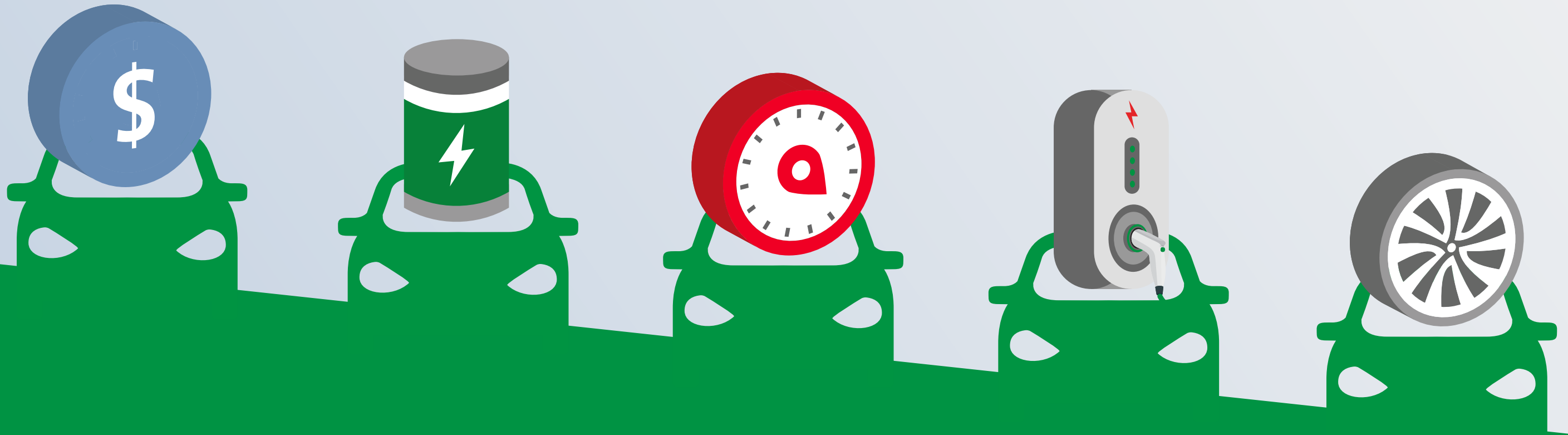


ACCELERATING THE EVOLUTION

The tipping points to mainstream electric vehicle adoption



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DISCLAIMER

IT'S MORE THAN JUST OIL. IT'S LIQUID ENGINEERING.



FOREWORD

WE MUST DRIVE A LOW-CARBON RECOVERY AS QUICKLY AS POSSIBLE.

2020 will go down in history as the year the novel coronavirus changed lives, economies and attitudes forever. The human cost of the pandemic has been the world's primary concern, but the global economy - and in particular the automotive sector - has also been hugely impacted.

The spread of the virus and the subsequent lockdowns have rocked international supply chains, shuttered forecourts and restricted travel to an extent that would have been unimaginable previously. Yet the crisis has also showcased the innovation and agility that drives the automotive industry, with OEMs turning their design, engineering and manufacturing capabilities to produce much-needed ventilators and protective equipment.

When we emerge into a post-pandemic world, we must continue to apply this engineering prowess to help solve the global challenge of achieving net-zero carbon emissions in line with the Paris Agreement. Whilst everyone - from business leaders and policymakers to investors and consumers - has a key role to play in meeting this challenge, the automotive industry's efforts to reimagine transportation will be more important than ever.

Electric vehicles (EVs) are one of the technologies that can help power this change. But unfortunately consumer demand is not yet driving EVs into the mainstream. Even prior to the outbreak, just one in 50 new cars sold was an EV. When the recovery does take hold, we will need to focus on the acceleration of widespread EV adoption.

IDENTIFYING THE CRITICAL CHALLENGES

This acceleration relies on meeting a number of remaining critical challenges. Barriers - whether real or perceived - that are preventing consumers from making the switch. It is these challenges that *Accelerating the EVolution* seeks to quantify and help solve.

In order to learn more about these challenges, we interviewed nearly 10,000 consumers, fleet managers and EV industry professionals across eight of the world's most important EV markets to understand more about how the automotive industry can supercharge EV adoption. We set out to understand the five 'critical challenges' (price, charge time, vehicle range, infrastructure and vehicle choice) that are acting as roadblocks to consumers making the switch to EVs.

REALISING THE OPPORTUNITY

Our study reveals the 'tipping points' for price, charge time and vehicle range that, if achieved, could accelerate the mainstreaming of electric vehicles: a price point of \$36,000, a charge time of 31 minutes and a range of 469 kilometres. For the winners of the EV race, the opportunity is vast. Our proprietary economic model, developed as part of our research study, calculates that meeting these tipping points presents a \$376 billion opportunity for annual EV sales across our eight markets by 2025.

THE FUTURE IS NOW

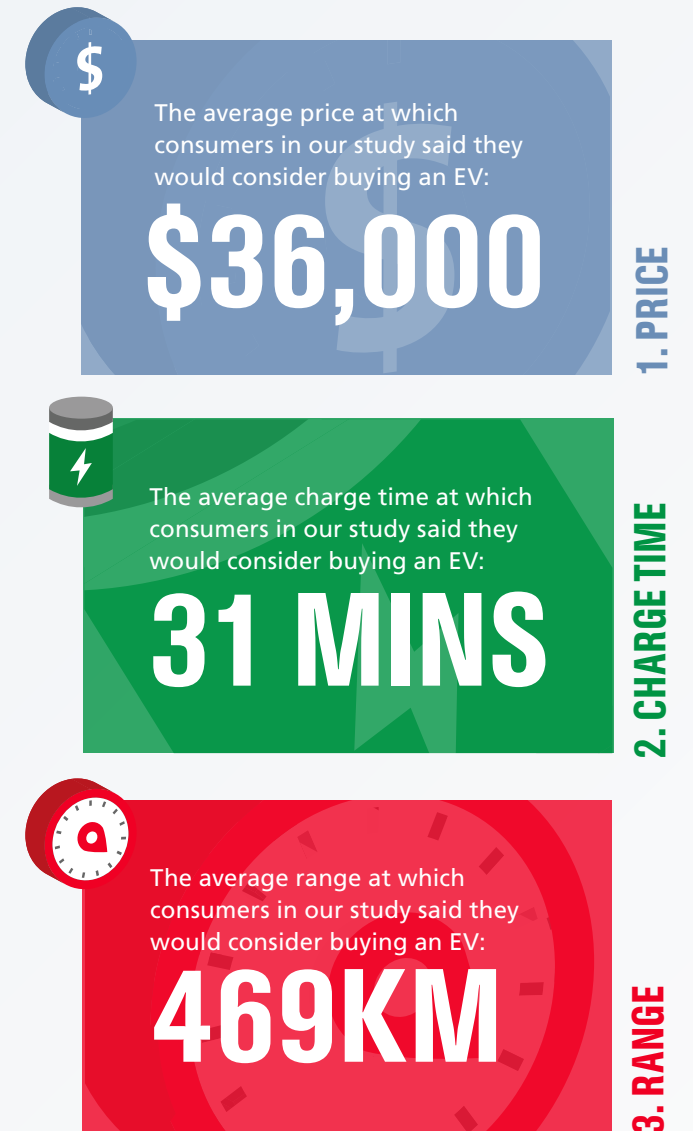
Even in these uncertain times, the automotive industry is rising to the critical challenges. EVs are already on the market that meet at least one of the tipping points for price, charge time or range.

OEMs have already demonstrated what the industry can achieve, in response to the coronavirus crisis. With EV technology constantly improving, the challenge now will be to drive a low-carbon recovery and accelerate the EVolution as quickly as possible.



Mandhir Singh,
chief executive officer,
Castrol

THE TIPPING POINTS TO MAINSTREAM EV ADOPTION



EXECUTIVE SUMMARY

Accelerating the EVolution: The tipping points to mainstream electric vehicle adoption examines five critical challenges that must be overcome to accelerate the pace of EV adoption. Exploring the views of nearly 10,000 consumers, fleet managers and industry specialists across eight of the world's most important EV markets, our study also identifies the likely 'tipping points' – the price, charge time and range that need to be achieved for electric vehicles to become mainstream.

THE ROAD TO FULLY ELECTRIC

Our data highlights that many consumers and fleet managers are waiting to see how the market develops before making the switch. Although just one in 50 new cars sold is an EV¹, the majority of consumer respondents to our survey said they themselves would consider buying an EV in 2024, just four years away. However, 61% of consumers are adopting a 'wait and see' approach and believe that research and development into battery technology will be fundamental to driving the development of the fully electric car market. And although 58% of fleet managers are personally motivated to make a positive difference to the environment by making their fleet fully electric, over half (54%) are waiting for their competitors to make the switch before they do.

THE FIVE CRITICAL CHALLENGES TO MAINSTREAM EV ADOPTION:

Critical challenge 1: Price

The purchase price of an EV is the most important critical challenge for consumers, and the tipping point price tag when mainstream adoption is likely to be achieved is just under **\$36,000**, equivalent to the average price of a car in the United States. Nearly two thirds of the consumers we surveyed (63%) view the current array of EVs on the market as beyond their price range.

¹ [mckinsey.com/industries/automotive-and-assembly/our-insights/expanding-electric-vehicle-adoption-despite-early-growing-pains](https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/expanding-electric-vehicle-adoption-despite-early-growing-pains)

Critical challenge 2: Charge time

The length of time it takes to charge a battery was the second most important critical challenge for consumers. According to our study, the mean charge time tipping point for mainstream adoption is **31 minutes**, equivalent to the length of the average lunch break. Although this is far longer than the average internal combustion engine (ICE) refuel, it is only 10 minutes longer than our respondents' average break at a rest stop (21 minutes).

Critical challenge 3: Range

Vehicle range was the third most important critical challenge for consumers in our study. For mainstream adoption to be achieved, EVs need to reach a range of **469km** – equivalent to the distance between London and Paris. ICE equivalents can achieve between 500 and 1,000km.

Critical challenge 4: Charging infrastructure

Consumers in our study ranked charging infrastructure as their fourth most important critical challenge. Seventy percent of consumers told us they believe the majority of cars will become fully electric when charging infrastructure becomes as easily available as service stations. Most important is having the ability to charge at home or nearby (70%), followed by having a charge point at work or nearby (67%). As we might expect from environmentally-conscious EV switchers, nearly two thirds of consumers (62%) told us they expect charging points to guarantee the electricity they provide is from renewable energy sources.

Critical challenge 5: Vehicle choice

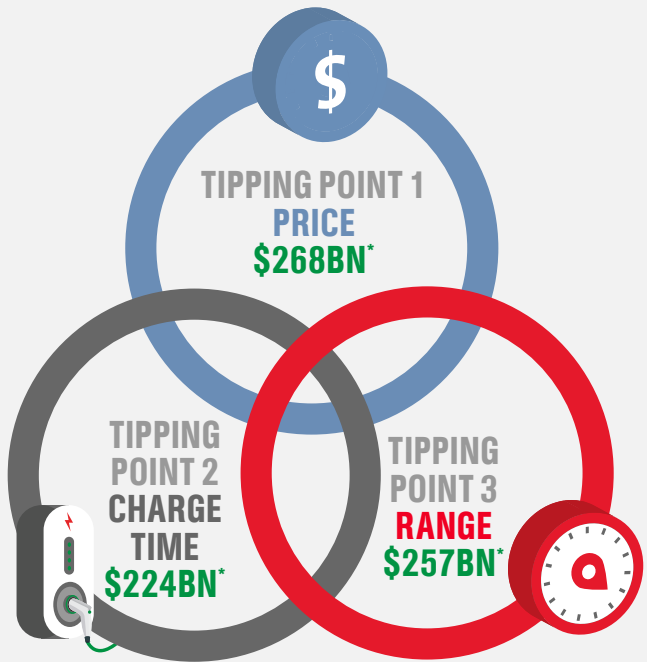
While vehicle choice was the least important critical challenge for consumers, it was the second most important buying factor for fleet managers in our research. To achieve mainstream adoption, creating more familiar models will be key: over half of consumers (54%) and fleet managers (53%) in our study said they would consider making the switch if there was an EV-equivalent to their favourite ICE car.

