IEA IA-HEV Task 18

ev ecosystems

Future of Markets for Electric Vehicles:

Expectations, Constraints & Long-Term Strategies

urban foresight

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Report of a roadmapping workshop facilitated by Urban Foresight for the International Energy Agency Hybrid & Electric Vehicle Implementing Agreement and the Austrian Institute of Technology

Requests for further information should be directed to:

Dr. David Beeton
Operating Agent | EV Ecosystems
IEA Hybrid & Electric Vehicle Implementing Agreement
c/o Urban Foresight Limited
david.beeton@urbanforesight.org

Contact AIT – Austrian Institute of Technology:

Björn Budde
Scientist, Country Delegate | EV Ecosystems
IEA Hybrid & Electric Vehicle Implementing Agreement
AIT – Austrian Institute of Technology
Foresight & Policy Development Department
bjoern.budde@ait.ac.at

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Urban Foresight Limited
Registered in England and Wales No.7705420
8 The Crescent | Newcastle upon Tyne | NE7 7ST | United Kingdom
www.urbanforesight.org

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1 Introduction

Governments around the world have initiated policies and programmes to promote the adoption of electric vehicles (EVs). Business models and commercial incentives are also emerging to make EV ownership a more attractive proposition. However the future growth of markets for EVs is still uncertain and by no means guaranteed.

This report presents the outputs of a workshop which considered the factors that will impact adoption of EVs and the associated requirements for policymakers and industry. The workshop was held in Vienna in December 2012 as part of the EV Ecosystems project, which is a global task force run by Urban Foresight for the International Energy Agency's Hybrid & Electric Vehicle Implementing Agreement (IA-HEV). The workshop was hosted by the Austrian Institute for Technology.

This paper summarises the outputs of the workshop. This includes a ranking of the barriers to EV adoption, and visions of "best," "worst" and "probable" scenarios for the development of global markets for EVs.

The following organisations are thanked for their contribution to the workshop and continued support for the EV Ecosystems project.

A3PS	Magna Powertrain
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2 EV Barriers

Prior to the workshop, a list was compiled of frequently cited barriers to EV adoption. The workshop participants were then asked to identify the three barriers that they believed would have the greatest impact on EV adoption. This resulted in the below ranked list of priority barriers.

Table 1: Ranked list of priority barriers developed in the workshop

Rank	Barrier	Description
1	High purchase cost	EVs and PHEVs retail at higher prices than comparable internal combustion engine models.
2	Business models	The long-term commercial viability of business models associated with the provision of EVs and recharging infrastructure.
3	Performance and choice of vehicles	EVs will possibly not be suitable for all applications and will not match the performance, range and flexibility of comparable conventionally-fuelled vehicles.
4=	Ability to value whole-life running costs of vehicles	Consumers mainly concentrate on the purchase price as opposed to the whole-life benefits such as lower maintenance and fuel costs.
4=	Lack of public awareness and knowledge	The current level of public awareness and knowledge of EVs is low, with the average consumer having little understanding about their operation, driving experience and potential benefits. Furthermore, improvements in EV performance and efficiency are only of use if consumers are aware of them.
4=	Lifespan of batteries	Questions about the longevity of batteries, how this will affect performance and residual value.
7=	Availability of recharging infrastructure	Concerns about the lack of public recharging infrastructure and the time required to recharge limit the distances that can be travelled in an EV and is a cause of 'range anxiety' amongst drivers.
7=	Risk of lack of standardisation and interoperability	The lack of common standards for plugs, sockets, access keys and ICT systems could impact the confidence of consumers and manufacturers.

In addition to these barriers, the below factors were not considered to be priorities, but are also often identified as barriers to EV adoption.

