respondents would not consider an EV on the basis of inadequate UK charging infrastructure</b>  <b>61% said that long charging times would discourage them from purchasing an EV</b>	<b>46% of respondents said the lack of a public charging point near their home was a main barrier</b>  <b>36% said that it takes too long to recharge an EV battery</b>	

# But other sources reflect that there are a variety of other solutions for range anxiety

		Hypothesis 1	Hypothesis 2	Key:	Out of scope
	Barriers	Solutions	Urgency	Addressed?	
<b>1 EV Cost and Availability</b>	<ul style="list-style-type: none"> <li>i. High sticker price (upfront cost)</li> <li>ii. High running costs (e.g. high cost to charge, high cost of specialised parts, expensive battery repair)</li> <li>iii. Lack of availability of vehicles</li> </ul>	<ul style="list-style-type: none"> <li>• State / Government intervention: Fiscal incentives (e.g. subsidies for upfront EV costs, import/road/VAT tax exemptions)<sup>6</sup></li> <li>• Market: Economies of scale and tech advancements, lower battery costs</li> </ul>	<p><b>High:</b> Short-term need to address</p>	<b>Partially</b> <ul style="list-style-type: none"> <li>• Need continued and new Govt. grant / exemption schemes (e.g. £3500 Plug-in Grant to 2020, £20m taxi grant funding, 2% Bik + 100% FYA<sup>5</sup>)</li> </ul>	
<b>2 EV Battery Range and Battery Life</b>	<ul style="list-style-type: none"> <li>i. Current average battery range is c.250 miles (vs. 400-mile ICEs)</li> <li>ii. Short battery life is a barrier to development of second-hand market, which will delay uptake</li> </ul>	<p><b>Market development / Private sector:</b></p> <ul style="list-style-type: none"> <li>• Focus on car manufacturers to tackle</li> <li>• Achieved through economies of scale in EV production, improving battery technologies and capacities, improved EV efficiency</li> </ul>	<p><b>Medium:</b> Short to mid-term need to address</p>	<b>Partially</b> <ul style="list-style-type: none"> <li>• Most manufacturers have developed battery tech for 200 to 300-mile ranges</li> <li>• When this becomes cost competitiveness is now key</li> </ul>	
<b>3 En-route Charging Infrastructure</b>	<p><b>Range Anxiety 1</b></p> <ul style="list-style-type: none"> <li><b>a. Interoperable coverage</b> </li> <li><b>b. Lack of consumer visibility / awareness of CP coverage (knowing there is a CP nearby)</b></li> <li><b>c. Lack of geographical coverage (6999 locations in the UK today<sup>7</sup>)</b></li> </ul> <p><b>ii. Charging speed</b> </p> <p>Too much time taken to charge EV (particularly in locations where consumers typically do not want to spend a lot of time e.g. petrol stations – refuelling ICE vehicles takes c. 7mins)</p>	<p><b>a</b> Publicise to educate the public on benefits and availability of CPs</p> <p><b>b</b> Install rapid CPs focusing on network gaps (e.g. motorways/ rural areas) – AEVB<sup>2</sup> mandatory for CPs in petrol stations / motorway service stations</p> <p><b>c</b> Government : AEVB<sup>2</sup> standardising requirements for CP interoperability</p> <ul style="list-style-type: none"> <li>• Private funding or Govt. provision to install more rapid DC CPs with significant coverage and publicity. Will also reduce wait times.</li> <li>• Strategic investment in connection infrastructure for CPs to enable &gt; 300kW power capacity to meet speed of charge needs for all EVs (e.g. E-HGV charging)</li> </ul>	<p><b>Medium:</b> High need to educate public now. Need for chargers to plug network gaps in the mid-term</p> <p><b>Medium:</b> No urgency for &gt;200kW CPs, but RCs will improve EV driver experience and drive EV adoption</p>	<b>Partially</b> <ul style="list-style-type: none"> <li>• Building regulation changes increasing coverage and visibility<sup>3</sup></li> <li>• Gov. funding growing on-street resi CPs</li> <li>• NCR<sup>4</sup> database to learn user habits</li> <li>• £40m gov. grant: wireless charging</li> <li>• 'Go Ultra Low', 'RTZ'<sup>8</sup> comms campaign</li> <li>• AEVB<sup>2</sup>: interoperability and multiple CPs at petrol stations / motorway services</li> </ul> <p><b>No</b></p> <ul style="list-style-type: none"> <li>• There are not enough rapid CPs to meet current demand for faster charge times (4366 RCs in 1393 UK locations<sup>7</sup>)</li> <li>• Charging Infrastructure Investment Fund; £400m to spend on CPI but not clear what this will target</li> </ul>	

## 3.2 Key range anxiety research case studies

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# Our ten highest scoring sources all identified range anxiety as a key barrier to EV adoption

**High level findings of our analysis from the top 10 out of 45 sources we reviewed**

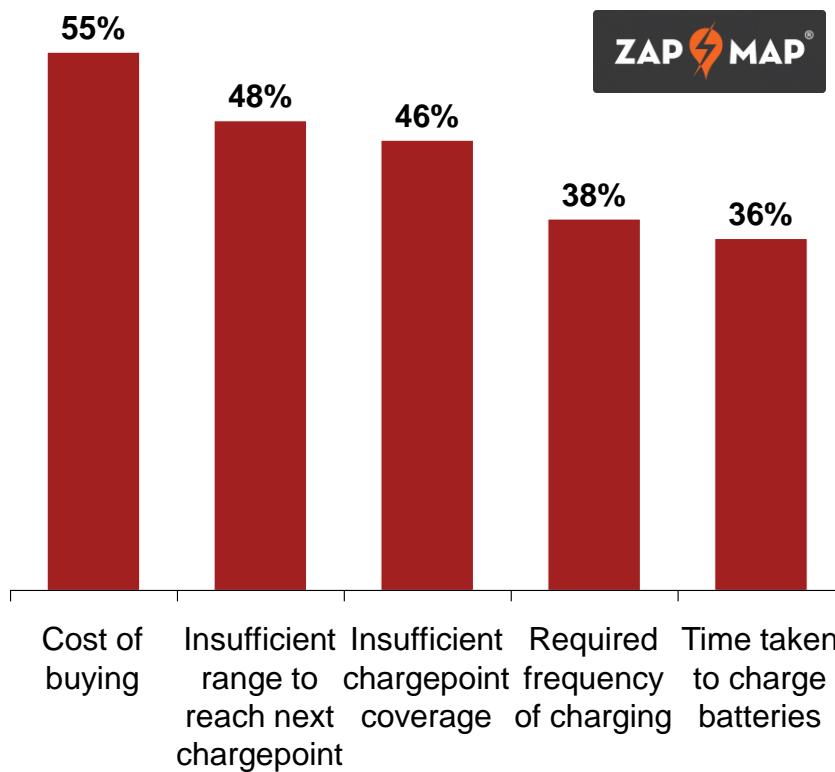
Source	Source Type	Score (/69)	Summary of key findings
Baringa	Survey	58	<ul style="list-style-type: none"> <li>States that range anxiety is the second biggest barrier for EV (cost was identified as the greatest barrier)</li> </ul>
Confused.com	Industry Report	50	<ul style="list-style-type: none"> <li>Cites range anxiety as the number one barrier to EV adoption</li> <li>Suggests that improved coverage of CPI<sup>1</sup> as most effective solution</li> </ul>
AA Populus Driving Survey	Survey	50	<ul style="list-style-type: none"> <li>Finds that the number one factor that would convince AA non-EV drivers to purchase an EV is a 'real world' driving range of &gt;250 miles</li> </ul>
AutoTrader	Market Report	49	<ul style="list-style-type: none"> <li>Quotes Steve Hood, Director of EVs at Ford Europe who suggests that increased rapid charging coverage will help dispel the range anxiety myth</li> </ul>
European Federation for Transport and Environment	Commercial Report	46	<ul style="list-style-type: none"> <li>States that being able to recharge cars within the recommended driving break time is expected to be a game changer for market uptake</li> </ul>
OVO Energy	Survey	45	<ul style="list-style-type: none"> <li>Reports that lack of charging points was identified as the largest barrier to EV uptake by the 2000 respondents to its 2017 survey</li> </ul>
AA public attitudes article	Article	44	<ul style="list-style-type: none"> <li>Highlights that range anxiety is a myth but concedes that 85% of its survey respondents said there wasn't enough CPI coverage</li> </ul>
Department for Transport (ONS)	Government Report	44	<ul style="list-style-type: none"> <li>Identifies range anxiety along with high sticker prices as the primary barrier to EV adoption in the UK</li> </ul>
Automotive World	Industry Report	43	<ul style="list-style-type: none"> <li>Mentions that Ford believe that a rapid charging infrastructure (e.g. Ionity) is a specific antidote to the perceived relative inconvenience of driving EVs</li> </ul>
Department for Business, Environment and Industrial Strategy	Government Report	41	<ul style="list-style-type: none"> <li>Suggests that rapid charging points on motorways will be instrumental in reducing range anxiety, particularly in rural areas</li> </ul>