MAKING THE SWITCH

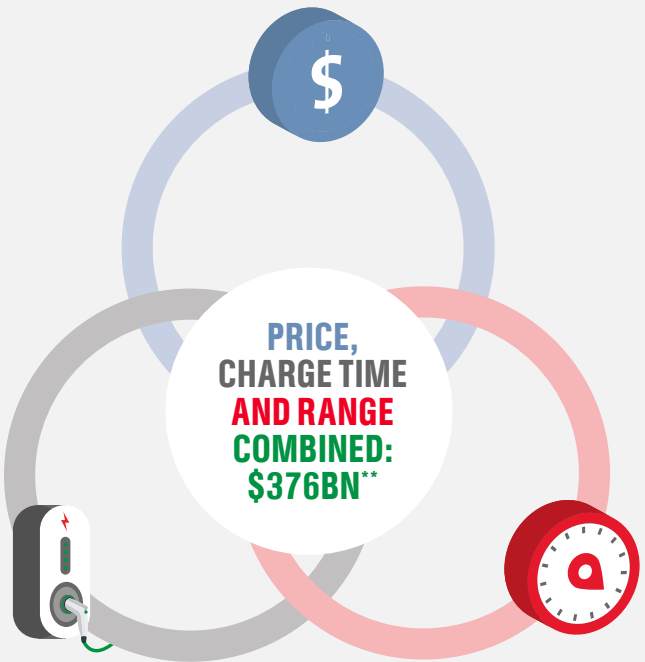
Meeting these five critical challenges will be central to achieving mainstream EV adoption. Improvements in one critical challenge could help allay concerns customers may have in other areas. Each one of the critical challenges

has to some extent, already been met by some vehicle models. An equally critical challenge is helping consumers understand that, in many cases, the future that they want from electric vehicles is closer than they may think.

MEETING THE TIPPING POINTS: THE SIZE OF THE PRIZE



*The potential market share if each of the individual tipping points are achieved. The individual tipping points cannot be added together because many consumers prioritised multiple tipping points. See p43 for Methodology.

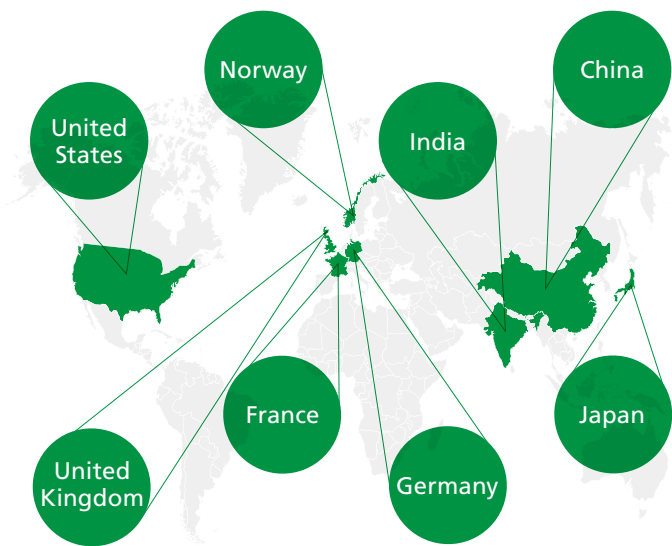


**The potential market share for EVs if all the tipping points are achieved. The individual tipping points cannot be added together because many consumers prioritised multiple tipping points. See p43 for Methodology.

BRIEF METHODOLOGY

Accelerating the EVolution is designed to provide the automotive industry, policymakers and wider stakeholders with insights into some of the critical challenges and tipping points for accelerating the mainstream adoption of electric vehicles.

Our study combines opinion research and economic modelling to examine how consumers, fleet managers and the automotive industry view the future of fully electric vehicles (EVs) across eight of the world's most important EV markets based on size, growth potential and maturity: China, France, Germany, India, Japan, Norway, the United Kingdom and the United States. The study examines five 'critical challenges' to growth in the EV market and identifies the 'tipping points' that, if overcome, could drive mainstream adoption. It also highlights the market opportunity for the automotive industry in meeting them.



Our study is based on opinion research conducted with three statistically robust sample groups:

9,000 consumers

who currently hold a driver's license and are responsible for the purchase and cost of maintaining their vehicle.

750 fleet managers and transport managers

responsible for fleet purchasing decisions for corporate use, local and long-haul delivery as well as taxi or on-demand services.

30 automotive industry professionals

(encompassing original equipment manufacturers (OEMs), Tier 1 suppliers and battery and technology innovators) responsible for purchase decisions of products for fully electric vehicles. Referred to collectively as 'the automotive industry' in this report.

Opinion research conducted December 2019 to January 2020. See p43 for sample size by country.

Identifying the tipping points

The tipping points were the top three critical challenges as ranked by the consumers who took part in our study. To establish the tipping points, we asked our sample groups to identify at what purchase price (excluding incentives or subsidies), rapid charge time and range per full charge they would consider purchasing an EV. To calculate the global tipping point figures for consumers and fleet managers we took the average (mean) from these sample groups.

Calculating the market opportunity

Our proprietary economic model combines data from our opinion research and publicly available figures on EV market share from the International Energy Agency² and national automotive bodies to reveal the potential market share of EVs if a tipping point is met. Using this market share figure we calculated the potential economic value (in dollar terms) in meeting a tipping point (or all three tipping points combined) to the automotive industry. For a more detailed overview of our research methods please refer to the Methodology on p43.

² iea.org

KEY TERMS

Critical challenges:
The five challenges we have examined in our research that, if achieved, could supercharge the mainstream adoption of electric vehicles.

Tipping point:
The average point at which the respondents to our survey said they would consider making the switch to an EV.

Mainstream EV adoption:
Defined as the point at which 50 percent or more consumers would consider purchasing an electric vehicle.

Electric vehicle (EV):
A fully electric vehicle is propelled exclusively by a fully electric motor, using energy stored in rechargeable batteries (BEV, Battery Electric Vehicle).

Internal combustion engine (ICE):
An engine powered by burning liquid fuels, such as gasoline or diesel.

Plug-in hybrid car:
Sometimes referred to as a PHEV (Plug-in Hybrid Electric Vehicle). Typically uses rechargeable batteries to power an electric motor and another fuel, such as gasoline, to power an internal combustion engine (ICE).

Rapid charge:
Most rapid charge points operate at 50kW.

Ultra-fast charge:
The next generation of charging stations deliver 150kW, and can charge a vehicle in 10-20 minutes.

PART ONE

THE ROAD TO MAINSTREAM EV ADOPTION

Electric vehicles (EVs) will revolutionise mobility across the globe, playing a pivotal role in the decarbonisation of the road transport sector. But despite the growing hype around this once-niche sector and steadily rising EV sales, the industry is still a long way from mainstream adoption. Our study shows the vast majority of consumers around the world are still opting for ICE cars, and three in five (61%) consumers are adopting a “wait and see” approach to their EV purchasing decision.

2024 – the year of the EV?

Consumer anticipation of the rapid shift to electric vehicles is high, but when will it happen? If the industry can address the critical challenges and increase capacity quickly enough, mainstream EV adoption could be just around the corner. The majority of consumers told us that they would consider buying an EV by 2024 – just four years away.

Despite their individual enthusiasm, consumers are less confident about their fellow car buyers making the switch. According to our research, consumers believe that it won't be until 2030 that the majority of new cars purchased are electric, six years later than they would personally consider purchasing an EV. This lag suggests that

consumers are positive about going electric, but they understand that there are still critical challenges to be resolved before the majority of people make the switch.

India and China in the driving seat

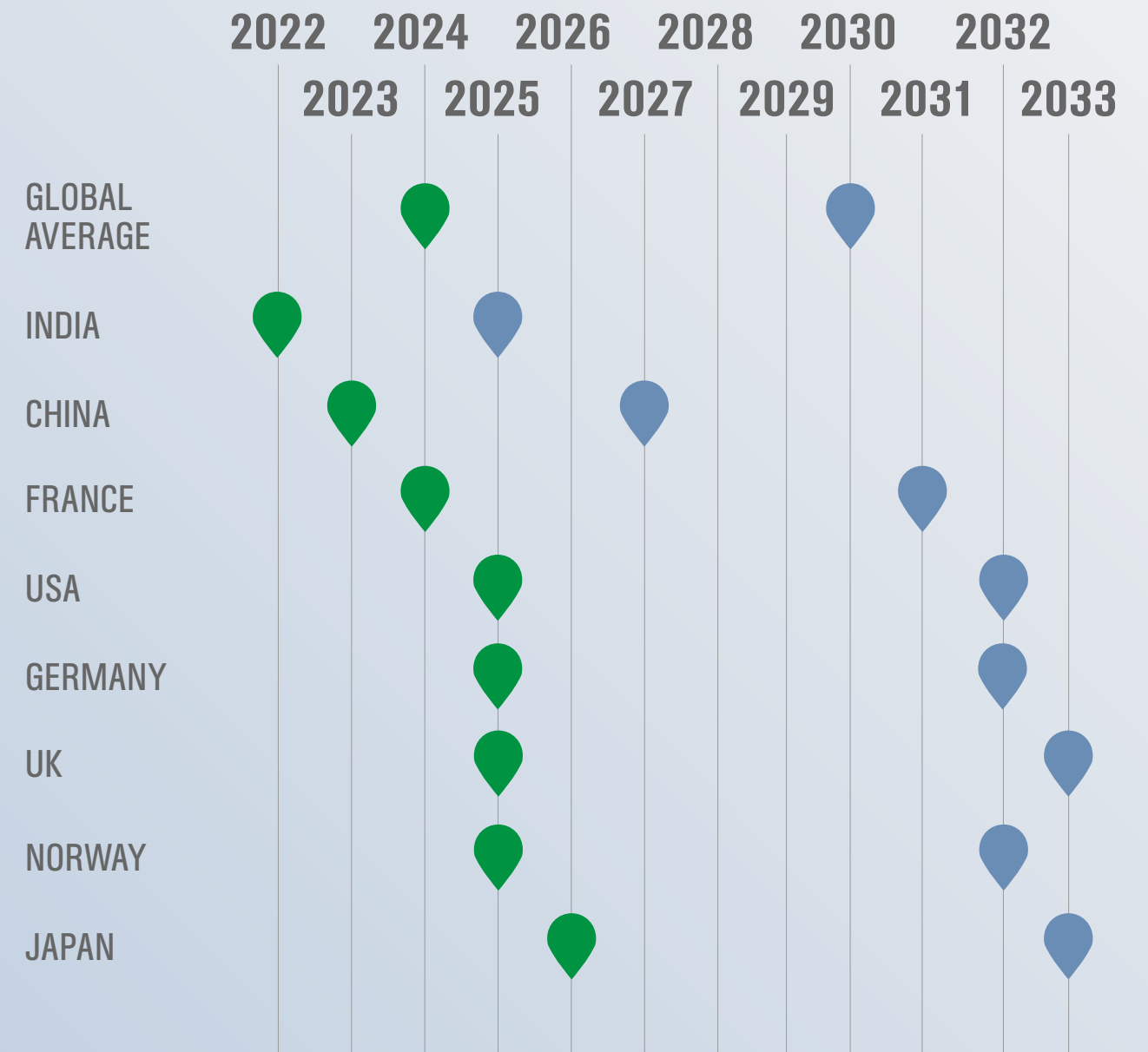
Global attitudes to EV adoption are positive, but some markets are more forward-thinking than others. Of the eight markets in our study, Indian consumers would consider buying an EV as soon as 2022, closely followed by Chinese consumers just a year later. Despite the success of Japanese OEMs in the EV market – Nissan's LEAF has recently passed the 450,000 sales milestone³ – our research indicates Japanese consumers are more hesitant, and would not consider buying an EV until 2026.

