elementenergy

Availability and Affordability of ZEVs

Interim Report

for

BEUC and ECF

October 2017

Element Energy Limited
Suite 1
Bishop Bateman Court
Thompson's Lane
Cambridge CB5 8AQ

Tel: 01223 852499
Fax: 01223 353475

Contents

Authors

For comments or queries please contact:

Alex Stewart (alex.stewart@element-energy.eu +44 (0)1223 852495)

Christopher Fernandes (Christopher.fernandes@element-energy.eu)

List of Abbreviations

AV	Autonomous Vehicle
BEUC	The European Consumer Organisation
BEV	Battery Electric Vehicle
EC	European Commission
ECF	European Climate Foundation
EE	Element Energy
NREL	National Renewable Energy Laboratory
OEM	Original Equipment Manufacturer
PHEV	Plug-in Hybrid Electric Vehicle
T&E	Transport and Environment
TCO	Total Cost of Ownership
ULEV	Ultra-Low Emissions Vehicle
ZEV	Zero-Emissions Vehicle

1 Introduction

In 2016, Element Energy carried out a detailed study for BEUC and ECF on the future ownership costs of low carbon cars and the implications for consumers and policy makers. The report, entitled *Low carbon cars in the 2020s: Consumer impacts and EU policy implications*, found that a transition to low and zero emission cars is likely to have strong and positive impacts on EU consumers. Technology cost projections showed that the total costs of ownership (TCO) of low emission models will become equivalent to conventional petrol and diesel cars in c.2025, before country-specific incentives are taken into account. The analysis also showed particular benefits for buyers of second- or third-hand low emission vehicles, as the fuel and maintenance cost savings for these vehicles are the dominant ownership costs for used cars.

The 2016 study considered TCOs in conventional ownership models, in other words the new car buyer and subsequent owners buying a car for personal use, and reselling it after a number of years (or scrapping it in the case of the final owner). Building on this work, ECF and BEUC wished to carry out a supplementary study with a particular focus on the following:

- Availability of ultra-low emission vehicles, in terms of the number of models on the market now and in the future but also true availability in dealerships across Europe
- Affordability of ZEVs, and whether lease offers for ZEVs are competitive with offers available for conventional vehicles
- The impact of new ownership models such as car sharing or the introduction of autonomous vehicles in the future, and how these influence costs of vehicle ownership or mobility

This supplementary study employs the same vehicle cost and performance model and TCO analysis carried out for the 2016 study, to ensure consistency with the original results. All core assumptions such as vehicle technology costs, fuel prices, insurance costs etc. are the same as in the previous study unless explicitly stated otherwise. Given the similarity in methodologies, detailed descriptions of the model and original assumptions are not repeated here, and the reader is referred to the public report of the 2016 study for further information. This is available at:

http://www.element-energy.co.uk/publications/

A non-technical summary of the report written by BEUC is accessible at:

http://www.element-energy.co.uk/wordpress/wp-content/uploads/2017/01/Low-carbon-cars-in-the-2020s-Consumer-impacts-and-EU-policy-implications-BEUC-Summary-Report.pdf

1.1 About this report

The first part of this report, focussing on vehicle availability (Section 2), is presented in this document. The two other sections mentioned above, which deal with affordability of ZEVs and the impact of new ownership models, will be published in the coming months.

2 Availability of ZEVs and ULEVs

2.1 Methodology and data acquisition

Availability of zero emission vehicles in a wide range of models is an important prerequisite of widespread uptake. This is because customers are likely to have preferences for certain non-powertrain attributes of new vehicles, such as size, styling, boot space, entertainment features etc. If ZEVs are only available in a limited number of models, potential customers may not buy them if it requires compromises on the vehicle brand and these other attributes. It should be noted that some drivers are likely to prefer petrol/diesel cars for other reasons, for example the long driving range or engine sound, and for those customers availability of more ZEV models will have little or no effect on their buying patterns. However, for potential buyers open to choosing a ZEV, availability of a range of models maximises the chances of them finding a vehicle that meets all of their needs.