Subject of  
following 3  
slides



# With our highest scoring source, Baringa, identifying rapid charging as a key alleviator of RA

Main barriers to EV ownership (% of respondents who consider a barrier)



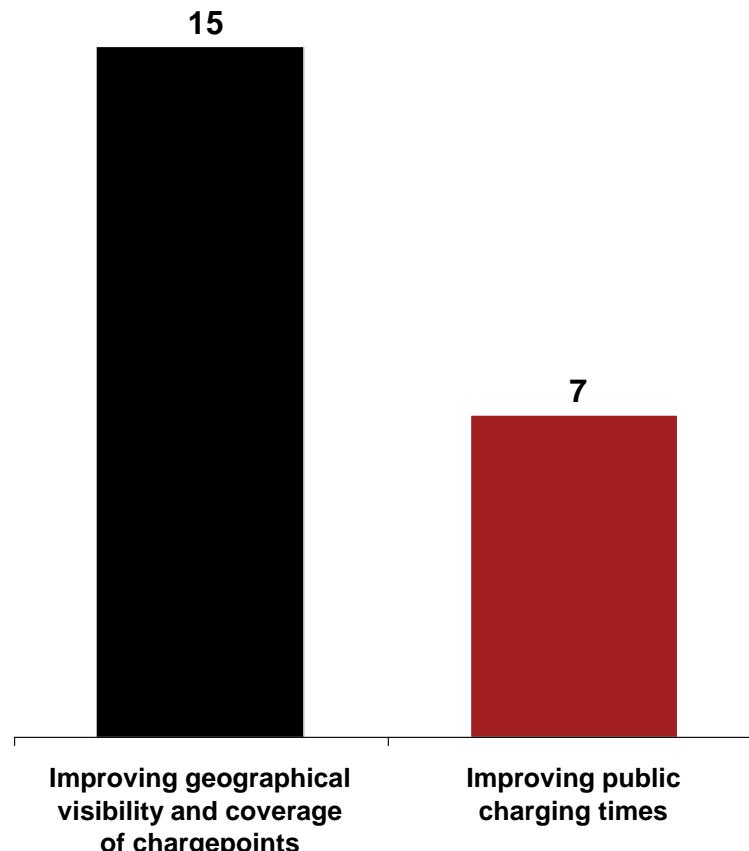
## Case study: Baringa

- Baringa highlight the **important role rapid charging infrastructure will have in EV uptake**, citing results from a 2018 ZapMap survey (see *right*)
- They suggest that the **average maximum amount of time** consumer drivers would be **willing to wait in order to charge** in-transit is **just 13 minutes**
- They also mention that **the technology to facilitate this already exists**, with ABB's 350kW chargers already able to add 200km of range to a car in 8 minutes
- Identify that **proper selection and evaluation of appropriate locations for ultra-fast DC charging should be a consideration for Charge Point Operators**, citing moves by the Ionity<sup>1</sup> collaboration and Pivot Power



# While Confused.com identified geographical visibility as most effective at reducing perceived RA

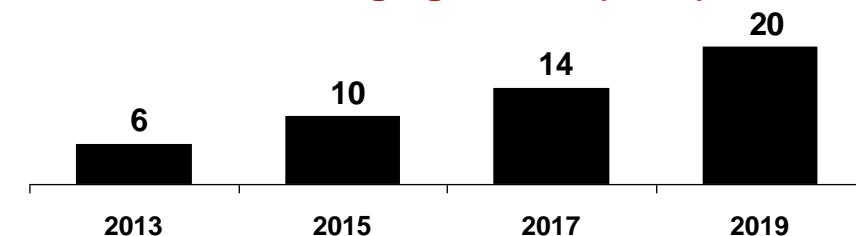
## Most effective methods for reducing range anxiety (number of sources reviewed)



## Case study: Confused.<sup>com</sup>

- 72% of respondents to the survey would not consider purchasing an EV on the basis of **inadequate UK charging infrastructure**
- Confused suggest that while range anxiety is a myth, improved charging point visibility and coverage are still needed to help drive EV adoption
- However, Confused go on to suggest that **charging point coverage is likely to improve with time regardless**, citing Zap Map data (see below)

## Number of UK Charging Points<sup>1</sup> ('000s)





# The AA monthly survey was the next highest scoring source, citing a need for motorway rapid chargers

## Case study background:



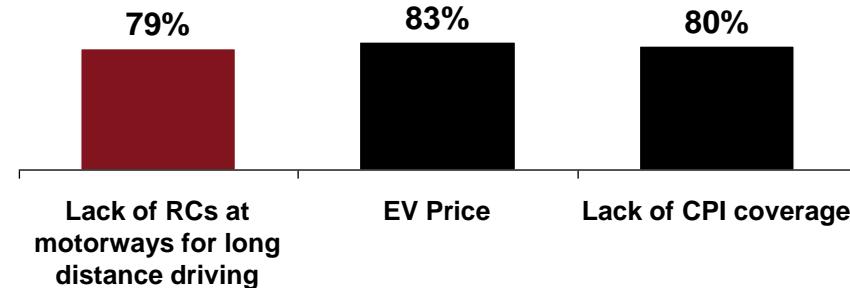
- Highlights from the AA's **2018 and 2019** monthly Driver Poll surveys
- EVs were largely discussed through **May - Sept 2018**
- The AA partners with market research experts **Populus**
- The poll is the **largest dedicated motoring opinion panel in Europe.**
- There were on average **c.10,000 respondents** for each monthly survey
- As this report was finalised a newer AA poll shows that en route Rapid Charging is **one of the top three factors** policy makers can influence to increase uptake of EVs<sup>1</sup>

## Case study findings:



- 43% of respondents demand a "real world driving range" of at least **250 miles<sup>2</sup>**
- 31% cited rapid charging at petrol stations (30 minutes to reach 80%) as one of **top 3 preferences**
- But only a very **small proportion** intend to use a plug in **hybrid (5%)** or go **pure electric (3%)** in their next car