THE MAJORITY OF CONSUMERS WOULD CONSIDER BUYING AN EV BY 2024.

The year of the EV:
Individual and Mainstream EV Adoption

Individual Intention

Mainstream Adoption



³ europe.nissannews.com/en-GB/releases/nissan-brings-excitement-from-the-road-to-the-track-with-leaf-nismo-rc-unleashed-for-the-first-time-in-europe

Fleet managers' electric dreams

Fleet managers are already seriously considering going electric, with nearly two thirds (64%) of respondents saying they considered buying EVs when they made their most recent fleet purchase. Rapidly electrifying fleets are expected by 2030, with 71% of fleet managers anticipating the majority of their fleet to be electric within the decade.

Climate change and pollution concerns drive EV advocacy

More than ever, consumers are considering the impact of their buying decisions on the environment. In our research six in 10 consumers globally (61%) say concerns about climate change will accelerate mainstream adoption of electric vehicles. The same is true for air pollution, which consumers say will have just as much impact on people going electric (61%).

But these figures vary significantly between different countries and social groups. For the Chinese respondents to our survey, over three quarters of consumers (76%) believe that pollution concerns will speed up widespread EV use. In Norway, where air quality is less of an issue, this drops to just under half (49%) of respondents. Those surveyed who live in cities are significantly more likely to believe that concerns over pollution will accelerate EV adoption (65%) than those who live outside urban areas (48%).

Generation electric

Generational differences may have the greatest impact on EV adoption, signalling an irreversible shift towards electric. Younger consumers believe that environmental issues will have a greater impact than their older peers, with 70% of millennials⁴ telling us that pollution concerns will drive widespread EV adoption, compared to just half of baby boomers (51%).⁵ It is a similar

story when it comes to concerns about climate change: 69% of millennials told us this will make people switch to EVs, while only 52% of baby boomers agree.

Shifting gears

Environmental concerns mean consumer appetite and governmental support for EVs is higher than ever before – so why does the global market penetration rate for EVs remain relatively low? While anticipation is high and consumers and businesses believe society is on the cusp of an EV revolution, the industry needs to convert societal good intentions into purchase behaviour. Attitudes are pro-electric but, as we will explore in the next chapter, a range of critical challenges are putting the brakes on demand for EVs.

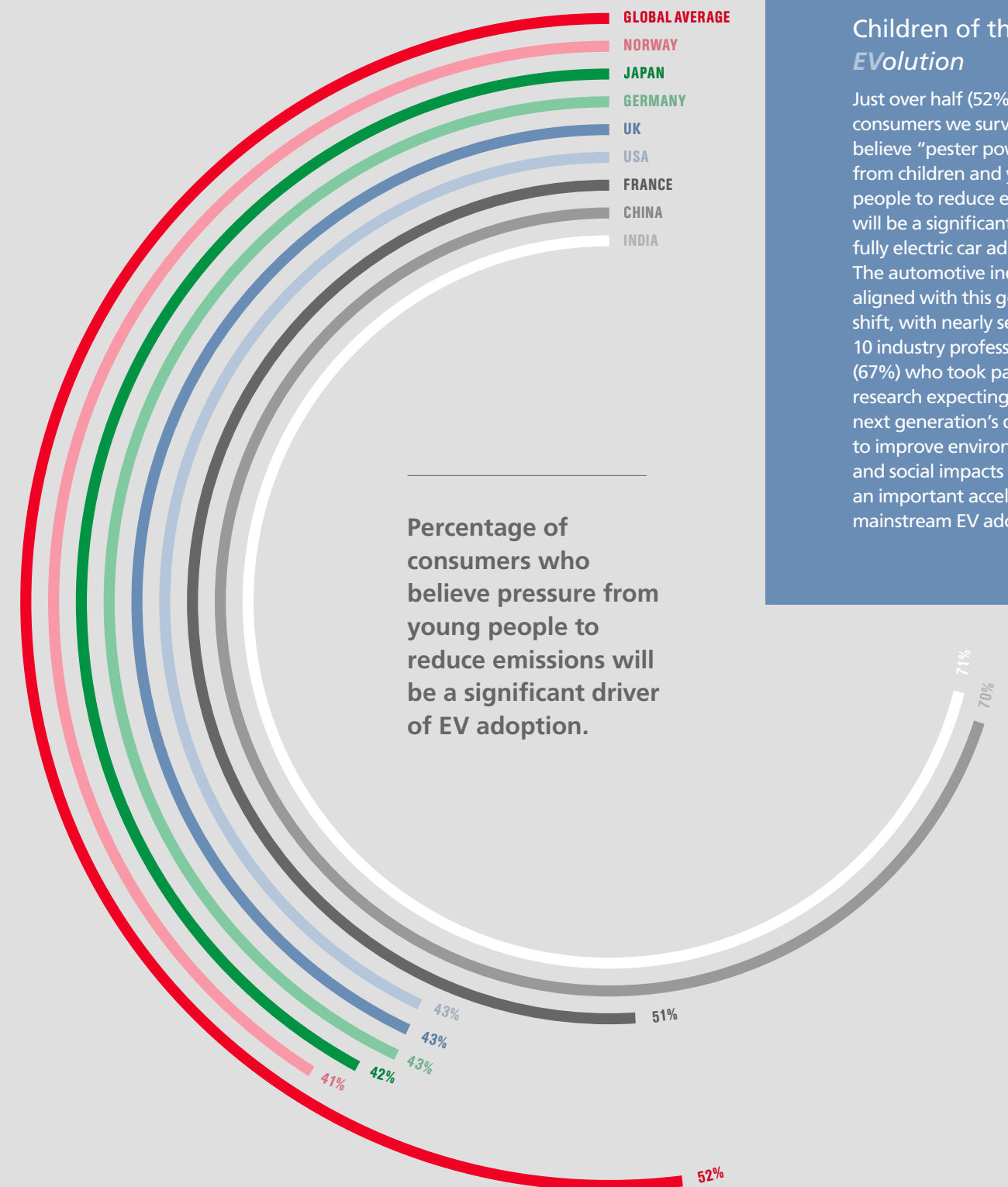
“

Our research shows that while consumers are positive about EVs, perceptions about performance and cost is holding back mainstream adoption. However, if the automotive industry can overcome these challenges the potential size of the prize is huge, with our study estimating the EV market could grow to \$367 billion per year if consumer expectations for price, charge time and range are met.”

— A. S. Ramchander,
vice president of global marketing, Castrol

⁴ Defined as individuals born between 1981 and 1996.

⁵ Defined as individuals born between 1945 and 1964.



Children of the EVolution

Just over half (52%) of the consumers we surveyed believe “pester power” from children and young people to reduce emissions will be a significant driver of fully electric car adoption. The automotive industry is aligned with this generational shift, with nearly seven in 10 industry professionals (67%) who took part in our research expecting that the next generation’s demands to improve environmental and social impacts will be an important accelerator of mainstream EV adoption.

CHINA SPOTLIGHT

WHAT DRIVES THE WORLD'S LARGEST EV MARKET?

CONSUMERS FROM CHINA
SAID THEY WOULD CONSIDER
BUYING AN EV AS SOON AS

2023

ONE SAFETY FIRST

Safety is a top concern for the world's largest EV market. In our research, 85% of Chinese consumers believe the vehicle safety rating would be an important or very important consideration when looking to purchase an EV.

TWO ENVIRONMENTALLY MINDED

Protecting the environment is an important motivation for consumers in China, with three quarters of surveyed consumers believing that concern about climate change (76%) and pollution (76%) will accelerate mass EV adoption. As well as driving a shift from gasoline to electricity, Chinese consumers want power to be created sustainably, with three quarters saying they expect the electricity in charging points to come from renewable sources.

THREE ACTING QUICKLY

Chinese consumers are looking to buy EVs sooner than almost any other market in our research, on average saying they would consider buying one by 2023. They are also optimistic about future EV ownership levels generally, believing that the majority of Chinese consumers will be purchasing EVs by 2027 – three years earlier than the global average.

FOUR PREPARED TO PAY

Consumers in major Chinese cities are prepared to pay \$41,910 for an EV – one of the highest prices in our study, and nearly \$6,000 above average. The automotive industry is keen to supply this growing market, with 67% of industry professionals naming China as a priority for the sale of EVs, followed by Japan (44%) and the UK (33%).



PART TWO

CRITICAL CHALLENGES AND TIPPING POINTS

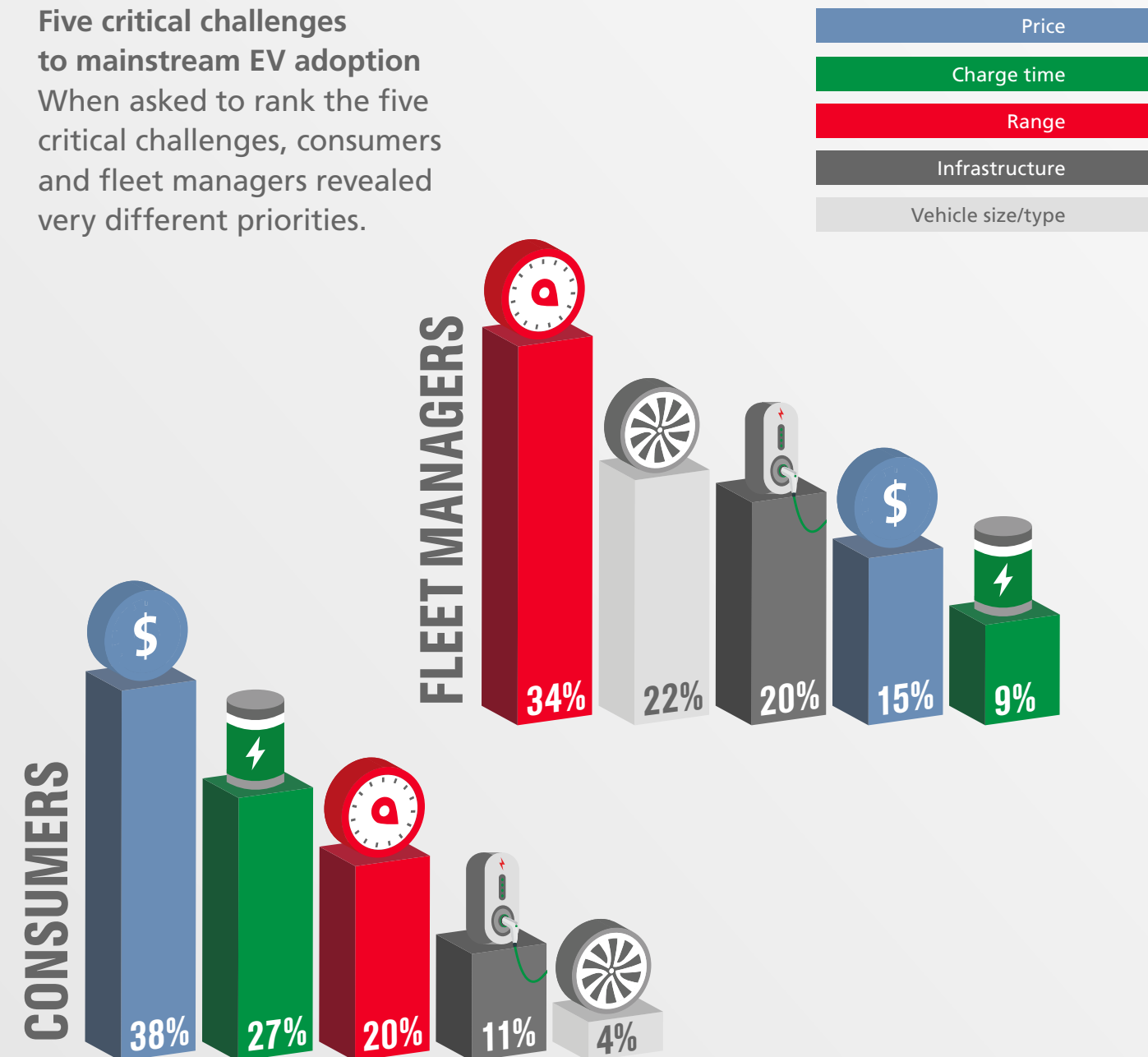
FIVE CRITICAL CHALLENGES TO MAINSTREAM EV ADOPTION

The study examines five 'critical challenges' that, if resolved, could accelerate the mainstream adoption of electric vehicles: price, charge time, range, infrastructure and vehicle choice.