Table 2: Frequently cited barriers to EV adoption that were not identified as priorities in the workshop

Barrier	Description
Backing the wrong technology	Perceptions that EVs will ultimately be superseded by other technologies such as hydrogen fuel cell vehicles.
Residual value	Questions about the extent to which EVs will retain their value for resale and the effects of depreciation of batteries.
EV image	Cars are a powerful signifier of social and personal identity. The performance limitations of EVs may affect public perception and desirability.
Green credentials	The carbon intensity of electricity generation, concerns about the whole-life impact of EVs and the sustainability of materials required for battery production.
Lack of allocated parking for domestic recharging	The ability to recharge an EV at home is dependent on the availability of allocated and ideally off-street parking.
Lack of aftersales support networks	Concerns about the availability of support and necessary skills at dealerships, garages and breakdown services.
Limited range of EVs and range anxiety	Drivers place a very high utility on the ability to drive long distances, even if such trips are rare.
Aversion to new technology	Consumers can be cautious and prefer familiar and trusted technologies.
End of life of batteries	The capital and environmental cost of disposing of batteries once they have reached the end of their natural life.
Finite materials used in battery manufacturing	The security of supplies of finite materials used in the production of EV batteries such as lithium and rare metal elements.
Capacity of local electricity distribution networks	Large numbers of drivers recharging at similar times will place significant pressure on the local distribution network.
Concerns about the safety of EVs	The actual and perceived risks of quiet running vehicles and the risk of combustion of EV batteries.

3 Hopes, Hypes and Disappointments

The issue of repeated hopes, hypes and disappointments regarding new technologies was examined during the afternoon session of the workshop. A short presentation based on the analysis conducted by the AIT was given, which is described below.

Periods of hypes and subsequent disappointment seem to occur quite frequently in the field of green propulsion technologies. Since the 1990s there have been various hypes concerning electric vehicles, fuel cell vehicles or bio-fuels and some experts argue that electric vehicles are currently in a hype phase. In order to avoid disappointment and potential drawbacks, experts and policy makers should be aware of these expectation dynamics to avoid flawed decisions.

The presentation showed that there are always incentives for actors with stakes in the development of a technology to hype “their” technology. Moreover, these incentives to hype a technology are even greater the more complex a technology is, and/or if the successful deployment of the technology needs the build up of a new infrastructure. This makes green propulsion technology such as electric mobility or fuel cell technology particularly prone to hype-disappointment cycles.

Moreover most of the technology assessment exercises today focus on the analysis of the future performance characteristics of a technology (e.g. range, energy density, etc.) while many other developments such as general trends in the mobility or energy sector are often not taken into account very systematically. However, changes in the mobility sector may have a large impact on technological choice. For example, in a future mobility system based on the smart combination of several transport modes (e.g. high speed trains and carsharing), a technology such as electric vehicles is highly promising, whereas it may not be if we expect consumers to insist on a multipurpose vehicle with a range similar to today’s conventional cars.

The same holds concerning future development in the energy sector. In the case of a transition towards renewable energy sources, electric vehicles may diffuse much faster than in a scenario in which electricity is produced from fossil resources such as coal. Furthermore, the diffusion of smart grids may facilitate the diffusion of electric vehicles, whereas a lack of smart grids may be a barrier to the widespread use of electric vehicles. Although these issues are not related to electric vehicles and their performance (e.g. batteries), they will have a significant influence on the future of electric vehicles and thus should be taken into account systematically.

Against this background, an analytical framework to analyse and assess expectations concerning electric vehicles was discussed. It encompasses the analysis at different levels (technological, sectoral and societal or landscape level). In order to have a broader picture concerning the future of a technology such as electric vehicles, one should take into account potential changes at all of these levels.