### Main Non-EV owner EV purchasing concerns (%)

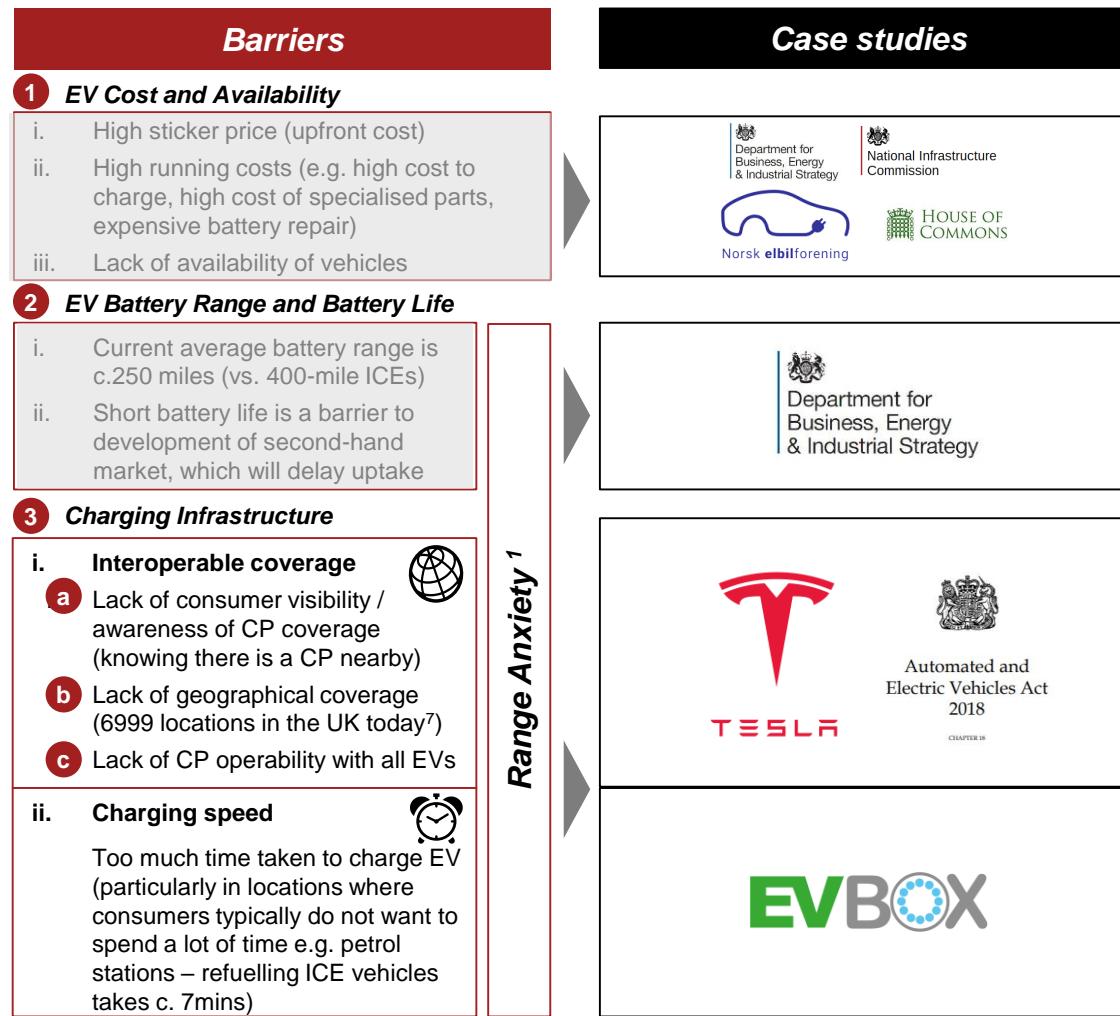


## 3.3 Other relevant case studies

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# We also found other interesting case studies relevant to range anxiety and other EV barriers

Key: Out of scope





For example, Tesla drivers cite national coverage and reliability as reasons for high satisfaction rates

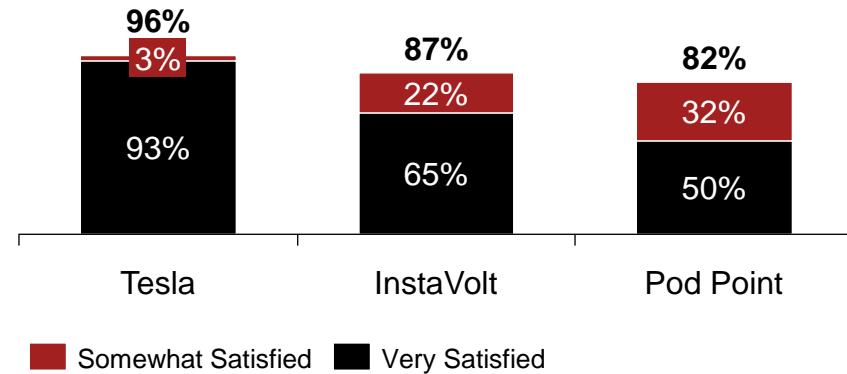
### Tesla destination chargers, UK



### Case study: ZAP MAP®

- Survey suggests that **reliability and national coverage** are reasons that **93%** of respondents were '**very satisfied**' with the Tesla Supercharger network
- Ensuring reliability of performance and speedy repairs are key to maintaining visibility of CPs with customer base

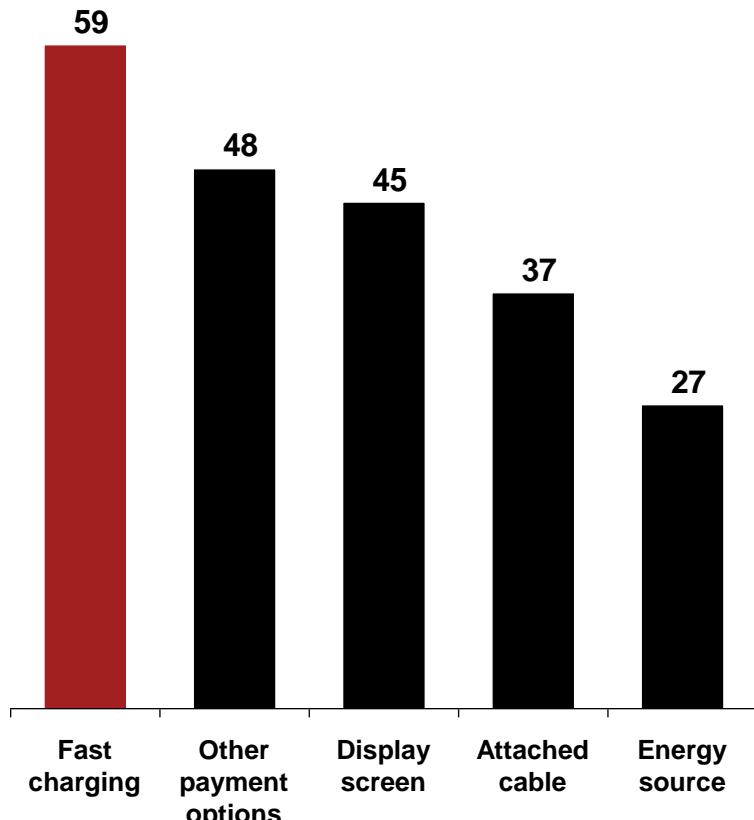
### 'Satisfied' customers of UK CP networks 2018<sup>1</sup> (%)





# We also found that charging time is the public charge point improvement EV users most desire

EV users' most requested features for a public charging station (% of respondents)