The following section provides an opportunity roadmap for OEMs: which of the five critical challenges are most important to consumers and business, and how could they be solved? We also reveal the tipping points for price, charge time and range. These tipping points are the average figures – in US dollars, minutes and kilometres – when the consumers in our study told us they would consider purchasing an EV.



Five critical challenges to mainstream EV adoption
When asked to rank the five critical challenges, consumers and fleet managers revealed very different priorities.



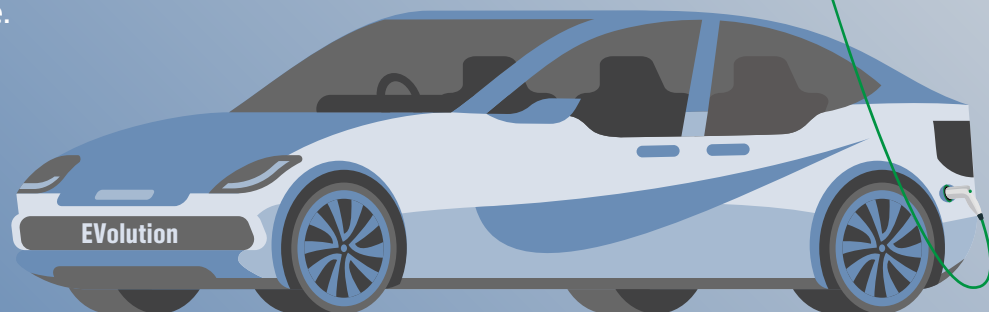
CRITICAL CHALLENGE 1: PRICE

THE \$36,000 CHALLENGE

Price is the **number one** consideration for consumers when looking to buy a new EV.

63% of consumers believe that EVs are currently beyond their budget.

Fleet managers are less price sensitive, ranking cost as the fourth most important critical challenge.



For the consumers in our survey, **purchase price** is the number one consideration when looking to buy a new vehicle. This suggests that when it comes to the EV market, the price tag is putting off many interested customers. It is likely that many ICE drivers are not aware of the extent to which the initial outlay may be offset by lower running costs. Also, finance products that spread the upfront cost over time may not be available in all markets and to all consumers.

To reach the tipping point for price, EVs would need to roll off the forecourt for around **\$36,000**. While this is the global average, attitudes to price vary significantly between markets. Japanese consumers are willing to pay the most for an EV, at nearly \$43,000, closely followed by China at a few hundred dollars less. The UK's tipping point for price is the lowest in the study at just under \$30,000. Despite a generally positive attitude towards EV adoption, consumers in the UK need the cost to fall before they consider making the switch.



THE SIZE OF THE PRIZE:

A \$268 BILLION OPPORTUNITY

Reaching a price tag of \$36,000 will mean a significant boost to EV sales, with electric vehicles representing a **market of \$268 billion per year** by 2025 across the eight markets in our study if this tipping point is achieved. Globally, this suggests that EVs could represent 12% of all new cars sold by 2025.

See Methodology on p43 for how size of the prize figures are calculated.

“

For mainstream adoption to be achieved, we need to reframe the conversations around the price of EVs, focusing on the overall cost of ownership rather than the upfront cost of the vehicle. Ultimately, EVs are cheaper to run than ICE vehicles and – as they have fewer moving parts - are likely to have lower maintenance and repair costs.”

— Shyam Balasubramanian, director, Castrol Innovation Growth Accelerator

THE PRICE IS RIGHT

Crucially, the industry is already meeting the critical price challenge, with a number of EVs available at around the \$36,000 price point.

But while the industry has already made strides towards increasing access to EVs by lowering their price, the choice of more affordable models is limited and EVs remain more expensive – at least in terms of purchase price – than their ICE equivalents. As a result, nearly two-thirds (63%) of consumers view EVs as beyond their budget.

While some individual EV models have reached this price tipping point, three-fifths of the consumers who took part in our study said that EVs achieving an equivalent price to ICE vehicles will be critical to the mainstream adoption of electric vehicles. But this may still be some way off, with the industry professionals in our survey predicting that price equivalence will not be achieved until 2035. The primary barrier remains the cost of batteries, although advances in battery technology and efficiencies from increasing the scale of EV production could bring savings.

MISPERCEPTIONS ON PRICE

Reducing the purchase price for electric vehicles is a clear challenge for the automotive industry, but with some models already available at around the tipping point price, manufacturers face another challenge: consumer perceptions. More than six in 10 consumers surveyed (61%) believe that EVs are aimed at the high-end market. As the Tesla Model 3 becomes the world’s most popular EV,⁶ there is a risk that high-profile, first-mover luxury brands for early-adopters may inadvertently hold back mainstream uptake, as they help to drive the perception that EVs are out of reach.

Increased consumer awareness about the wide range of EV price points could correct this misconception and support mainstream adoption. Educating consumers could help them realise that many EVs are more affordable than they think.

“

The initial purchase price is not at all attractive for the customer, it needs to come down. The financial benefits of transitioning to an EV are not yet substantial enough or well enough understood, which makes the overall initial price a key negative issue.”

— Deputy general manager, OEM, Shanghai

TOTAL COST OF OWNERSHIP

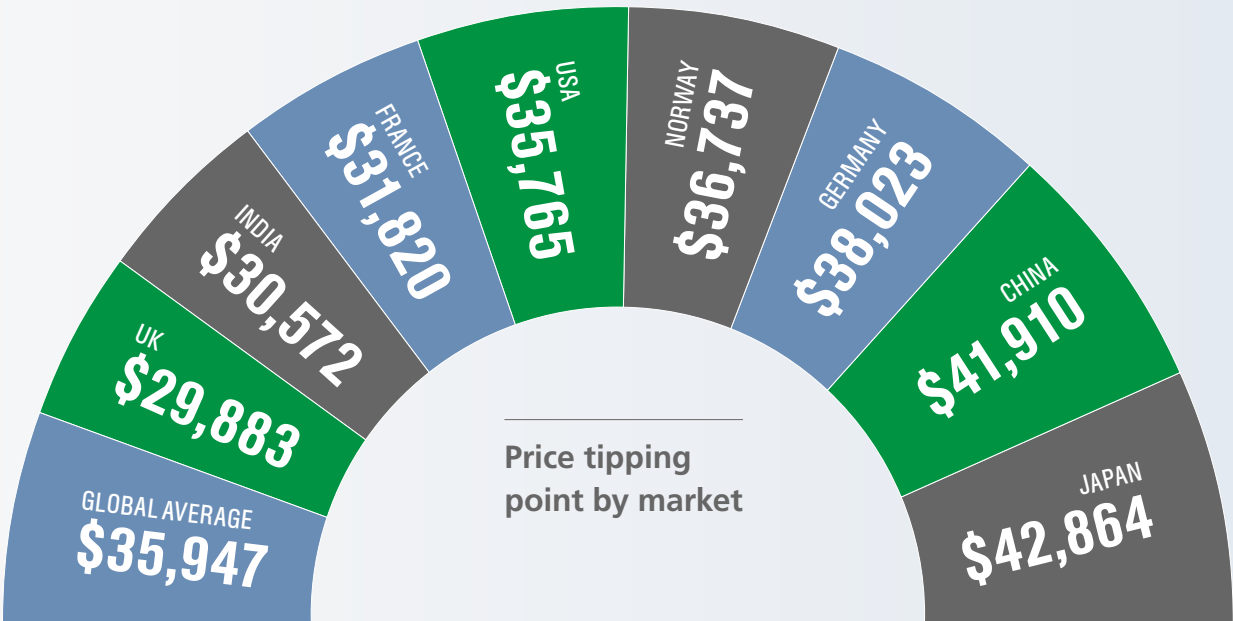
Consumers tend to focus on the initial cost of vehicles rather than the total cost of ownership. Despite their higher purchase price, EVs can be cheaper to operate over the long term. EVs are much cheaper to refuel, with different service and maintenance needs. Research in the journal Applied Energy⁷ found that in the UK, Japan and the US, the lower running costs of EVs combined with government subsidies mean that they could reach price parity with ICE vehicles in as little as four years.

“

If we compare the cost of ownership of a gasoline car with that of an EV, taking into account all of the running and maintenance costs of the vehicle post purchase, we have already reached relative cost parity in terms of ownership. So, it is the initial price that might be considered the barrier – not the running costs.”

— President, EV consultancy, US

⁶ statista.com/statistics/960121/sales-of-all-electric-vehicles-worldwide-by-model/
⁷ sciencedirect.com/science/article/abs/pii/S030626191731526X?via%3Dihub



Price tipping point by market



ELECTRIFYING THE USED CAR MARKET

Buying second-hand is one way for price-conscious consumers to lower their initial outlay, and with the majority of consumers buying used cars, this market is critical to a buoyant automotive industry. But as things stand currently, used electric vehicles are causing consumer concern. The speed of innovation is leading consumers to fear technology obsolescence: more than half (57%) of survey participants cited resale value as an important factor that prevented them buying an EV in their most recent car purchase.

The next challenge will be to show consumers that the performance of the used car market for EVs and their eventual resale value will be comparable to ICE vehicles. By doing this, the industry will help to support a solid used EV market and help to alleviate consumer anxieties around depreciation.

MEETING THE CRITICAL CHALLENGE FOR PRICE

Addressing the high up-front cost of EVs is vital for achieving widespread adoption. But significant manufacturing and R&D costs, supply chain pressures and intense international competition make this no easy task. OEMs are investing heavily to reduce the overall initial price of EVs by driving down the cost of batteries. As the battery is one of the largest contributors to the overall cost of an electric vehicle, new manufacturing techniques and building economies of scale will help to bring this cost down further.

INDUSTRY INSIGHTS: PRICE PAIN POINTS

“

The issue with EVs is the initial pricing really: we need to get the volumes up to bring the overall build prices down. We need to develop new components from new suppliers. If we can get the volumes up, overall production prices will reduce and quality will also increase. At the moment, the need for new products is driving up the overall price.”

— Senior design engineer, OEM, Beijing, China

FLEET MANAGERS LESS PRICE SENSITIVE

Price is key for consumers, but business customers have different priorities. The fleet managers who took part in our survey indicated they are less price sensitive and would be willing to consider switching their fleet to majority electric at a unit price of \$49,525. What’s more, while consumers rank price as the most important factor for supercharging mainstream adoption of EVs, fleet managers rate it as their fourth most important concern, behind range, vehicle choice and infrastructure.