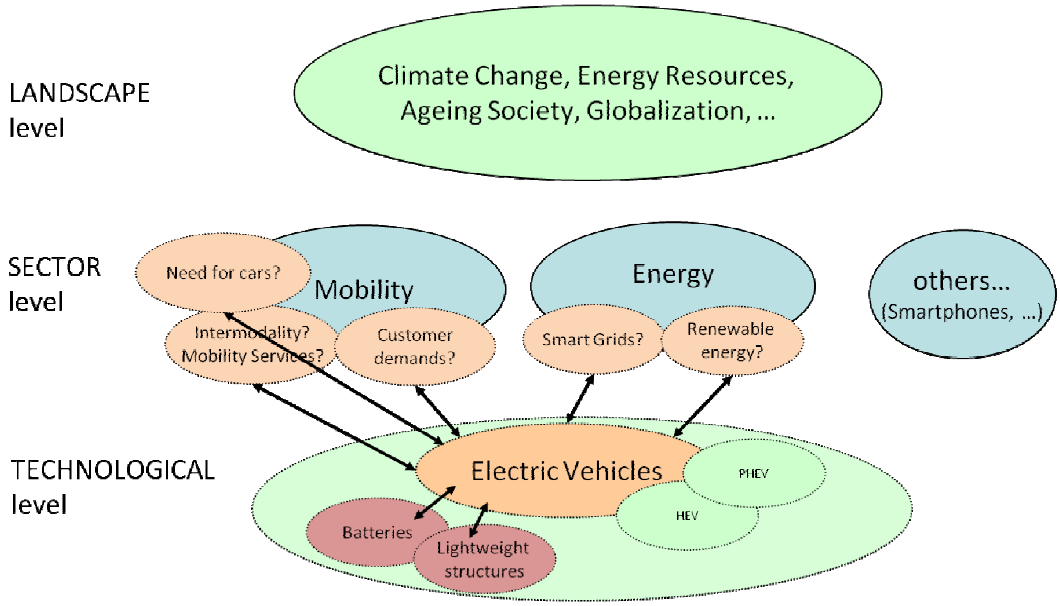

Figure 1**: Analytical framework expectations (source: Budde 2012)**

Moreover it was concluded that there ***is the need for proactive expectations management to avoid excessive hype and disappointment***, as visualized in Figure 2.

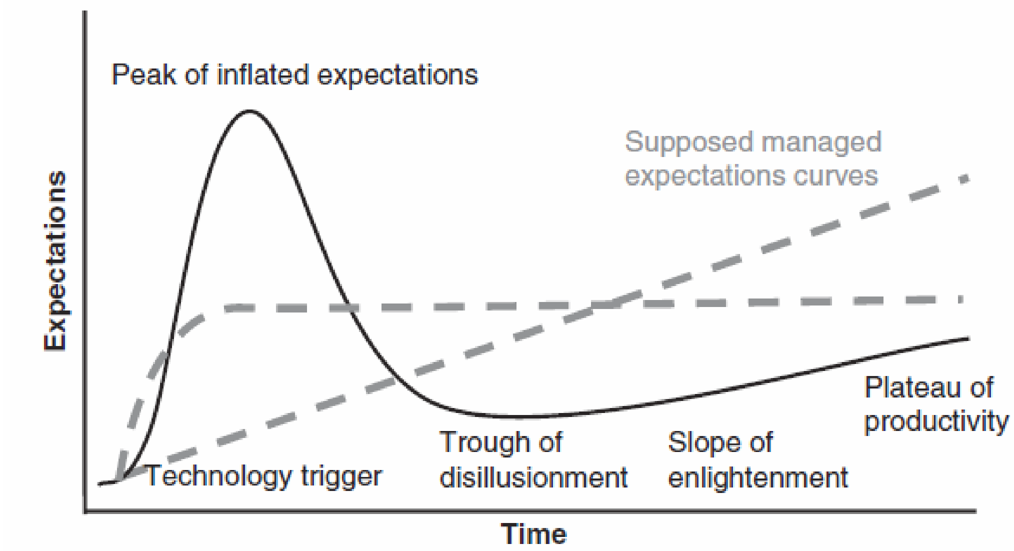

Figure 2**: Expectation management (source: Bakker and Budde 2012)**

In order to achieve this expectation management (or to be able to cope better with the effects of disappointment) the following strategies could be applied:

- manage expectations consciously among stakeholders (business partners, policy, customers), e.g. through the development of shared roadmaps, visions, scenarios

- develop strong institutions with a stable policy backup
- have robust long term planning, which can survive minor changes in the environment (disappointment)
- establish long term programmes with commitment by key actors to guarantee some level of continuation after the hype
- take into account different levels of expectations (technological level, sectoral and societal level)
- manage linkages and relations between technological options in order to use synergies instead of competing, e.g. the framing of an ongoing "Electrification of transport" rather than "Electric Vehicles vs. Hydrogen and Fuel Cells"

And in case of a phase of disappointment:

- avoid dropping disappointing options immediately and completely
- conduct a re-evaluation of a disappointing option with regard to robust "side" knowledge which could be otherwise useful in the future (electric drive train knowledge is valuable for battery electric vehicles and for fuel cell vehicles)

History has shown that radical innovation has always been a lengthy and bumpy process.

It is noted that the findings and strategies described above are based on several research projects, and were presented as an input to the scenario and roadmapping exercises described in the following sections. They do not therefore necessarily reflect the position of the participants of the workshop.