## Case study: **EVBox**

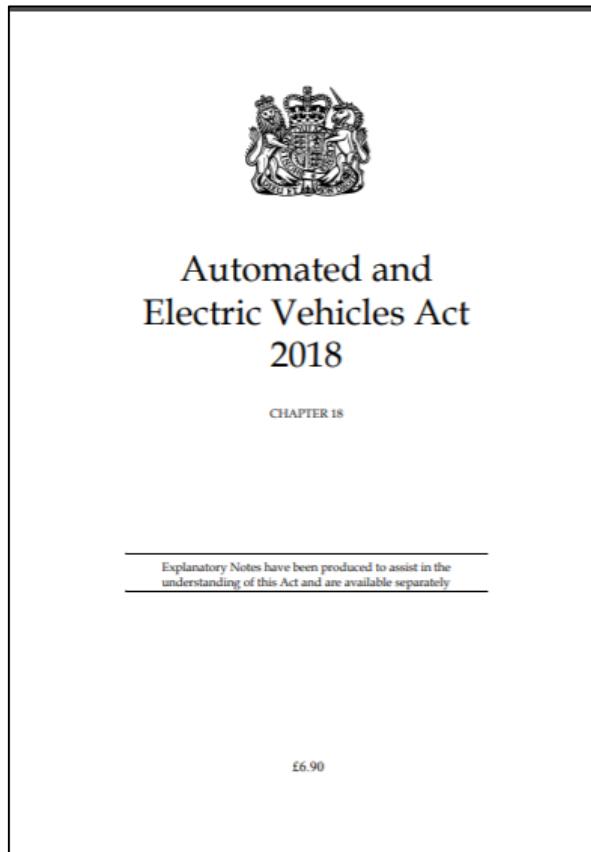
EVBox surveyed 850 EV (*BEVs with >100km range*) users and found that:

- 55% of respondents have **never used a fast charging station**
- 42% respondents say that **the largest incentive to buying a personal charger is faster charging**, 4x higher than next largest incentive (safer charging)
- 47% said they were **dissatisfied with current EV infrastructure**
- 51% said they had purchased an EV in order to contribute to a sustainable future

*“Do electric drivers expect charging to be something like refuelling? They do favour speed over everything else, so it does seem like this is the case.” - EVBox*



# Charge point interoperability is another issue for EV drivers but is being addressed in the UK



## The Automated and Electric Vehicles Act 2018

### Aim

UK to become a world leader in the rollout of low-emission transport:

- Improvement of electric charging infrastructure across the country
- Motorway services upgrades
- Insurance rule modernisation to cover self-driving vehicles

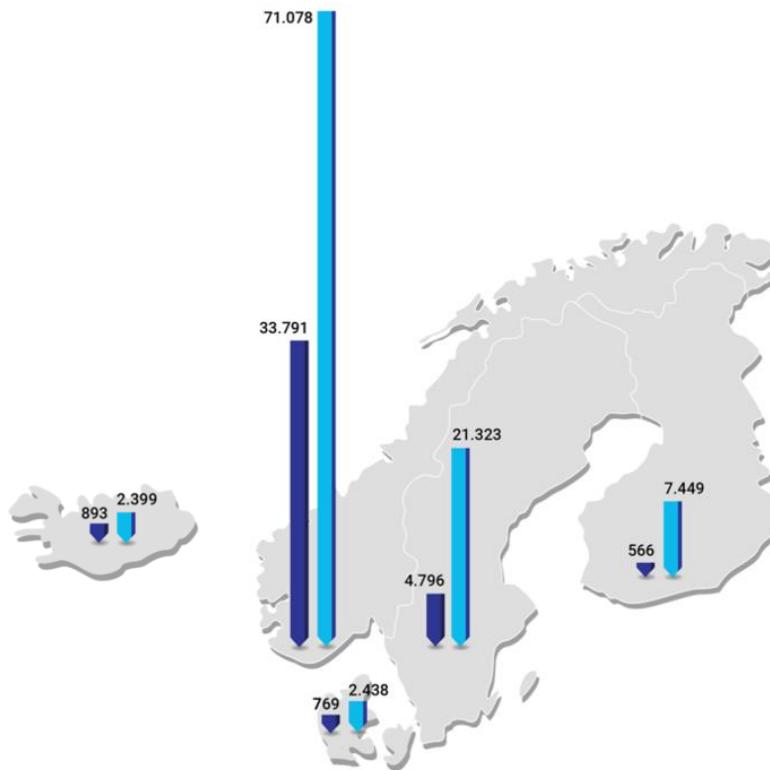
### How?

Increase consumer confidence in EV charging by:

- ensuring public charge points are compatible with all vehicles
- standardising payment at charge points
- setting standards for reliability

# In terms of the cost barrier, Norway has shown that fiscal incentives are effective in driving EV uptake

## Nordic EV barometer: estimated electric car sales 2017 - 2018

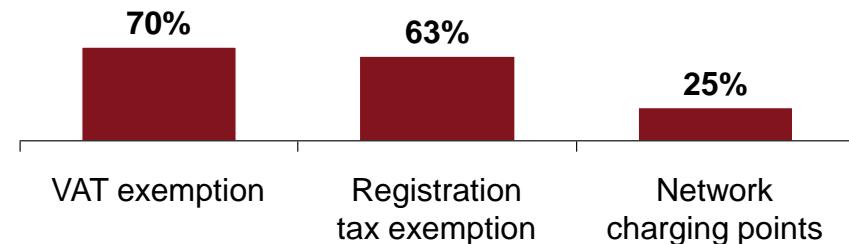


## Case study:

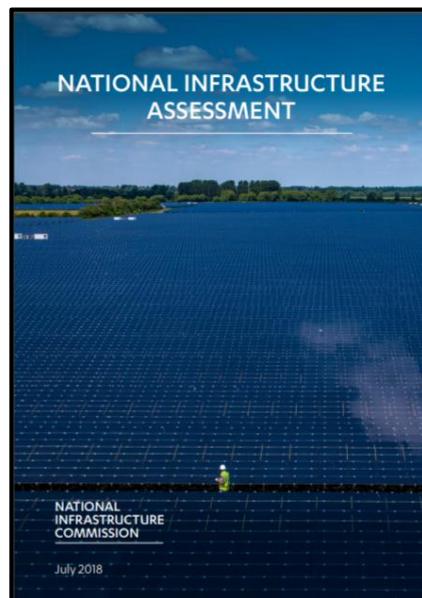
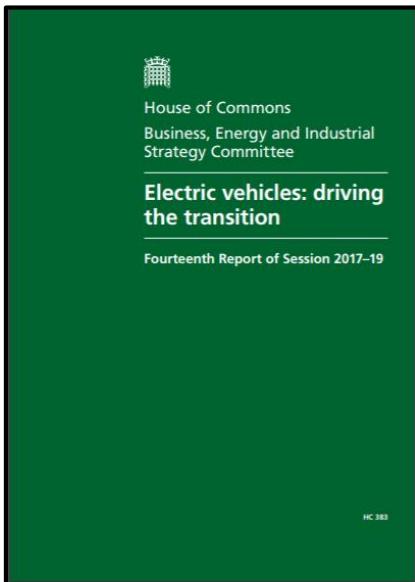


- In Nordic countries (particularly Norway which boasts high EV penetration), reduction in the purchase price has been the main driver influencing the decision to buy an electric car
- VAT and registration tax exemption are cited as the most important factors among a wide set of incentives
- However, Norwegian EV drivers also cite range anxiety as being the largest barrier to EV adoption (21% vs 6% for sticker prices)

## Perceived importance of policy measures that would entice respondents to purchase an EV (%)<sup>1</sup>



# While BEIS<sup>1</sup> also highlighted fiscal policy and as well as battery prices as key to increasing EV uptake



## Case study:



HOUSE OF  
COMMONS



Department for  
Business, Energy  
& Industrial Strategy



National Infrastructure  
Commission

### BEIS committee witnesses said that...

- further fiscal incentives are needed, as they are the primary driver for EV adoption
- charging infrastructure investment is not a current issue, there just needs to be the EV drivers there to use the infrastructure

### The BEIS report says that...

- Government's ambition to develop a national charging infrastructure is at odds with its decision to leave delivery to local authorities and private actors
- Highlights that when battery performance improves and cost reduces, EV uptake is likely to also increase