As bulk-buyers of cars with sophisticated purchasing strategies, fleet managers are able to take into account the lower maintenance costs of EVs, and focus on the total cost of ownership rather than simply up-front cost. The purpose of the fleet also impacts price sensitivity: more visible and customer-focused taxi and local delivery fleet managers are willing to pay around \$7,500 more for an EV than long-haul delivery and corporate fleet managers, according to our research.



CRITICAL CHALLENGE 2: CHARGE TIME

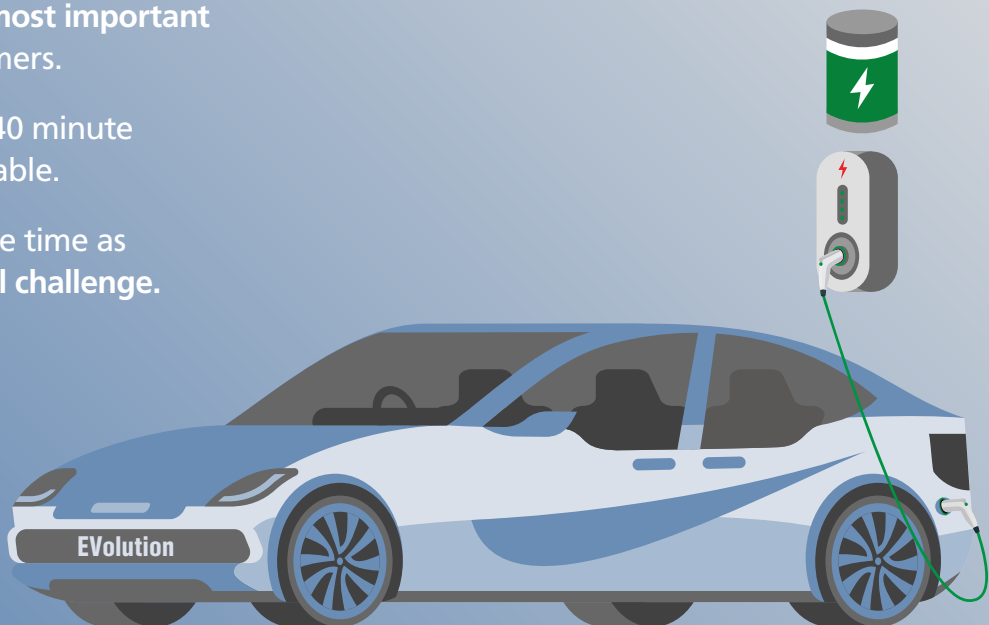
THE 31 MINUTE CHALLENGE

2

Charge time is the **second most important** critical challenge for consumers.

57% of OEMs told us a 30-40 minute charge time is already available.

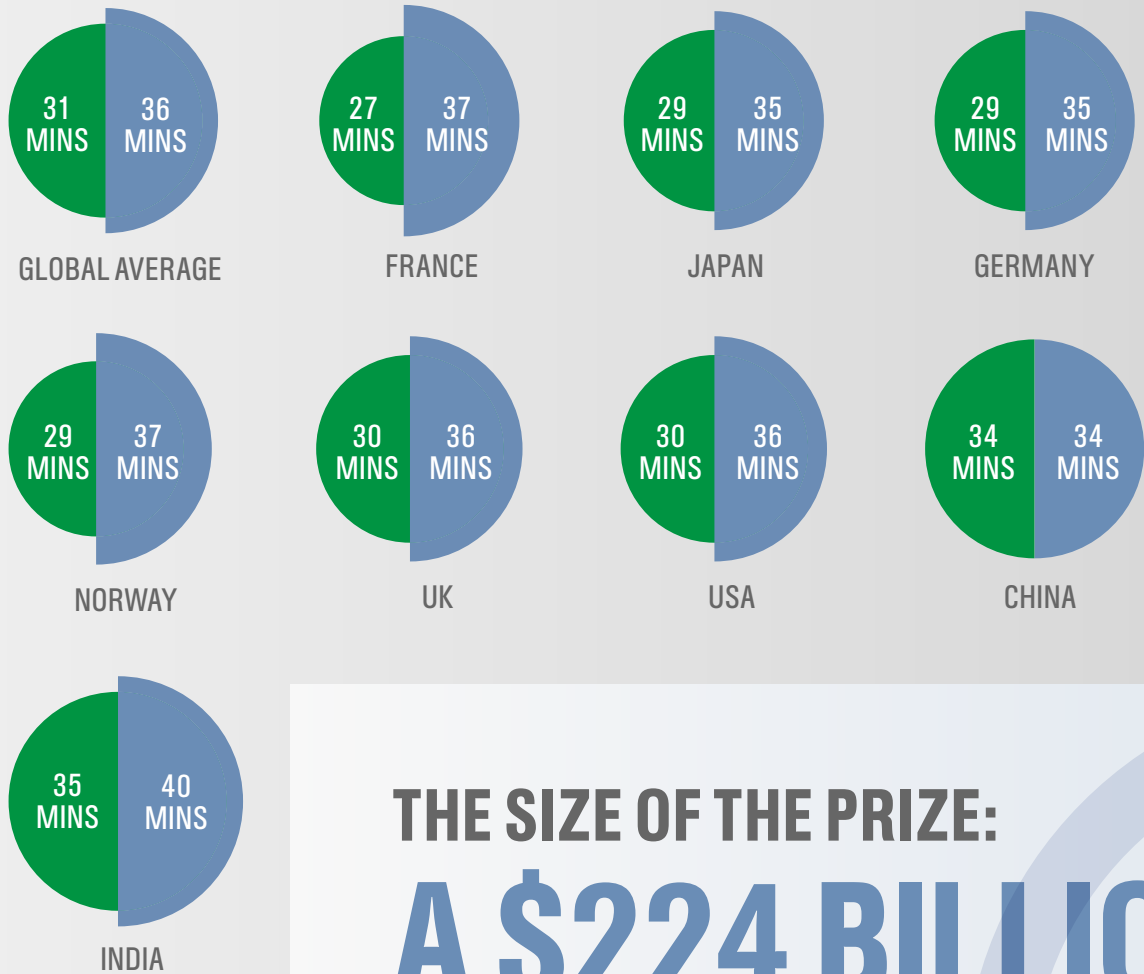
Fleet managers rated charge time as their **least important critical challenge**.



Charge time is precious. Consumers in our survey rank charge time as the second most important critical challenge that will supercharge the mainstream adoption of EVs. But how quickly do EVs need to charge before consumers will switch to electric? **31 minutes is the magic number**, with half of consumer respondents saying they would consider purchasing an EV that could charge to full capacity in around this time.

The good news for manufacturers is that most consumers seem willing to wait significantly longer to recharge than a typical ICE refuel, which can usually be completed within five minutes. And achieving this charging time tipping point is within reach, with more than half of industry professionals (57%) saying that a charge in 30-40 minutes is already available.

Charge time tipping point by market



THE SIZE OF THE PRIZE:

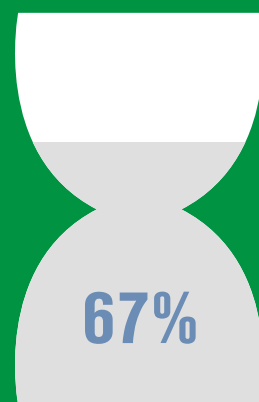
A \$224 BILLION OPPORTUNITY

A 31 minute charge time will mean a significant boost to EV sales, with electric vehicles representing a **market of \$224 billion per year** by 2025 across the eight markets in our study if this tipping point is achieved. Globally, this suggests that EVs could represent 10% of all new cars sold by 2025.

See Methodology on p43 for how size of the prize figures are calculated.

TIME TO CHARGE

While some EV models can hit the charge time tipping point, they are the exception, especially for owners with more affordable models. Charging an electric car currently takes anything from 30 minutes to overnight depending on the battery capacity and charging point used, and only ultra-fast (150kW) chargers are capable of consistently achieving the 31-minute tipping point.



Two out of three consumers believe the majority of new cars will be electric when the rapid charge time of EVs becomes comparable to their ICE equivalents.

Although some time is often saved because consumers rarely charge their battery from empty, most advertised 30 minute charge times only reach 80% battery capacity in this time. Waiting times can also be slower if there aren't enough charge points available to meet demand, meaning consumers could have to wait for a charger to become free before they plug in their vehicle.

Bringing charge times down to 31 minutes for all consumers is the first part of this critical challenge for the industry, but the ultimate goal is charging as quickly as an ICE refuel. Two out of three (67%) consumers told us they believe the majority of new cars will be electric when the rapid charge time of EVs becomes comparable to ICE equivalents. Over half (57%) of the automotive industry professionals who took part in our survey told us that they could already hit a charge time of 30-40 minutes today.

“

In my view, the optimal charging time would be similar to what it takes to fill up a full tank of petrol and that has to be the goal. But, I think with EVs there might be a little higher tolerance. 20-30 minutes is quite desirable and should be acceptable.”

— President,
EV consultancy company, US

FAST CHARGING LOWER PRIORITY FOR FLEET MANAGERS

Fast charging is crucial for consumer confidence, but it's a lower priority for businesses, according to our research. Fleet managers told us that charge time is the least important critical challenge for corporates, perhaps because charging infrastructure can be provided easily on business premises.

Fleet managers are prepared for their vehicles to take longer for a full charge than consumers, and our study indicates that the tipping point for when fleet managers would consider taking their fleet electric is a full five minutes longer.

36 MINUTES

On average fleet managers are prepared to wait 36 minutes to charge, while long-haul delivery managers are even less sensitive at 39 minutes – perhaps due in part to existing industry regulations about required rest periods.

“

As electric vehicles perform better and charge faster, the thermal stress on their batteries is increased. To deal with this increased pressure, next-generation battery electric vehicles are moving to direct cooling for battery thermal management. Advanced coolant e-fluid has important properties to enable this enhanced thermal management, keeping the batteries cool and the car running even in extreme conditions.”

— Rebecca Yates, Castrol product development director, Industrial and Driveline Lubricants

MEETING THE CRITICAL CHALLENGE FOR CHARGE TIME

Research and development into new and improved battery and e-fluid technologies will be vital to tackle the charge time critical challenge. Manufacturers recognise the vital importance that battery technology has to play in the success of electric vehicles, with over three-quarters (77%) of industry professionals stating that the future of the EV market depends on the strength of the relationship between car makers and battery manufacturers.

Charge time tolerance is also tied to good charging infrastructure, and consumer expectations will also depend on when, where and how they can charge. While ICE vehicles take under five minutes to refuel, on average consumers say that they wait for 21 minutes at a rest stop. With the right infrastructure at service stations where consumers break up their journeys, this additional wait time has the potential to encourage a vibrant new 'charging economy'.

Working to improve the perception and reality of charge times is a vital step for OEMs, but educating consumers about how to fit EV charging into their daily lives will be equally important. Where ICE vehicles are generally refuelled 'at the pump', EVs can be recharged in a far greater array of locations. Helping consumers shift their expectations from rapid, on-demand power to charging up at home or work - a 'top-up' mindset - could help reduce excessive focus on the need for charging speed.

EV CHARGING FACTS

Not all EV charging stations deliver the same power, which determines how quickly a vehicle can reach **80% charge**.

Home charging: Without any specialised equipment, a standard outlet typically takes **10-20 hours** to charge a vehicle.

Fast charging: Commonly chosen for homes and workplaces, a fast charge outlet delivers 3-22kW power, charging a vehicle in **3-4 hours**.