4 Future Scenarios

4.1 Introduction

Three scenarios were developed by breakout groups in the workshop. These scenarios considered the future development of markets for EVs, identifying a "best", "worst" and "probable" case.

A roadmapping approach was used to structure key issues into different time horizons and to establish links between developments in markets, products, services, technologies and the necessary underpinning resources. These scenarios are shown in the following sections, with a short explanation of the key points raised.

4.2 Best-Case Scenario

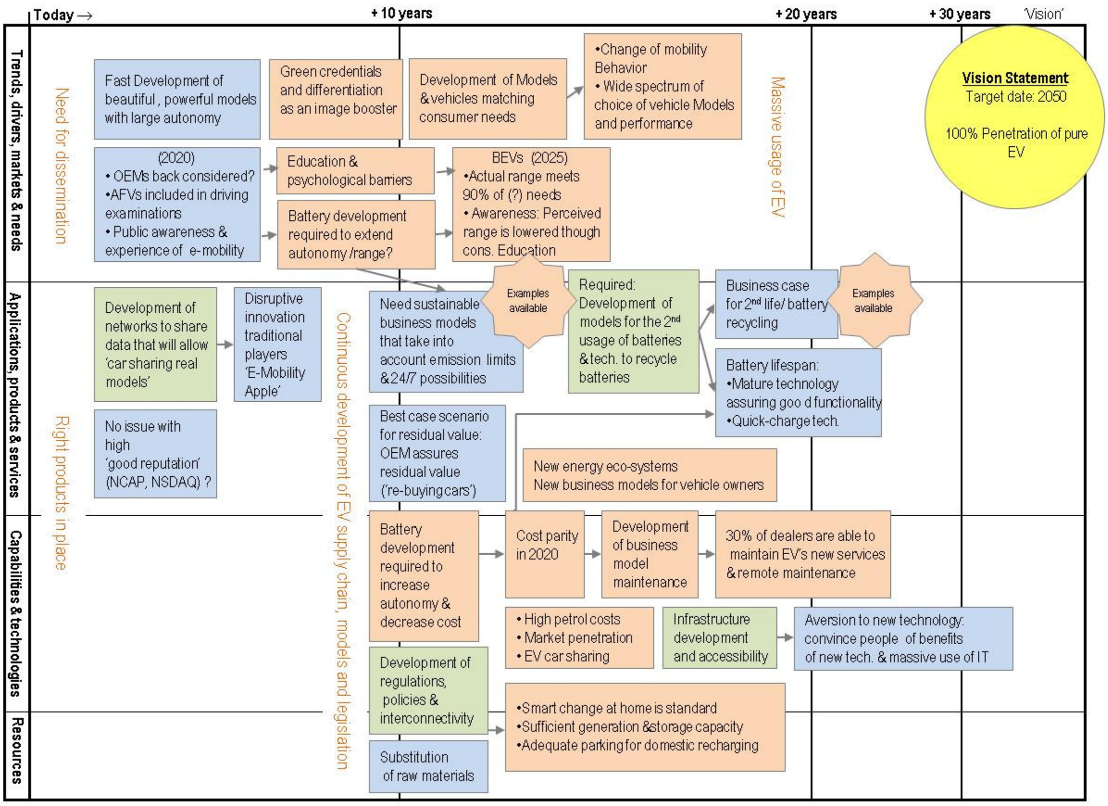

Figure 3: Group analysis of the best-case scenario

The best-case scenario envisages a future where EVs achieve 100 per cent penetration, with complete phasing out of all fossil-fuelled vehicles.

Central to achieving this will be a campaign of dissemination and awareness raising. This will promote greater levels of understanding of the capabilities, benefits and imperatives for adopting EVs. It will also address a current short-term constraint whereby the general public have little knowledge of EVs and limited access to relevant information.

A further important factor in increasing EV adoption will be the introduction of new model vehicles to the market. This greater choice will enable more needs to be met and increased competition on price and performance. This will accelerate advances in technology, seeing new disruptive innovations enter the market. It will also see EVs reach cost-parity with fossil-fuelled equivalents by 2020.

The key to success will be providing customers with EVs that are perfect for their needs. On the whole, it was felt that the mass market will require simple cars that are straightforward to drive. Simple operation of EVs also requires the provision of necessary recharging infrastructure. This would ultimately see every home equipped with a recharging point.