Previous studies have attempted to estimate the perceived value of brand or model choice for consumers. Greene et al. (2001) found that a very limited model choice (for example only 1 available model in a given segment) had the same impact on alternative fuel vehicle sales as increasing the sales price by €3,645[1]. A more recent study conducted by Element Energy for the UK Department for Transport using a survey of would-be car buyers found a perceived 'penalty' of €1,815 for powertrains in which only one model was available in a segment[2]. In the early years of ZEV deployments, these values are small compared with the additional purchase price of the vehicles (before incentives are taken into account). However, as other barriers to ZEV uptake improve in future (e.g. purchase prices, higher ranges, more widespread infrastructure), lack of model choice or real world access to ZEVs through dealerships becomes increasingly important.

The aim of this availability task was to quantify the number of ZEV (primarily BEV and PHEV) models currently on the market and examine how this is likely to change in the short and medium term. Element Energy's existing database of ZEV models was used as a starting point for this work, and this was updated to include all models on the market or announced up to mid-September 2017. Expected future model availabilities were then divided into announced models in the short term (c.2020) and medium term (c.2025). Models included in the short-term database are those that have been named and given a date for start of production or market release, as opposed to concept cars or press releases referring to un-named future models being electrified. Medium term projections are based on Original Equipment Manufacturer (OEM) projected sales volumes and expected market shares rather than specific model announcements. In some cases, OEMs publish statements about the numbers of new (but as-yet unnamed) models to be introduced in the future, for example the 12 new zero emission models expected from the Renault-Nissan-Mitsubishi group by 2022[3]. Where available, the following information for each model was compiled and added to our database:

- Manufacturer and model name
- Year of introduction (and European introduction year if different)
- Segment
- Powertrain (e.g. BEV, plug-in hybrid, fuel cell)
- New model / refresh of existing model

[1] Based on a $2,500 penalty in 2001 USD, converted to 2017 EUR. Study available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.199.2796&rep=rep1&type=pdf
[2] Element Energy (2017) - Survey of consumer attitudes to plug-in vehicles (in press)
[3] https://electrek.co/2017/09/15/renault-nissan-mitsubishi-alliance-12-new-all-electric-vehicles/

- Motor output power in kW
- Battery size / range (for BEVs/PHEVs)
- Expected selling price

Research on the current and future availabilities was initially conducted through a systematic review of OEM websites and press releases. The amount and quality of data available for each model depends strongly on the OEM (some OEMs release information early while others published limited official information until closer to introduction) as well as the actual introduction date (generally more information is available for models being introduced in the near-future). Wherever possible, information which was lacking or unavailable was complemented with other sources such as published strategy documents, executive statements, employee interviews or news articles in the automotive press.

2.2 Results of the Market Review

2.2.1 Current and short-term availability

As mentioned previously, current availability refers to the number of models available for purchase in Europe today. Short-term availability is defined here as all future named models which have been named by the OEMs and have been given an expected production date. This excludes most concept cars or prototypes and generally limits the scope to approximately 3 years into the future.

Figure 1 below shows the cumulative availability of Battery Electric Vehicles (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs) in Europe, from 2010 to 2020. It shows how the number of models available to European customers has been rising steadily over recent years. This is in large part as a response to new car CO_2 standards in Europe (95 gCO_2/km by 2021[4] for average new car emissions) and equivalent measures in other international markets.

The market review showed that in 2017, there were 19 BEVs and 25 PHEVs available for purchase in Europe, representing a large increase compared to 2010 when only 3 BEVs and no PHEVs were available. For comparison, a study carried out by Transport and Environment (T&E) recently reported that there were over 417 vehicle models available to European customers with petrol and diesel internal combustion engines (ICE) [5]. This indicates that there is a significant lack of choice for customers who are not willing to buy a car from a particular brand or who do not like the non-EV features such as the styling or equipment of a particular model. For example, within the B-segment 'supermini' category there are BEVs offered by Renault (the Zoe) and BMW (the i3), but no BEV versions are available in most of the bestselling models in that segment such as the Ford Fiesta, VW Polo or Opel Corsa.