Rapid charging: Specialist charging points that offer 50kW power, charging a vehicle in **30-40 minutes**.

Ultra-fast charging: The next generation of charging stations deliver 150kW, and can charge a vehicle in **10-20 minutes**.



CRITICAL CHALLENGE 3: RANGE

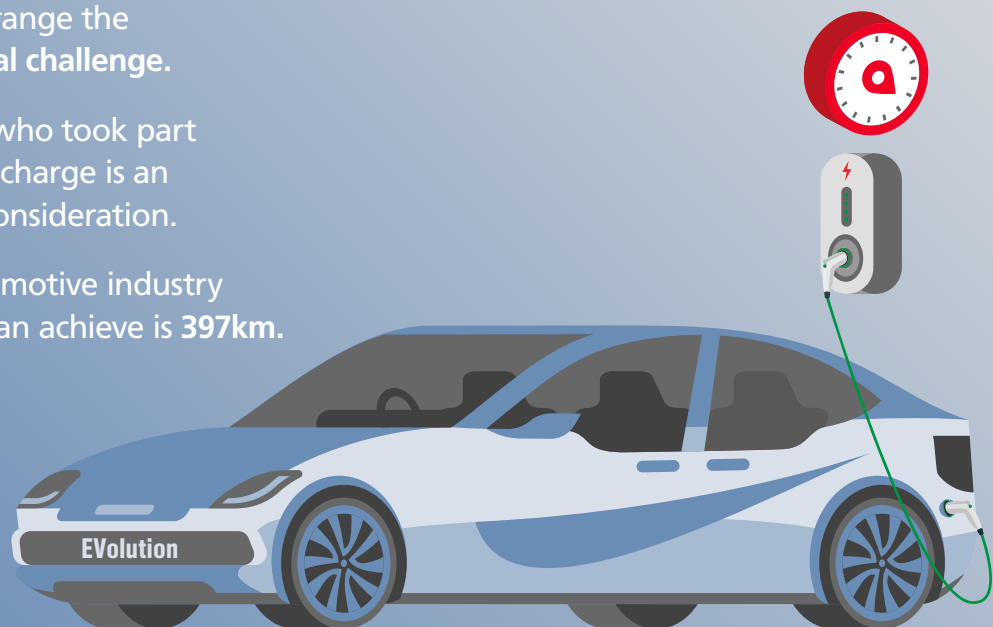
THE 469KM CHALLENGE

3

Consumers ranked vehicle range the **third most important critical challenge**.

For **eight in 10 consumers** who took part in our study, range per full charge is an important EV purchasing consideration.

The average EV range automotive industry professionals told us they can achieve is **397km**.



Range is the third most important critical challenge for consumers in our research. The majority of consumers told us they would consider purchasing a fully electric car when an EV can travel a distance of **469 km** between charges – equivalent to driving from London to Paris. Fleet managers indicated they have even higher expectations, requiring a range of 550 km.

469KM



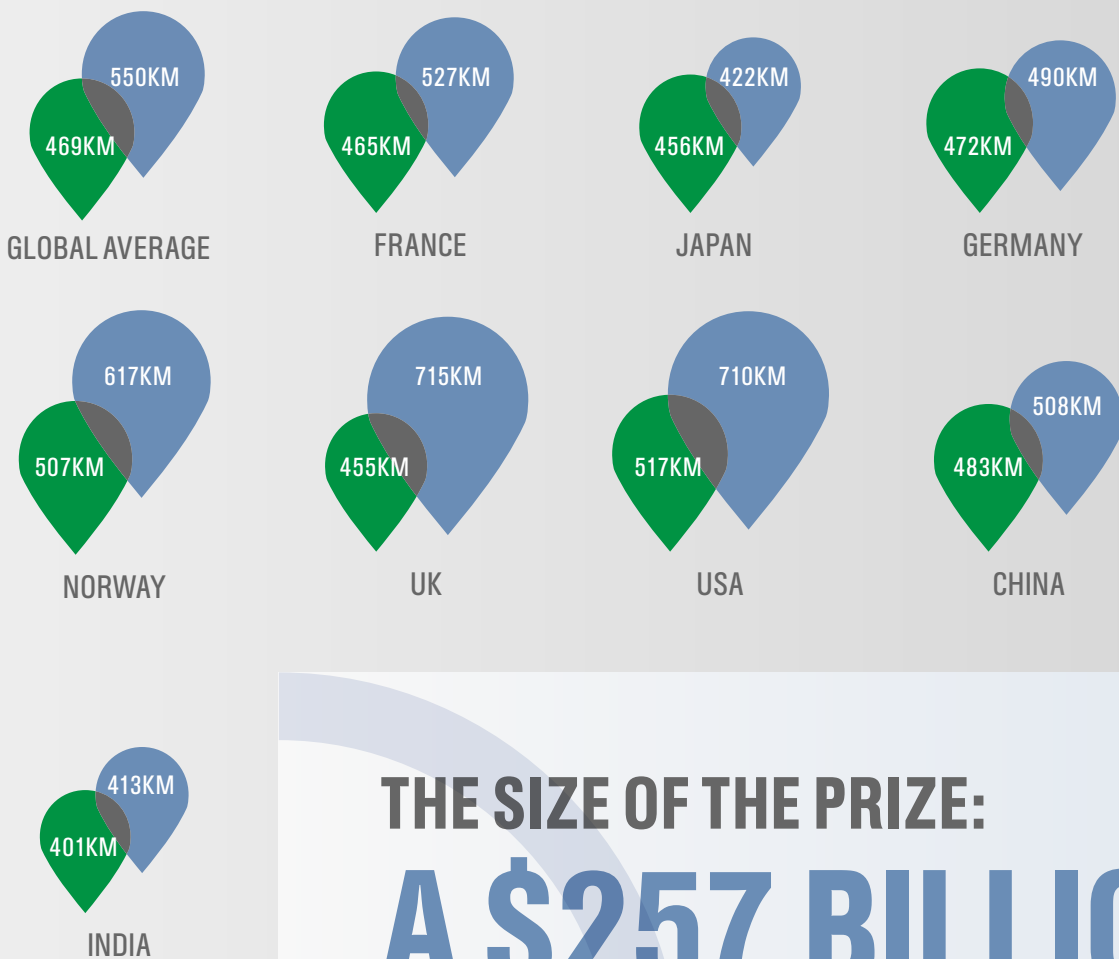
Average range required for consumers.

550KM



Average range cited for fleet managers.

Range tipping point by market



THE SIZE OF THE PRIZE:

A \$257 BILLION OPPORTUNITY

A 469 km range will mean a significant boost to EV sales, with electric vehicles representing a market of **\$257 billion per year** by 2025 across the eight markets in our study. Globally, this suggests that EVs could represent 12% of all new cars sold by 2025.

See Methodology on p43 for how size of the prize figures are calculated.

“

I believe there is a general misunderstanding about how EVs are used which needs to be clarified with the public. Mostly there is a misconception about the number of miles driven in a day. Most people do not drive more than the typical range of an EV throughout the day.”

— Chief purchase officer, automotive supply chain, US

Range anxiety

ICE vehicles typically have a range of 500-1,000km so consumers have come to expect their vehicle to go this distance in one refuel. This expectation – and the reputation EVs have for relatively low ranges – has manifested in acute range anxiety for consumers considering making the switch to an EV. Eight in 10 consumers in our survey claim that the distance you can travel per full charge is an important or very important consideration when looking to purchase an EV. Three in five consumers (63%) and fleet managers (61%) also told us that the current range available is a significant barrier to the mainstream adoption of fully electric vehicles.

Despite the expectation of a 469km range, however, car owners rarely travel that distance in one trip. Three in 10 consumers (30%) told us they primarily use their car for commuting, while the same number mainly use their car for local shopping trips or the school run.

“

Having charging facilities located near coffee shops and shopping malls along with supercharging should reduce the anxiety among consumers about the vehicle range.”

— President, EV consultancy company, US

Meeting the critical challenge for range

A 469km range is well within the capabilities of long-range EVs already on the market. Tesla’s Model S Long Range, for example, boasts a range of over 600km. At the lower end of the market, however, range tends to fall far below this: some city models can only travel around 100km. As the EV market develops – and a broader selection of EVs with different ranges become available – consumers will be able to select the model that best matches their driving requirements.

The average range automotive industry professionals tell us they can currently achieve is 397km – just 72km less than the tipping point for this category. As investment continues to pour into battery R&D, electric vehicle range is improving all the time. Seven in 10 consumers (68%) that we surveyed believe the majority of new cars will be electric when electric vehicle range is comparable to what an ICE vehicle can achieve with a full tank of petrol.

“

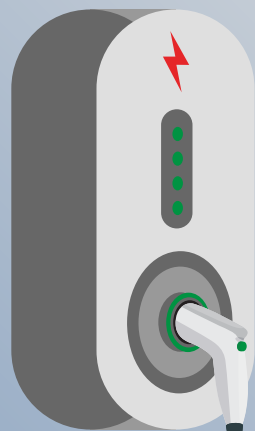
As engineering in electric vehicles evolves, it is creating new technical challenges in the area of transmission fluids. The demands on e-transmissions are more severe than conventional transmissions, with maximum torque delivered at low speeds and the growing trend for the integration of electric motors into the transmission. Advanced transmission e-fluids are needed to protect the gears and allow electronics to function correctly over their lifetime.”

— Matthias Donner, Castrol global technology manager, Driveline Lubricants



CRITICAL CHALLENGE 4:
INFRASTRUCTURE

THE GLOBAL CHARGE POINT CHALLENGE



4

Consumers ranked infrastructure as the **fourth most important critical challenge**.

70% of consumers told us they believe the majority of cars will become fully electric when charging infrastructure becomes as easily available as service stations.

Without a strong and reliable infrastructure of EV charging points in cities, towns and highways, the EV transition is destined to falter. Challenges around charging infrastructure links are connected to consumers' range anxiety: EV owners need to know they can always find a charge point easily. When it comes to new car sales, 70% of consumers we surveyed believe the majority of cars will become fully electric when charging infrastructure becomes as accessible as service stations. In our research, consumers ranked infrastructure as the fourth most important challenge for EVs, while fleet managers ranked it third. While it's not the most important concern, charging infrastructure will need concerted investment or it could become a barrier to widespread EV uptake.

Home is where the charge is

Getting infrastructure right could have big benefits for the industry, with 64% of consumers telling us they would consider buying a fully electric car if they were confident suitable charging infrastructure existed to support their driving habits, with a preference for home charging. For those without access to home or local charging, easily accessible public charging locations are vital. A lack of charging points could mean having to travel longer distances to top up, or queuing to plug in.



“

The advent of supercharging will allow people the ability to travel longer distances during which time a break should be taken anyway. So if the charging points can be linked to the places where people will stop it would be ideal and a 20 minute charging time would work well.”

— President, EV consultancy company, US

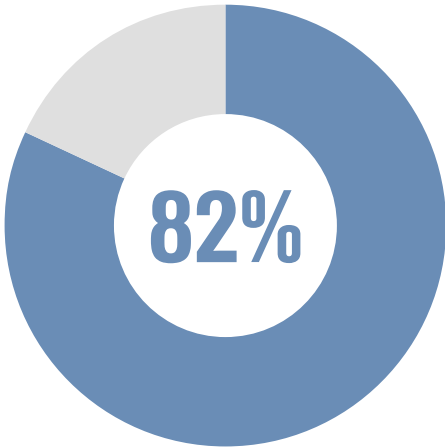
“

The challenge is to determine the more common destinations and places where the supercharging points can be sited and used. Having them at service stations would be beneficial as it will encourage people to take a break from driving while the car is taking 20 minutes to charge. But the challenge is where to position the charging points and whether the infrastructure can cope with them. Obviously popular destinations or spots would be the best place to position the charging points but then all of the same people will be stopping at the same points.”