### The NIC<sup>3</sup> recommends...

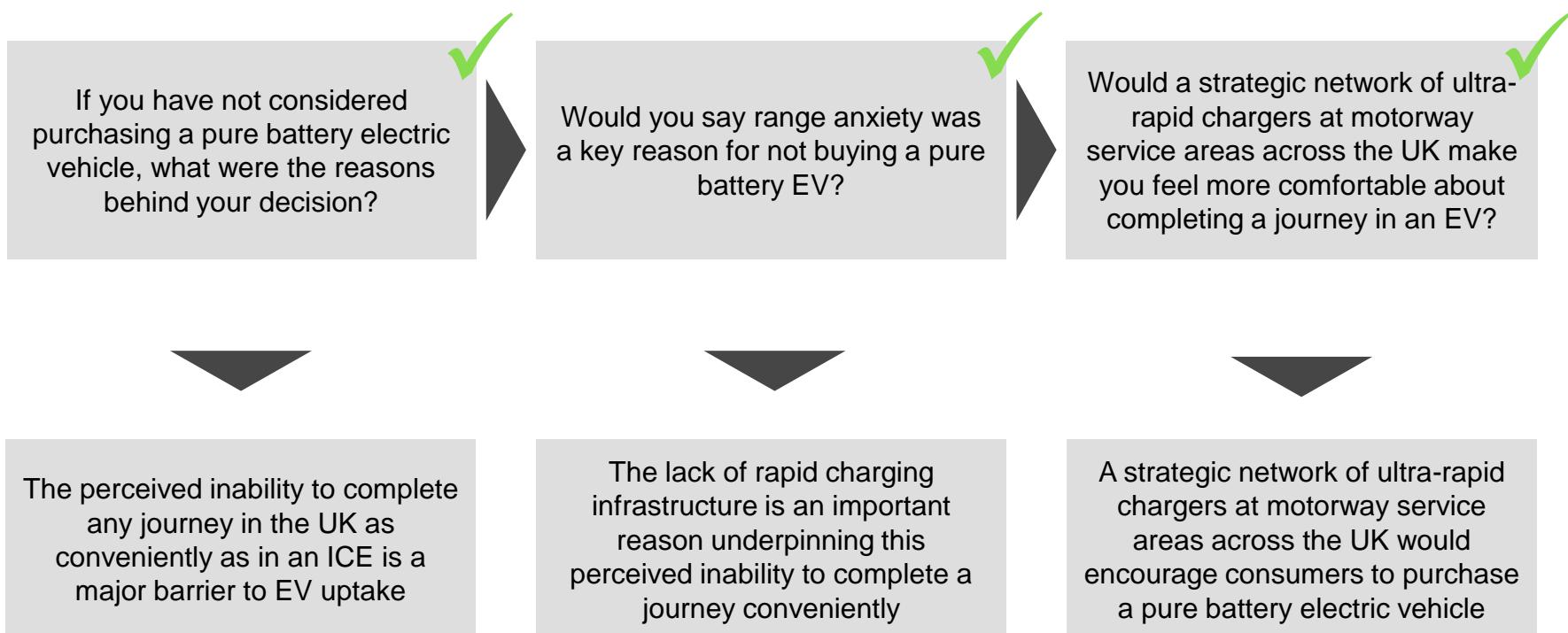
- Government subsidise the provision of rapid charge points in remote areas by 2022
- The NIC also recommends that future road investment reflect the potential impact of connected and autonomous vehicles

# 4. Gap Analysis

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# For B2C customers, there is solid evidence of the importance of a rapid charging network

**Existing surveys provide robust answers to the key questions**

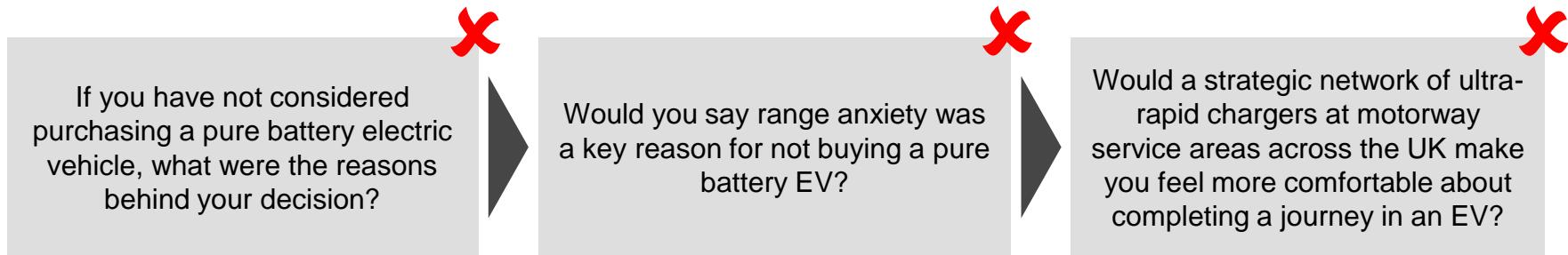


**Legend:** ✓ At least one survey reviewed answered question

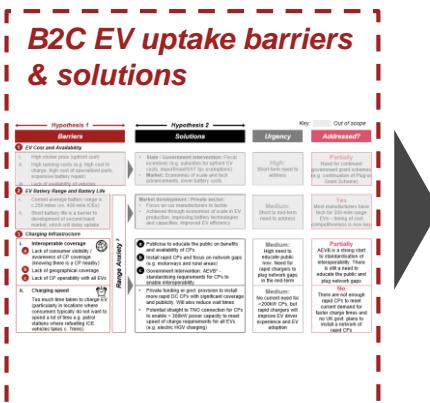
✗ No surveys reviewed answered question

There a gap in research of B2B EV adoption barriers and further analysis should be considered

We did not find any survey that answered our ‘right type of questions’<sup>1</sup>, directly linking a strategic  
of ultra-rapid chargers to range anxiety...



**... and there was a lack of B2B research in general:**



## Sources directly linked to B2B analysis from research scan:

- #24 – **GemServ** workshop: mentions range anxiety but does not discuss rapid charging
  - #33 – **ENA** report: charge point infrastructure is a barrier – no mention rapid chargers as solution
  - #36 – **BEIS** Parliamentary committee: charge point infrastructure is not a barrier
  - #38 – **PwC** IoT survey: no mention of range anxiety or rapid chargers – focuses on EV benefits for SMEs

## **Interview findings on B2B:**

- **Fleet Operator** – range anxiety one of multiple problems with fleet electrification. Rapid chargers needed but only in 10-15 years. Charge point infrastructure in rural areas is key but does not need to be rapid
  - **Charge Point Operator** – Rapid chargers needed for >4 hour journeys but most fleets operate <4 hour journeys

**Legend:** ✓ At least one survey reviewed answered question



## No surveys reviewed answered question

# 5. Next steps

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# Potential next steps

**There is a risk that the market may not invest in a rapid charging network, given the scale of the investment and the uncertainty of future revenue streams. We recommend that the industry assess whether there are likely to be barriers to the development of this critical infrastructure**

1

**Identify whether there is a case of market failure in EV rapid charging and in what context**

- Discuss with investors, motorway service associations, OEMs, energy networks and Charge Point Operators:
  - **where they see investment in EV charging and over what timelines** and;
  - **whether there is a case of market failure**
- If there is a case of market failure identify:
  - **where the market may fail to deliver (in specific charging locations, higher power charging for battery electric trucks etc.)**

2

**Identify what role Government should play in facilitating motorway rapid charging, if any**

- If justified by the evidence, enter into a dialogue with BEIS and OLEV around EV transit rapid charging. Highlight if there is a **gap between what the market can provide and what drivers require** to facilitate and be prepared for large scale EV adoption
- Identify **what a Government led EV rapid charging framework needs to look like** if the market is to invest in motorway rapid charging and Government is to reach its 2040 Road to Zero targets

**We also observe that, given the lack of research into the views of B2B EV users, there would be merit in conducting further research in this area.**