[4] European Commission Climate Action Website: https://ec.europa.eu/clima/policies/transport/vehicles/cars_en

[5] T&E (Sept. 2017) - Carmakers failing to hit their own goals for sales of electric cars: Missed targets due to a lack of choice, availability and marketing

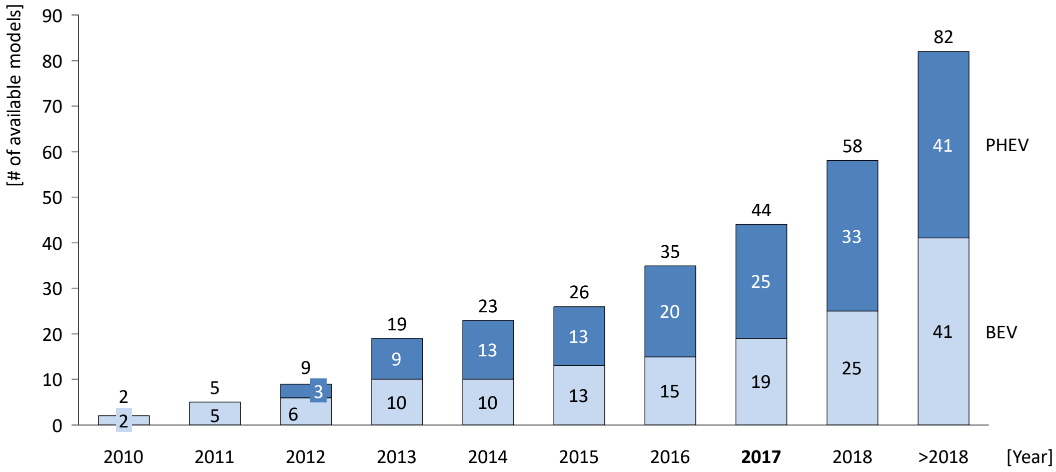

Figure 1 Current and short-term model availability in Europe

Figure 2 and Figure 3 show how BEV and PHEV models are distributed across the various car market segments, where segment E+ comprises segments E and above. The first thing to be noted when comparing the two figures is that PHEVs models are concentrated in the large and premium car segments with no models available in the A and B segments until 2017, while BEVs are spread out more evenly across the segments.