— Chief purchase officer, automotive supply chain, US

INVESTING IN LOCAL INFRASTRUCTURE

As the number of EVs on the road continues to grow, investment in charging infrastructure will be crucial to allow consumers to easily charge their car. Currently, charging infrastructure varies greatly around the world. Of our respondents in China, eight in 10 consumers (82%) have access to a public charging point, but that drops to less than one in five in the US (40%) and Norway (39%). Consumers living in urban areas are more likely to have charge points nearby, with 65% telling us they have access to a charging point within five miles of their home, compared to just 26% living outside cities.



In China, eight in 10 consumers told us they have access to a public charging point.

MEETING THE CRITICAL CHALLENGE FOR INFRASTRUCTURE

Building an effective EV charging infrastructure requires strategy as well as scale. Ensuring that infrastructure is precisely planned to fit with traffic flows and motorist behaviour will be vital to accelerating the EV industry.

Manufacturers are already taking the challenge seriously and know how critical good charging infrastructure is to widespread EV adoption. Although refuelling infrastructure is traditionally outside the domain of automobile manufacturers, the vast majority of industry professionals in our study (83%) say investment in public charge point infrastructure is part of or critical to their strategy.

83% of industry professionals say investment in public charge point infrastructure is part of or critical to their strategy.

GOING GREEN

Consumers are also concerned about the source of electricity used to supply the charging infrastructure supporting the EV sector. Six in 10 consumers (62%) told us they expect charging points to guarantee the electricity they provide is from renewable energy sources, and nearly as many expressed concerns about the environmental impact of EV batteries (58%). Chinese consumers are especially focused on renewable energy, with three quarters expecting clean energy from charging infrastructure providers.

“

Having a charge point at home means that an EV driver can plug in and charge at home, typically overnight: just like charging a mobile phone. The charge time depends on a number of factors including the speed of the charger, the battery capacity and the vehicle’s on-board charging rate. But for a typically fully electric vehicle like the Nissan LEAF, a charging time of around six to seven hours can be achieved with a 7kW charger.”

— Mateo De Renzi, chief executive officer, BP Chargemaster

THE CHARGE ECONOMY

A new ‘charge economy’ could be developed around charge points as they integrate into everyday life at shopping centres, car parks, roadside and other destinations. EV owners will be more inclined to travel to places with easy top-up facilities, and many will also want activities, retail,

food and drink facilities while they charge. A constantly available electric charging infrastructure will be crucial for helping consumers adopt EV technology, supporting the shift to a top-up charge mentality while stimulating business opportunities around hot spot areas.

CRITICAL CHALLENGE 5: VEHICLE CHOICE

THE VARIETY OF VEHICLE CHALLENGE

5

Whilst vehicle choice was the least important critical challenge for consumers, it was the **second most important** for fleet managers.

Even so, **54%** of consumers told us they would consider an EV if there was a model available equivalent to their favourite ICE model.



Increasing the availability of electric vehicle types and sizes will be more critical for supercharging EV adoption by businesses than consumers. In our study, fleet managers put a high value on the availability of the right kinds of cars, vans and trucks, saying that vehicle choice will be the top factor in accelerating the mainstream adoption of electric vehicles as fleet vehicles.

Fleet managers’ focus on vehicle choice is due to a need for modes of transport that suit their precise business needs – whether that is specialist vans for trade companies or luxury models for executives. But while businesses rate vehicle choice as the second most important challenge after range, consumers told us it is the least important factor for them, with just 4% rating it as their top concern.

“

Some of the benefits of EVs over ICE are that they are cost effective, noise free and a symbol of modernisation, and the designs are also very nice.”

— Chief executive officer,
EV manufacturer, China



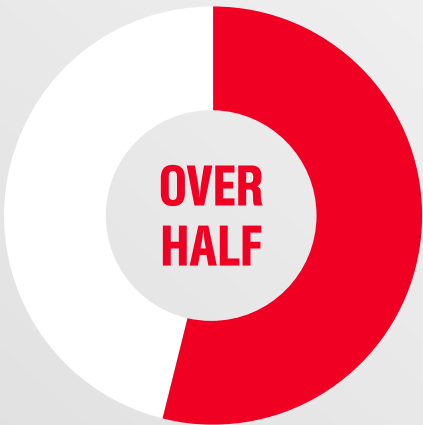
CHOICE IS KING

Carmakers are introducing a wave of new models as the world's biggest manufacturers race to lower the carbon emissions of their product range. The majority of EV models to date have been targeted at niche markets, but 2020 will see 271 models on the market⁸.

Even if vehicle choice is not the top priority for consumers, this model diversification is likely to help accelerate EV adoption, as many consumers want to purchase familiar vehicles from well-known brands. The availability of familiar, trusted models is an important consideration: in our research, over half of consumers (54%) and fleet managers (53%) said they would consider an EV if there was a model available equivalent to their favourite ICE model.

ICE cool

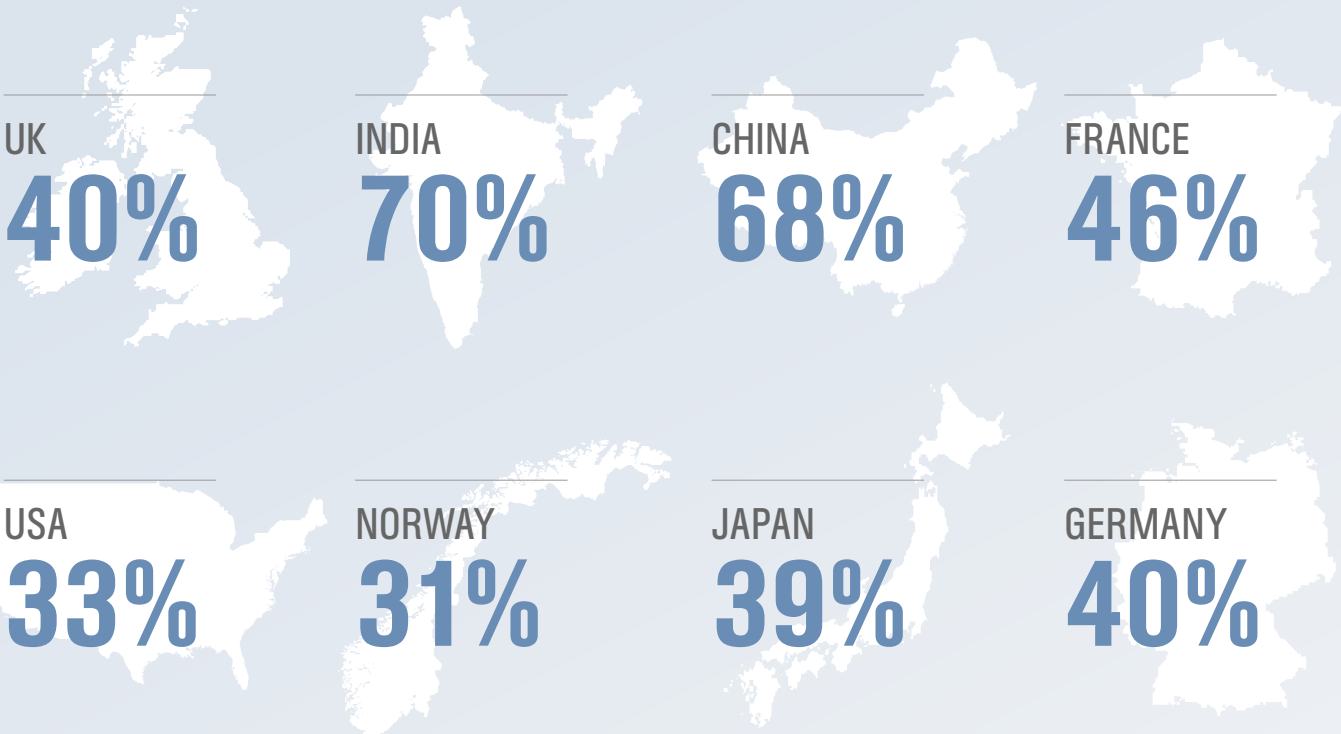
But among the choice of vehicles available, do consumers want a completely reinvented car or an EV that looks and feels like their favourite ICE model? Views on whether EVs are more desirable consumer products than their ICE equivalents vary greatly by market, with respondents in India (70%) and China (68%) most enthusiastic about their appeal but Norway (31%) and the US (33%) appearing far less convinced. While high-end brands such as Tesla continue to capture media attention with high-tech features and luxury branding, cutting edge EV designs could remain a niche choice. Many mainstream EV models are mimicking the familiar look of their ICE equivalents even when aspects of this design are not required for EV functionality.



of consumers (54%) and fleet managers (53%) said they would consider an EV if there was a model available equivalent to their favourite ICE model.

Consumers who believe fully electric vehicles are more fashionable than their combustion engine equivalents.

GLOBAL AVERAGE
48%



The limited choice of electric vehicles may mean new releases are a novelty and still have the power to command attention compared to their ICE equivalents. With new EV models being released all the time, it won't be too long before electric cars

will just be cars. The number of EV models available will rise to 488 globally by 2025.⁹ With vehicle choice expanding at a rapid rate, the automotive industry will need to develop a range of products to appeal to diverse consumer and business needs.

^{8/9} LMC Automotive (2019)

FLEET MANAGER SPOTLIGHT

With different priorities, needs and driving behaviours, the critical challenges for fleet managers are significantly different from those for consumers. Range takes top priority, while price and charge time decline in importance.

Outside these critical challenges for the automotive industry, what social and commercial pressures are holding back the electrification of corporate fleets?

Business leaders may be less inclined to make the shift than those who directly purchase and maintain commercial vehicles. In our study, half of fleet managers (51%) would like to take their fleet electric but encounter resistance from their leadership teams. Being an early adopter of electric vehicles is seen as high risk for corporates (53%), meaning that many companies won't take their fleets to fully electric until their competitors do so (54%). Under half (49%) of fleet managers told us that leadership from senior executives to improve their environmental and social impact drove their buying decisions.



of fleet managers would like to take their fleet electric but encounter resistance from their leadership teams.

A snowball effect?

Although many businesses are adopting a “wait and see” approach to EV adoption, there may be a snowball effect as more fleets make the switch. Our research shows over half (54%) of fleet managers are waiting for a consensus on the dominant EV technology before switching to electric, suggesting that once a critical mass of users have assessed a range of models and technologies there will be significant increases in the number of electric fleets.

Nearly half of fleet managers (47%) told us they expect customers’ calls for them to improve their environmental and social impact to be the most important source of pressure to drive corporate adoption of fully electric cars as fleet vehicles. But they also expect this pressure to be felt as strongly from shareholders, the general public and their own employees.

Personal motivations

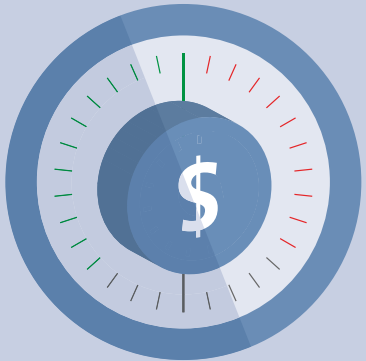
Fleet managers are also open to shifting towards EVs, with nearly six in 10 (58%) respondents feeling personally motivated to make a positive difference to the environment by making their fleet fully electric.

The adoption of EVs by businesses with full fleets in operation also has the potential to have a much wider impact by providing the reassurance that consumers need to make the switch to electric. In our study, nearly two in three consumers (62%) believe the majority of new cars will be electric when consumers gain trust in the reliability of fully electric car technology after seeing it used effectively by public transport and delivery services.