# 6.1 Appendix: Summaries of research reviewed

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# Summaries of sources 1-10

## High level findings of our analysis from the top 10 out of 45 sources

Source	Source Type	Score ( /69)	Summary of key findings
Baringa	Survey	58	<ul style="list-style-type: none"> <li>States that range anxiety is the second biggest barrier for EV (cost was identified as the greatest barrier)</li> </ul>
Confused.com	Industry Report	50	<ul style="list-style-type: none"> <li>Cites range anxiety as the number one barrier to EV adoption</li> <li>Suggests that improved coverage of CPI<sup>1</sup> as most effective solution</li> </ul>
AA Populus Driving Survey	Survey	50	<ul style="list-style-type: none"> <li>Finds that the number one factor that would convince AA non-EV drivers to purchase an EV is a 'real world' driving range of &gt;250 miles</li> </ul>
AutoTrader	Market Report	49	<ul style="list-style-type: none"> <li>Quotes Steve Hood, Director of EVs at Ford Europe who suggests that increased rapid charging coverage will help dispel the range anxiety myth</li> </ul>
European Federation for Transport and Environment	Commercial Report	46	<ul style="list-style-type: none"> <li>States that being able to recharge cars within the recommended driving break time is expected to be a game changer for market uptake</li> </ul>
OVO Energy	Survey	45	<ul style="list-style-type: none"> <li>Reports that lack of charging points was identified as the largest barrier to EV uptake by the 2000 respondents to its 2017 survey</li> </ul>
AA public attitudes article	Article	44	<ul style="list-style-type: none"> <li>Highlights that range anxiety is a myth but concedes that 85% of its survey respondents said there wasn't enough CPI coverage</li> </ul>
Department for Transport (ONS)	Government Report	44	<ul style="list-style-type: none"> <li>Identifies range anxiety along with high sticker prices as the primary barrier to EV adoption in the UK</li> </ul>
Automotive World	Industry Report	43	<ul style="list-style-type: none"> <li>Mentions that Ford believe that a rapid charging infrastructure (e.g. Ionity) is a specific antidote to the perceived relative inconvenience of driving EVs</li> </ul>
Department for Business, Environment and Industrial Strategy	Government Report	41	<ul style="list-style-type: none"> <li>Suggests that rapid charging points on motorways will be instrumental in reducing range anxiety, particularly in rural areas</li> </ul>

# Summaries of sources 11-20

## High level findings of our analysis from sources 11 – 20 out of 45 sources

Source	Source Type	Score (/69)	Summary of key findings
RAC	Market Report	41	<ul style="list-style-type: none"> <li>Finds that 73% of non-EV drivers would require pure battery EVs to be the same price or lower than an ICE before they would consider one</li> </ul>
RAC Foundation	Industry Report	41	<ul style="list-style-type: none"> <li>Suggests that the EV charge point experience should be similar to that of refueling an ICE vehicle if EV adoption is to take flight</li> </ul>
Consumer Reports	Article	40	<ul style="list-style-type: none"> <li>Identifies in-car experience as key to range anxiety for actual EV users, with Tesla upgrading its Model S cars with a range assurance system</li> </ul>
National Infrastructure Commission	Industry Report	40	<ul style="list-style-type: none"> <li>Recommends that the UK government invest in UK CPI to achieve higher EV adoption, with importance stresses on investment on rural chargers</li> </ul>
Fully Charged	Survey	40	<ul style="list-style-type: none"> <li>Survey with 7.700 respondents who cited concern about range and a lack of charging point infrastructure, alongside cost, as the primary barrier</li> </ul>
Norsk Elbilforening	Survey	39	<ul style="list-style-type: none"> <li>Explains how Norway has achieved highest worldwide EV adoption through fiscal incentives/policy (e.g. VAT and registration tax exemptions)</li> </ul>
Mintel	Industry Report	39	<ul style="list-style-type: none"> <li>Identifies the top 5 barriers that respondents answered as being barriers to EVs, with charging time and accessibility being 1<sup>st</sup> and 3<sup>rd</sup> respectively</li> </ul>
Financial Times	Article	39	<ul style="list-style-type: none"> <li>Identifies range anxiety as the largest barrier to EV uptake, citing continental. The report explicitly mentions rapid charging as a solution</li> </ul>
Continental	Press Release	39	<ul style="list-style-type: none"> <li>Highlights range anxiety as a direct barrier to EV, and suggests that rapid charging is as important as battery capacity to solve range anxiety</li> </ul>
Forbes	Article	39	<ul style="list-style-type: none"> <li>Identifies range anxiety as the largest barrier to EV uptake, and mentions ChargePoint's Ultrafast DC rapid chargers as a direct solution</li> </ul>

# Summaries of sources 21-30

## High level findings of our analysis from sources 21 – 30 out of 45 sources

Source	Source Type	Score (/69)	Summary of key findings
Changsha University of Scientific Technology	Academic Paper	37	<ul style="list-style-type: none"> <li>"Range anxiety for a sample of EV users measured a buffer zone, the time between range anxiety onset and negative effects on driving occurs"</li> </ul>
Energy UK	Workshop	37	<ul style="list-style-type: none"> <li>Article provides recommendations to the UK Government to increase the uptake of EVs, with rapid CI direct solution to range anxiety</li> </ul>
Pod Point	Workshop	37	<ul style="list-style-type: none"> <li>Interview identifies small number of EVs as the largest barrier a large CI, and blames delivery times as a barrier with Nissan Leaf as an example</li> </ul>
GemServ	Commercial Report	36	<ul style="list-style-type: none"> <li>YouGov survey, with 35% stating that they would buy an EV if charging was more readily available, with 50% demanding a better CI</li> </ul>
ZapMap	Survey	36	<ul style="list-style-type: none"> <li>Article highlights that 88% of rapid charging network users are satisfied with the experience, but stated poor reliability as a key issue</li> </ul>
Driving Electric	Article	36	<ul style="list-style-type: none"> <li>Article suggests range anxiety is as EVs are available with a 300 mile range, at which point 37% of consumers would purchase one</li> </ul>
RAC Foundation	Industry report	35	<ul style="list-style-type: none"> <li>Explains how range is not an issue, but cites EV prices and battery life expectancy as the major barriers to EV uptake</li> </ul>
Leading EV Manufacturer	Interview	35	<ul style="list-style-type: none"> <li>Interview stating that CI is a loss leader for OEMs, and that lack of CI is the greatest barrier, with improvement in regulations and grid needed</li> </ul>
Clean Technica	Industry Report	34	<ul style="list-style-type: none"> <li>Focuses on the demands from EV users which include further range and better charging infrastructure, as well as software updates</li> </ul>
Big 6 Supplier	Interview	33	<ul style="list-style-type: none"> <li>Focuses on the importance of infrastructure. Interview focuses on the need for policy implementations to enable street level parking</li> </ul>