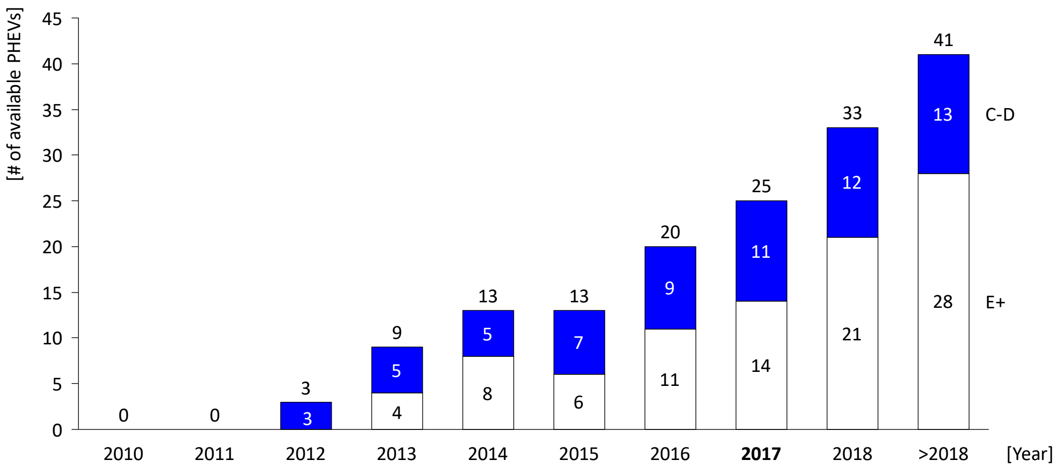

Figure 2 Availability of PHEVs in Europe by Segment

There are several reasons for OEMs' focus on the larger segments for PHEVs. The first is that larger vehicles have higher emissions than small ones on average, and so the CO_2 reductions from a PHEV powertrain are higher than for a small car. Secondly, larger cars tend to cover higher mileages (as they are used as company cars or primary cars for households), and have been less suitable for first generation BEV powertrains with limited driving ranges. Thirdly, PHEV powertrains require sufficient packaging space for an engine, traction battery and fuel tank which is more practical to integrate into large vehicles.

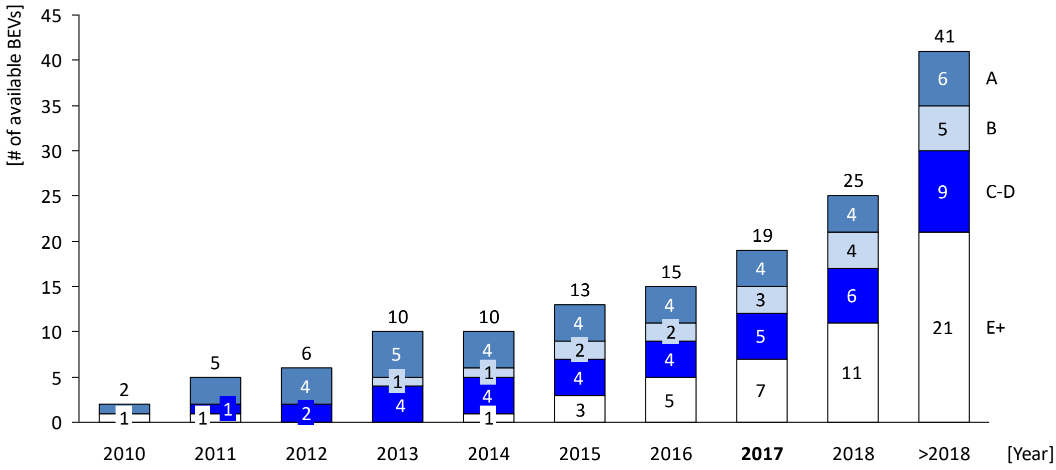

Figure 3 Availability of BEVs in Europe by Segment

In the BEV market, the opposite trend was prevalent until recently, with BEVs concentrated in smaller vehicles (with Tesla being the exception). This focus on smaller vehicles was consistent with minimising battery pack sizes while the cost per kilowatt-hour was high, and appealing to drivers in two-car households for whom low range vehicles could meet their mobility needs. In the coming years, BEVs are expected to be introduced into larger vehicle segments like large sedans and SUVs, with models including Jaguar I-Pace and Audi E-Tron Quattro.

2.2.2 Medium-term availability

Medium-term availability data, defined here as the availability of BEVs and PHEVs up to 2025 as projected by OEMs, exist in the form of expected EV sales volumes, expected EV market shares and general announcements on the expected number of production models with electrified powertrains.

The prevalence of OEM announcements with a focus on electrified vehicles has been increasing; the majority of major OEMs have stated targets or expectations in terms of available models and EV sales. This suggests that they recognise both the need to electrify their portfolios to meet future CO_2 targets, as well as the potential customer demand from competitively priced, long range electric vehicles.