CHARGE TIME
31 MINUTES



PRICE
£36,000



RANGE
469 KILOMETRES



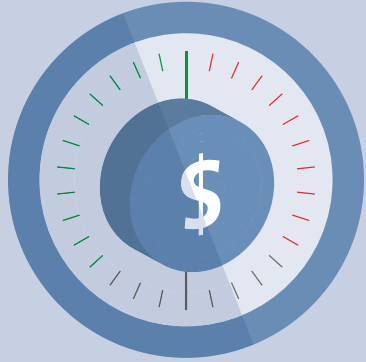
CONSUMERS

CONSUMERS’ VS FLEET MANAGERS’ TIPPING POINTS

FLEET MANAGERS



CHARGE TIME
36 MINUTES



PRICE
\$49,500



RANGE
550 KILOMETRES

PART THREE

MAKING THE SWITCH

The automotive industry faces many critical challenges on the road to mainstream EV adoption. Bringing down the cost and charge time for electric vehicles while increasing range, charging infrastructure and vehicle choice will be critical to persuading consumers to make the switch to EVs.

Currently, consumers are forced to choose the critical challenges that are most important to them. Lower priced models often have shorter ranges and slower charge times, meaning these tipping point targets are only met for consumers who can afford to purchase high-end vehicles. Investing in R&D, forming partnerships across the industry ecosystem, achieving economies of scale in production and developing new business models and service offerings will be essential for solving these critical challenges and supercharging mainstream adoption of EVs.

¹⁰ knowledge.wharton.upenn.edu/article/chinas-ev-market/
¹¹ bbc.co.uk/news/business-46745472

The connected critical challenges

The five critical challenges are connected, meaning advances in one will ease pain points in others. If charge times are drastically lowered, anxiety about EV range will reduce, because consumers will be able to top up more regularly without a long wait. Improving the availability of charging infrastructure will mean consumers are less concerned about queuing at charge points and are more likely to be within range of the next charge point before they run out of power. Increasing vehicle range will allow consumers to top up less often whenever and wherever is most convenient. And bringing down the cost of EVs for price-sensitive consumers will encourage drivers to make the subtle behaviour changes required for slower refuel times and shorter ranges.

The future is already here

While each of the individual critical challenges have been met by some models, consumer fears about the critical challenges are holding back the mainstream adoption of EVs. The key to accelerating the EV market therefore may lie in showing consumers that the future that they want from electric vehicles is closer than they think. Indeed, the future is already here.

Our research indicates that OEMs who want to win the race for market share should consider investing in improvements to meet each of the five critical challenges. Improvements to price, charge time, range, infrastructure and vehicle choice will give OEMs an edge over competitors and boost the user experience of owning an EV.

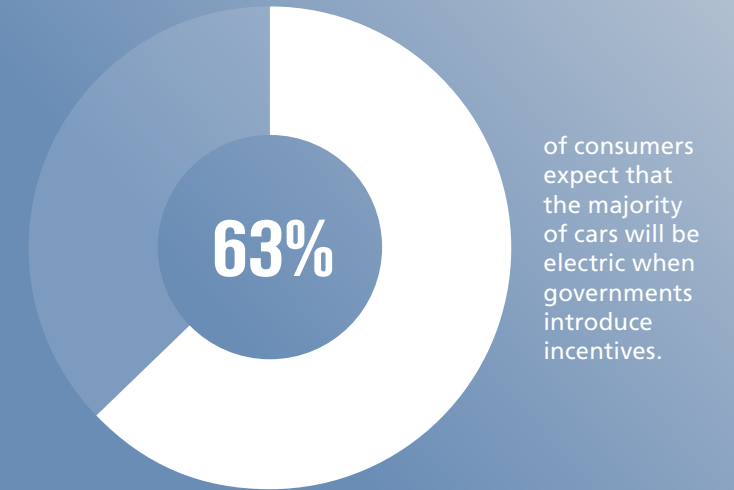
DRIVING THE CHANGE

More carrot, less stick

Across the world, consumers are more motivated by incentives than disincentives. There is a higher approval – and belief in the effectiveness – of incentives for consumers to buy EVs, rather than penalties for running ICE vehicles. Nearly two thirds of consumers (63%) expect that the majority of cars will be electric when governments introduce incentives such as tax breaks and subsidies for the ownership of EVs, compared to 56% who would say the same for penalties such as increasing tax on ICE vehicles.

Consumers want policymakers to lead the way, with the majority (58%) telling us that a lack of government incentives to buy an EV have been an important or very important factor in preventing them from buying one. With purchase price being consumers' most important tipping point, tax incentives could be a powerful tool to enable the automotive industry to offer ICE equivalent pricing for the same car models, at least until OEMs and their partners develop the cheaper and more effective battery technology for the market to sustain lower pricing.

Policies such as tax relief on the purchase price of an EV, reducing road tax or providing free parking and charging could tip a significant percentage of car buyers into switching to an EV. Our research indicates these policies are also much more likely to be more effective for city dwellers (62% compared to 43% who live elsewhere), which means they will be especially useful in helping tackle pollution levels in congested inner-city areas.



The role of government

Policymakers around the world can also help to create the right conditions for mainstream EV adoption. Governments have an important role to play in incentivising consumers to go electric. In some countries, such as Norway and China, regulation and legislation are already playing a pivotal role in making EVs more affordable and attractive for early adopters.

In China, by far the largest EV market, the government has incentivised consumers by providing subsidies since 2010 and ensuring that license plates for EVs are available immediately – while those buying ICE cars could have to wait up to a year.¹⁰ The Chinese government has also taken action to ban new companies that only make ICE vehicles and made it harder for existing companies to set up new factories for non-EV cars.¹¹

The Norwegian government has gradually introduced incentives for buying EVs since the 1990s, including tax breaks, use of bus lanes and free parking. Norway has lowered the upfront cost of buying an EV by scrapping import taxes and, in 2001, the 25% sales tax. It is now phasing out the sale of ICE vehicles altogether by 2025. Meanwhile, the UK has announced new sales will be banned by 2040, and are consulting on bringing this forward to 2035.

METHODOLOGY

Accelerating the EVolution is designed to provide the automotive industry, policymakers and wider stakeholders with insights into some of the critical challenges and tipping points for accelerating the mainstream adoption of electric vehicles.

Our study combines opinion research and economic modelling to examine how consumers, fleet managers and the automotive industry view the future of fully electric vehicles (EVs) across eight of the world’s most important EV markets based on size, growth potential and maturity: China, France, Germany, India, Japan, Norway, the United Kingdom and the United States. The study examines five ‘critical challenges’ to growth in the EV market, the ‘tipping points’ that, if overcome, could drive mainstream adoption of EVs, and the market opportunity for the automotive industry in meeting them.

SAMPLE SIZE BREAKDOWN BY MARKET

Market	Consumers	Fleet managers and transport managers	Automotive industry professionals
China	2,000	100	15
France	1,000	100	2
Germany	1,000	100	2
India	1,000	100	2
Japan	1,000	100	2
Norway	1,000	50	2
UK	1,000	100	2
US	1,000	100	3
TOTAL	9,000	750	30

Our study is based on **opinion research** conducted with three statistically robust sample groups between December 2019 and January 2020.

9,000 consumers

who currently hold a driver’s license and are responsible for the purchase and cost of maintaining their vehicle.

750 fleet managers and transport managers

responsible for fleet purchasing decisions for corporate use, local and long-haul delivery as well as taxi or on-demand services.

30 automotive industry professionals

(encompassing OEMs, Tier 1 suppliers and battery and technology innovators) responsible for purchase decisions of products for fully electric vehicles. Referred to collectively as ‘the automotive industry’ in this report.

CALCULATING THE POTENTIAL EV MARKET SIZE IF THE TIPPING POINTS ARE REACHED BY 2025

Step 1 Establish a baseline

In order to calculate the opportunity for EV market growth in our eight study markets we first established a baseline of expected market share at 2025 based on historic trends. To do this we analysed market data from the International Energy Agency (IEA) and national automotive bodies over the past four years to identify the market growth trajectory.

Step 2 Calculate the impact of achieving the tipping points

To calculate the potential market share for EVs in reaching the tipping points we developed three scenarios based on the opinion research findings for each of the three tipping points (price, charge time and vehicle range). These were calculated based on the total number of consumers who considered the tipping point a top five factor when purchasing an EV (from a choice of 18 factors). The proportion of consumers who put the tipping point in their top five gave us a potential market share based on EV ‘consideration’.

Step 3 Converting ‘consideration’ into buying behaviour

To convert this ‘consideration’ of purchasing an EV into the likelihood of actually purchasing one we developed a consideration conversion rate. This was calculated by identifying the consumers who opted for an EV at their

CALCULATING THE TIPPING POINTS

To establish the tipping points we asked our sample groups to identify at what purchase price (excluding incentives or subsidies), rapid charge time and range per full charge they would consider purchasing an EV. The ‘tipping point’ is the average (mean) figure provided by the sample group.

last car purchase decision as a proportion of all respondents who indicated they seriously ‘considered’ purchasing an EV at their last car purchase decision. This gave us a conservative estimate of the extent to which EV purchase consideration can be converted into buying behaviour.

Step 4 Baseline + achieving ‘tipping point’ = potential market size in 2025

The resulting three scenarios (for price, charge time and vehicle range) reveal the percentage of additional growth in new EVs sold, above the baseline, that we can expect to see when each individual tipping point is met. We then added this percentage to our 2025 baseline to reveal the potential market share (in both new EVs sold and USD) in achieving each of the three tipping points. Opportunities associated with individual tipping points are mutually exclusive and therefore cannot be summed (see below).

Calculating the market size for achieving all three tipping points

Whilst opportunities associated with individual tipping points cannot be summed, we can calculate the potential market size if they are achieved by calculating the number of consumers who considered one or more of the critical challenges in their top five (see: Step 2). This will give us the proportion of consumers who would consider buying an EV if any of the three tipping points are achieved.

ABOUT CASTROL



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The world of transport is going electric and e-fluids have a vital role to play. EVs play a key part in the mobility revolution and the pathway to decarbonising transport. Castrol's e-Fluid expertise extends across land, sea and even space.

IN SPACE

Castrol e-Greases help keep NASA's \$820 million InSight Mars Lander working in the unforgiving conditions on the Red Planet.

AT SEA

Castrol e-Fluids support equipment used in the transfer of power from an engine or electric motor to a propeller or thruster.

ON LAND

Castrol has developed a range of e-fluids to meet the needs of vehicle manufacturers. From transmission e-fluids, which are inside many EVs already on the road, to e-Greases and e-Coolants, these fluids enable electric vehicles to run smoothly, efficiently and stay cool.

Developments include Castrol's lowest viscosity e-transmission oil, designed for efficiency, durability and reliability. Castrol is partnering with major manufacturers to ensure its lubricants deliver what drivers want: to go further on a single charge, enable longer life of transmission and component parts, and ensure long-lasting battery health.

As EVs continue to evolve, Castrol's best brains are not only defining the fluids, but the way the fluids are defined: pioneering unique testing and monitoring methods, driving efficiency and economy going beyond the standard requirements of the fluids, taking consumer insights and engineering technical solutions; advancing technologies that will lead to breakthroughs for the transport of tomorrow.

**To find out more about Castrol
please visit www.castrol.com**

CREDITS

*Accelerating the **EV**olution: The tipping points to mainstream electric vehicle adoption* is based on in-depth research commissioned by Castrol, designed by Castrol and Man Bites Dog, with additional economic modelling of EV market potential by Oxford Analytica.

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