# Summaries of sources 31-40

## High level findings of our analysis from sources 31 – 40 out of 45 sources

Source	Source Type	Score (/69)	Summary of key findings
Zap Map	Article	32	<ul style="list-style-type: none"> <li>States that placing charging points in public spaces can attract EV with 90% of EV drivers using public charging places</li> </ul>
EV Box	Commercial Report	32	<ul style="list-style-type: none"> <li>Article has a strong focus on rapid charging, with 55% of EV driving respondents having never used a rapid charging station</li> </ul>
ENA	EV Forum Presentation	31	<ul style="list-style-type: none"> <li>Fleet operator case study with Royal Mail, who suggest: the following issues in the switch to EVs: cost, charging infrastructure, model choice</li> </ul>
Corporate Vehicle Observatory	Industry Report	31	<ul style="list-style-type: none"> <li>Focuses on different fleet vehicles, including financing, fleet composition, fleet growth, and different energy mixes including hybrid and EVs</li> </ul>
Innovate UK	Survey	31	<ul style="list-style-type: none"> <li>Survey which concludes that one of the remaining barriers inhibiting rapid uptake of EVs is lack of public recharging infrastructure</li> </ul>
Business, Energy and Industrial Strategy Committee	Interview	27	<ul style="list-style-type: none"> <li>Interview identifies no direct barriers to EV uptake. Suggests taxes and fiscal benefits as drivers of EV uptake, citing Norway as an example</li> </ul>
Chargemaster	Workshop	27	<ul style="list-style-type: none"> <li>Guide by Chargemaster, suggesting that the growing market needs to be serviced by workplace charging, with Government incentives taking place</li> </ul>
PwC	Survey	27	<ul style="list-style-type: none"> <li>Identifies reduced operational costs and CO2 emissions as the main driver of workplace EV charging infrastructure, particularly for SMEs</li> </ul>
GoUltra	Article	26	<ul style="list-style-type: none"> <li>Article highlights the need to dispel EV myths to improve EV uptake, with range and CI stated as false barriers</li> </ul>
International Energy Agency	Industry Report	25	<ul style="list-style-type: none"> <li>Consumer practices in the Nordic countries suggest that EVSE policies are secondary to economic incentives for the purchase of electric cars</li> </ul>

# Summaries of sources 41-45

## High level findings of our analysis from sources 41 – 45 out of 45 sources

Source	Source Type	Score ( /69)	Summary of key findings
Pod Point	Press Release	25	<ul style="list-style-type: none"><li>Non scientific article with no survey. Article provides comments on the EV driver experience</li></ul>
Daimler	Press Release	25	<ul style="list-style-type: none"><li>Car manufacturers suggesting that geographical distribution, ultra-rapid charging and choice of EV models are largest drivers of EV update</li></ul>
Green Energy Supplier	Interview	25	<ul style="list-style-type: none"><li>Interview with Head of smart charging, which states rapid charging is obsolete with current range, and charging habits are the major barrier</li></ul>
International Energy Agency	Article	22	<ul style="list-style-type: none"><li>Analyses the success of EVs in Norway, with significant legislation in favour of EVs including no import tax, VAT or road tax being drivers</li></ul>
Nordic EV Charging Specialist	Interview	17	<ul style="list-style-type: none"><li>Norway has high EV penetration given government fiscal incentives. Rapid charging is used at weekends for road trips and in winter for skiing</li></ul>

# Sources 1-10

## Source names

Source	Source Type	Source Title	URL
Baringa	Survey	Is the UK ready for electric cars?	<a href="https://www.baringa.com/getmedia/81a8c49b-cb7a-4e23-9f94-0f475f3222ee/Is-the-UK-ready-for-Electric-Cars-FINAL-WEB/">https://www.baringa.com/getmedia/81a8c49b-cb7a-4e23-9f94-0f475f3222ee/Is-the-UK-ready-for-Electric-Cars-FINAL-WEB/</a>
Confused.com	Industry Report	The Rise of Electric Cars: An in-depth look at a motoring revolution	<a href="https://www.confused.com/car-insurance/electric-cars-report">https://www.confused.com/car-insurance/electric-cars-report</a>
AA Populus Driving Survey	Survey	Driver Poll Surveys	<a href="https://www.theaa.com/about-us/public-affairs/aa-populus-driver-poll-summaries-2018#july2018">https://www.theaa.com/about-us/public-affairs/aa-populus-driver-poll-summaries-2018#july2018</a>
AutoTrader	Market Report	The evolution of the car	<a href="https://cdn-autotraderplc.azureedge.net/media/1590/auto-trader-market-report-march-2019.pdf">https://cdn-autotraderplc.azureedge.net/media/1590/auto-trader-market-report-march-2019.pdf</a>
European Federation for Transport and Environment	Commercial Report	Charging infrastructure report 2018	<a href="https://www.euractiv.com/wp-content/uploads/sites/2/2018/09/Charging-Infrastructure-Report_September-2018_FINAL.pdf">https://www.euractiv.com/wp-content/uploads/sites/2/2018/09/Charging-Infrastructure-Report_September-2018_FINAL.pdf</a>
OVO Energy	Survey	Whats stopping the Electric Vehicle Revolution	<a href="https://www.ovogen.com/blog/ovo-news/whats-stopping-the-electric-vehicle-revolution.html">https://www.ovogen.com/blog/ovo-news/whats-stopping-the-electric-vehicle-revolution.html</a>
AA public attitudes article	Article	Drivers still need to be convinced about electric vehicles	<a href="https://www.theaa.com/about-us/newsroom/what-drivers-think-about-electric-vehicles">https://www.theaa.com/about-us/newsroom/what-drivers-think-about-electric-vehicles</a>
Department for Transport (ONS)	Government Report	Public attitudes towards electric vehicles: 2016 (Revised)	<a href="https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/551446/electric-vehicles-survey-2016.pdf">https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/551446/electric-vehicles-survey-2016.pdf</a>
Automotive World	Industry Report	Charging the Electric Vehicle	<a href="https://www.automotiveworld.com/research/special-report-charging-the-electric-vehicle/">https://www.automotiveworld.com/research/special-report-charging-the-electric-vehicle/</a>
Department for Business, Environment and Industrial Strategy	Government Report	Electric vehicles: driving the transition	<a href="https://publications.parliament.uk/pa/cm201719/cmselect/cmbeis/383/383.pdf">https://publications.parliament.uk/pa/cm201719/cmselect/cmbeis/383/383.pdf</a>

# Sources 11-20

## Source names

Source	Source Type	Source Title	URL
RAC	Market Report	RAC Report on Motoring 2018	<a href="https://www.rac.co.uk/pdfs/report-on-motoring/rac10483_rom-2018_content_web">https://www.rac.co.uk/pdfs/report-on-motoring/rac10483_rom-2018_content_web</a>
RAC Foundation	Industry Report	Development of the UK CPN	<a href="https://www.racfoundation.org/wp-content/uploads/Development_of_the_UK_CPN_Harold_Dermott_December_2018.pdf">https://www.racfoundation.org/wp-content/uploads/Development_of_the_UK_CPN_Harold_Dermott_December_2018.pdf</a>
Consumer Reports	Article	Tesla aims to end range anxiety	<a href="https://www.consumerreports.org/cro/news/2015/03/tesla-aims-to-end-range-anxiety/index.htm">https://www.consumerreports.org/cro/news/2015/03/tesla-aims-to-end-range-anxiety/index.htm</a>
National Infrastructure Commission	Industry Report	National Infrastructure Assessment Chapter 3: Revolutionising Road Transport	<a href="https://www.nic.org.uk/wp-content/uploads/CCS001_CCS0618917350-001_NIC-NIA_Accessible.pdf#page=53">https://www.nic.org.uk/wp-content/uploads/CCS001_CCS0618917350-001_NIC-NIA_Accessible.pdf#page=53</a>
Fully Charged	Survey	Fully Charged Audience Survey	NO URL
Norsk Elbilforening	Survey	Nordic EV Barometer 2016, 2017, 2018	<a href="https://elbil.no/elbilstatistikk/nordic-ev-barometer/">https://elbil.no/elbilstatistikk/nordic-ev-barometer/</a>
Mintel	Industry Report	Hybrid and Electric Cars - UK - December 2016	<a href="http://reports.mintel.com/display/748922/#">http://reports.mintel.com/display/748922/#</a>
Financial Times	Article	Range anxiety holds back electric cars	<a href="https://www.ft.com/content/8984ebaa-f7f9-11e5-96db-fc683b5e52db">https://www.ft.com/content/8984ebaa-f7f9-11e5-96db-fc683b5e52db</a>
Continental	Press Release	Electric mobility: charging is just as important as driving	<a href="https://www.continental-corporation.com/en/press/press-releases/2018-01-31-laden-e-mob-121374">https://www.continental-corporation.com/en/press/press-releases/2018-01-31-laden-e-mob-121374</a>
Forbes	Article	ChargePoint's New Stations Promise Fast Charge In Minutes For Your Electric Car	<a href="https://www.forbes.com/sites/joannmuller/2017/01/05/chargepoints-new-stations-promise-fast-charge-in-minutes-for-your-electric-car/#731fd9f0492d">https://www.forbes.com/sites/joannmuller/2017/01/05/chargepoints-new-stations-promise-fast-charge-in-minutes-for-your-electric-car/#731fd9f0492d</a>