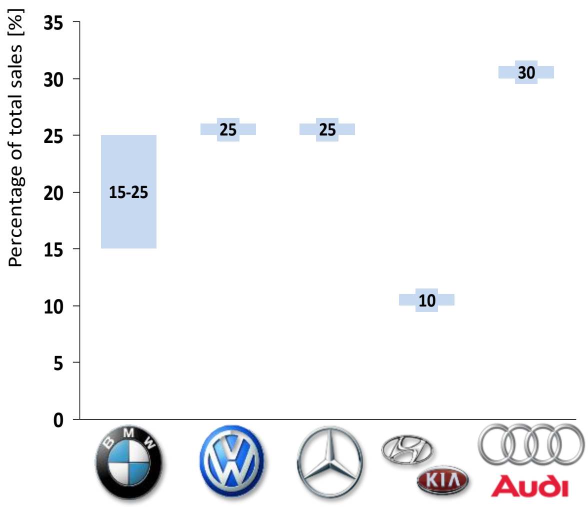

Figure 4 Sample of OEM electrified vehicle sales targets

Figure 4 gives a sample of OEM targets in terms of percentage of vehicle sales which they expect will be partially or fully electric by 2025.

Along the same lines, Mercedes-Benz intends to sell 100,000 EVs per year by 2020 (with 2015 global sales including all powertrains of c. 2 million units), Nissan expects that 20% of its EU sales will be electric by 2020 and Volvo announced that a goal to sell 1 million electrified cars by 2025.

With regards to model availability, VW Group has announced it will have 80 new BEVs by 2025 and that it wants to electrify its whole portfolio by bringing at least one electrified version of each of the 300 or so Group models across all brands and markets by 2030[6]. Jaguar has promised that 50% of its production vehicles will be available with EV or PHEV powertrains and Honda has announced that it aims to electrify two-thirds of its line-up by 2025.

Mazda, an OEM which has to date favoured improvements in internal combustion engine technology rather than electrification, has announced that it plans on electrifying all its offerings by 2030[7] as well as concluding a deal with Toyota which will partner them up to build an EV assembly plant in the U.S. with a value of $1.6 billion.

It should be noted that there is often some ambiguity in these medium-term OEM announcements, in terms of how 'electric' or 'electrified' vehicles are defined. For example, Volvo recently announced the following about its future electrification plans:

> *"Volvo Cars, the premium car maker, has announced that every Volvo it launches from 2019 will have an electric motor, marking the historic end of cars that only have an internal combustion engine (ICE) and placing electrification at the core of its future business."*

This was reported by many media outlets as Volvo producing only BEVs and PHEVs from 2019 and ceasing production of ICE vehicles. In fact, Volvo's commitment is to make all new models launched in 2019 or beyond electrified to some degree, from mild hybrid powertrains to PHEVs or BEVs. Models introduced before 2019 will presumably continue to be produced with standard internal combustion until their next refresh cycle. This underlines the need for caution when interpreting OEM statements to avoid misleading expectations of how many PHEVs and BEVs will be available in future model portfolios.

2.2.3 Anecdotal evidence and recommended further research

The data above considers availability in terms of the number of models offered to the market by OEMs. An additional dimension of availability is the extent to which electric vehicles can be found at dealerships or ordered without excessive waiting times. In other words, real-world availability of the vehicles for purchase through normal sales channels is more important than the theoretical availability which has been studied above.

For example, T&E showed that "available" models were not always available in showrooms and dealerships – notably the Opel/Vauxhall Ampera and Ampera-E (the European name for the Chevrolet Bolt). Indeed Opel dealers in Norway were recently instructed to stop taking new orders for the Ampera-E so it is not currently available for purchase[8]. Furthermore, it was found that other models which *were* available in showrooms may have long waiting times due to lack of manufacturing capacity, like the Hyundai Ioniq electric and BMW i3[9]. US studies have highlighted several other issues such as dealerships not making electric vehicles prominent in their showrooms, not knowing about available incentives or failing to

[6] (VW Group 2017) "The Volkswagen Group launches the most comprehensive electrification initiative in the automotive industry with "Roadmap E"" https://www.volkswagenag.com/en/news/2017/09/Roadmap_E.html
[7] http://autoweek.com/article/rumormill/mazda-electrify-all-its-models-2030-report-says
[8] https://electrek.co/2017/10/20/chevy-bolt-ev-opel-norwegian-dealers-stop-taking-orders/
[9] Transport & Environment (2017) - Slow electric car uptake due to lack of choice, availability and marketing spend – report

have charged EVs ready for test drives[10]. Anecdotal evidence suggests similar issues in Europe, including cases of dealers preferring to sell petrol/diesel cars to customers initially looking at ZEVs, due to higher sales margins on the former.

These trends are likely due to several factors, such as lack of knowledge among dealership staff of electric models, lower margins on current generation EVs, and a longer sales process from would-be EV buyers who may have lots of questions about the technology, suitability for their needs, incentives etc. There may also be an additional concern over lost aftersales revenue from electric vehicles requiring less maintenance than conventional vehicles, which encourages dealers to prioritise selling the latter.

Secondly, OEMs survey their customers and compile a customer satisfaction index (CSI) for each dealership and each salesperson. Underperforming dealers are met with fines which are passed on to the underperforming salespeople. This means a lot of money is at stake and salespeople consciously try to maximise their CSIs while avoiding situations which may be detrimental to customer satisfaction (such as long waiting times or lack of staff knowledge for BEVs)[11].

Traditionally, car sales teams are highly familiar with the features of internal combustion engine vehicles, and refuelling is already familiar to almost all customers. However, customers who want to buy an EV will tend to have more questions about the car, related to the technology itself (vehicle features or charging infrastructure) or tax benefits/incentives. Mystery shopper studies in the US suggest that a lack of knowledge on EV-specific features contributes to a negative customer experience, which in turn gives dealers an incentive to focus on selling petrol or diesel vehicles [12].

Another aspect which seems to hinder EV sales is that salespeople feel like they can sell ICEs faster and receive larger commissions[13], partly because customers know what they are buying and tend to ask fewer questions but also because of the larger margins they make on ICEs.

Finally, dealerships' largest source of revenue tends to be their service department. As EVs require less maintenance than their ICE counterparts, selling an EV potentially reduces profit margins on the initial sale but also on the future revenues from the after-sales department. This potentially creates a stronger incentive to sell conventional vehicles than ZEV models. It is not yet clear whether this will change in the longer term, as other EV-specific services or parts replacements (for example battery upgrades or replacements) provide revenues to compensate the lower annual maintenance cost. For example, the Renault connected car services for their battery electric vehicles (which allow remote activation of heating and cooling among other features) require a monthly subscription after the first year. Some of these revenues would go directly to the manufacturer rather than the dealer, so there remains an element of risk for dealers in terms of the certainty of revenues for petrol/diesel cars and the potential revenues for BEV servicing in the future.

Recommended further research

For a deeper understanding of influencing factors and their effects on the actual availability of current models, more real-world data for the EU is necessary for analysis. This could be

[10] See for example https://www.sierraclub.org/sites/www.sierraclub.org/files/uploads-wysiwig/1371%20Rev%20Up%20EVs%20Report_09_web%20FINAL.pdf
[11] http://insideevs.com/why-dealerships-fail-at-selling-electric-cars/
[12] https://its.ucdavis.edu/blog-post/the-future-of-electric-vehicles-part-1-car-dealers-hold-the-key/
[13] https://cleantechnica.com/2015/12/03/car-dealers-dont-like-selling-evs-no-duh/

achieved through surveying potential customers and EV owners about the sales experience, or through a ‘mystery shopper’ study where researchers visit dealerships directly to compare the sales process for conventional and electric cars. Finally, anonymous surveys of dealerships or sales teams by industry associations could highlight attitudes to EVs and the reasons for differing customer experiences from the dealers’ perspective.

Such field work could be carried out across different OEMs and Member States, to highlight any systematic differences in customer experiences. Repeating this survey work at regular intervals would also be valuable, as it would highlight whether these issues persist in the future, or whether they disappear for next-generation ZEVs with sales margins closer to industry norms and as dealer knowledge improves.

This publication is part of an activity which has received funding under an operating grant from the European Union's Consumer Programme (2014-2020).