# Sources 21-30

## Source names

Source	Source Type	Source Title	URL
Changsha University of Scientific Technology	Academic Paper	Range Anxiety Empirical	<a href="https://www.hindawi.com/journals/jat/2018/8301209/">https://www.hindawi.com/journals/jat/2018/8301209/</a>
Energy UK	Workshop	The Future of Energy	NO URL
Pod Point	Workshop	No Title	NO URL
GemServ	Commercial Report	Electric vehicle workshop, summary & next steps	<a href="https://www.gemserv.com/wp-content/uploads/2018/08/EV-Workshop-Summary-Report-Gemserv-002.pdf">https://www.gemserv.com/wp-content/uploads/2018/08/EV-Workshop-Summary-Report-Gemserv-002.pdf</a>
ZapMap	Survey	Zap-Map survey reveals top EV charging networks	<a href="https://www.zap-map.com/zap-map-survey-reveals-top-ev-charging-networks/">https://www.zap-map.com/zap-map-survey-reveals-top-ev-charging-networks/</a>
Driving Electric	Article	'Range anxiety' fades as electric cars' range increases	<a href="https://www.drivingelectric.com/news/794/range-anxiety-fades-electric-cars-range-increases">https://www.drivingelectric.com/news/794/range-anxiety-fades-electric-cars-range-increases</a>
RAC Foundation	Industry report	Ultra-Low-Emission Vehicle Infrastructure – What Can Be Done	<a href="https://www.racfoundation.org/wp-content/uploads/2017/11/Ultra_Low_Emission_Vehicle_Infrastructure_Harold_Dermott_September_2017.pdf">https://www.racfoundation.org/wp-content/uploads/2017/11/Ultra_Low_Emission_Vehicle_Infrastructure_Harold_Dermott_September_2017.pdf</a>
Leading EV Manufacturer	Interview	No Title	NO URL
Clean Technica	Industry Report	Electric Car Drivers: Desires, Demands, & Who are they	NO URL
Big 6 Supplier	Interview	No Title	NO URL

# Sources 31-40

## Source names

Source	Source Type	Source Title	URL
Zap Map	Article	Survey supports the need for a public EV charging network	<a href="https://www.zap-map.com/survey-supports-the-need-for-a-public-ev-charging-network/">https://www.zap-map.com/survey-supports-the-need-for-a-public-ev-charging-network/</a>
EV Box	Commercial Report	Manifesto of Electric Mobility	<a href="https://info.evbox.com/manifesto-electric-mobility">https://info.evbox.com/manifesto-electric-mobility</a>
ENA	EV Forum Presentation	Electric Vehicle Forum #1	NO URL
Corporate Vehicle Observatory	Industry Report	2018 Fleet Barometer	NO URL
Innovate UK	Survey	Electric Vehicle Charging for Public Spaces: Feasibility Studies	NO URL
Business, Energy and Industrial Strategy Committee	Interview	BEIS Committee: Development of charging infrastructure for electric vehicles examined	<a href="https://parliamentlive.tv/event/index/539de0d3-cdac-4ec4-a2e1-912721ae5121?in=10:03:09">https://parliamentlive.tv/event/index/539de0d3-cdac-4ec4-a2e1-912721ae5121?in=10:03:09</a>
Chargemaster	Workshop	Quick Guide To: Workplace Electric Vehicle Charging	<a href="https://bpchargemaster.com/wp-content/uploads/2017/12/Quick-Guide-To-Workplace-Electric-Vehicle-Charging.pdf">https://bpchargemaster.com/wp-content/uploads/2017/12/Quick-Guide-To-Workplace-Electric-Vehicle-Charging.pdf</a>
PwC	Survey	IoT Survey	NO URL
GoUltra	Article	That's Shocking! Brits underestimate benefits of switching to a pure electric car, and 42% don't think you can put one through a car wash	NO URL
International Energy Agency	Industry Report	Nordic EV Outlook 2018 - Insights from leaders in electric mobility	<a href="https://webstore.iea.org/global-ev-outlook-2018">https://webstore.iea.org/global-ev-outlook-2018</a> <a href="https://www.iea.org/gevo2018/">https://www.iea.org/gevo2018/</a>

# Sources 41-45

## Source names

Source	Source Type	Source Title	URL
Pod Point	Press Release	Top 8 things only EV drivers know	<a href="https://pod-point.com/electric-car-news/the-top-8-things-only-ev-drivers-know">https://pod-point.com/electric-car-news/the-top-8-things-only-ev-drivers-know</a>
Daimler	Press Release	A Joint Venture for Ultra-Fast, High-Power Charging Along Major Highways in Europe	<a href="https://media.daimler.com/marsMediaSite/en/instance/ko/BMW-Group-Daimler-AG-Ford-Motor-Company-and-Volkswagen-Group-with-Audi-Porsche-Plan-a-Joint-Venture-for-Ultra-Fast-High-Power-Charging-Along-Major-Highways-in-Europe.xhtml?oid=14866747">https://media.daimler.com/marsMediaSite/en/instance/ko/BMW-Group-Daimler-AG-Ford-Motor-Company-and-Volkswagen-Group-with-Audi-Porsche-Plan-a-Joint-Venture-for-Ultra-Fast-High-Power-Charging-Along-Major-Highways-in-Europe.xhtml?oid=14866747</a>
Green Energy Supplier	Interview	<i>No Title</i>	NO URL
International Energy Agency	Article	Nordic region offers valuable lessons for rapid EV deployment worldwide	<a href="https://www.iea.org/newsroom/news/2018/march/nordic-region-offers-valuable-lessons-for-rapid-ev-deployment-worldwide.html">https://www.iea.org/newsroom/news/2018/march/nordic-region-offers-valuable-lessons-for-rapid-ev-deployment-worldwide.html</a>
Nordic EV Charging Specialist	Interview	<i>No Title</i>	NO URL

## 6.2 Appendix: ‘Right types of questions’

---

# As part of the scoring criteria, we asked if the surveys we reviewed answered any of the below questions

## 'Right types of questions'

### 1) What are your typical driving habits?:

- What are the longest trips you make each year?
- How often do you make these trips?
- How far are they?

### 2) Have you considered purchasing a pure battery electric vehicle?

### 3) If yes, would this be your main car, or a second car?

### 4) If yes, what were the reasons for purchasing a pure battery electric vehicle?:

- Environmental
- Financial (cheaper to run a BEV)
- Other (please state)

### 5) If you have not considered purchasing a pure battery electric vehicle what were the reasons behind your decision?:

- Too expensive to buy
- Concerned by range anxiety

- Limited choice of models
- Other (please state)

### 6) Would you say range anxiety was the number one reason for not buying a pure battery electric vehicle?

### 7) If yes, would a strategic network of ultra-fast chargers at motorway service areas across the UK allay your concern about range anxiety?

### 8) If yes, would a strategic network of ultra-fast chargers at motorway service areas across the UK allay your concern about range anxiety and encourage you to purchase a pure battery electric vehicle?

### 9) If you purchased a pure electric battery vehicle which is the most likely way you would charge your vehicle?:

- Charge at home
- Charge at work
- Charge at destinations
- Rapid charging en-route such as at MSAs?



*Part of the PwC network*

# Thank you

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This work was carried out in association with Complete Strategy ([www.complete-strategy.com](http://www.complete-strategy.com)).

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