4.3 Worst-Case Scenario

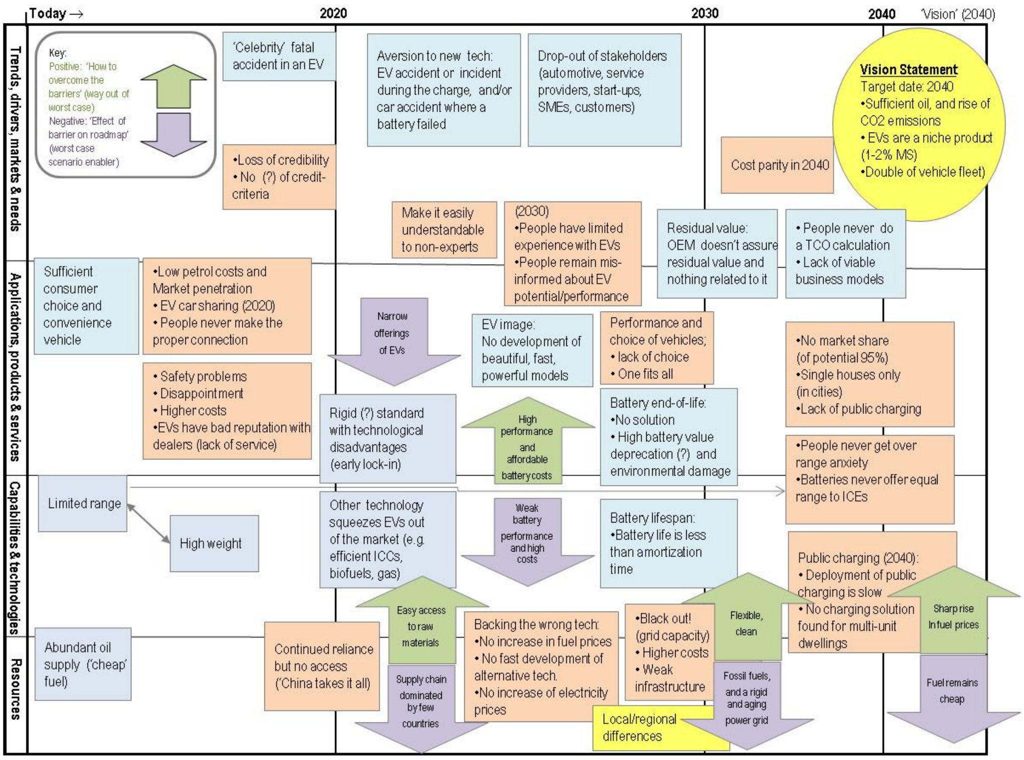

Figure 4: Group analysis of the worst-case scenario

The worst-case scenario predicts that fuel remains relatively cheap over the next years and batteries fail to deliver the performance required by the mainstream market. Accordingly, EVs remain a niche offering in a market that continues to be dominated by internal combustion engine (ICE) vehicles.

Negative user experiences and media commentary characterise EVs as being high cost and low on performance. This culminates in important stakeholders dropping their support for EVs. Politicians withdraw subsidies, vehicle manufacturers scale back their investments and utilities lose interest.

Potentially catastrophic incidents are also foreseen which seriously damage public confidence in EVs. Examples cited in the workshop were road traffic accidents or fires occurring as a result of malfunctions in batteries, recharging technologies or electric drive trains. These events, and other major issues that could go wrong for EVs, are predicted to most likely occur post-2020.

Recharging infrastructure is not provided in a way which makes operation of EVs simple and convenient. No solution is developed for multi-unit dwellings, necessary public infrastructure is not provided and countries get locked into rigid standards.

Consumers fail to connect with the total cost of ownership proposition of EVs. This, along with concerns about residual values and longevity of batteries means that EVs are never seen as a sensible investment.

Concerns over electricity grids also hold back EV progress. Grids are believed to lack the necessary flexibility or capacity to support EVs. Furthermore, limited progress in decarbonising electricity undermines the green credentials of EVs.

The lack of enthusiasm for EVs encourages a focus on alternative technologies. The relatively limited ambition of emissions reduction policy means that incremental improvements to the efficiency of ICEs are sufficient to meet legislative targets.

4.4 Probable Scenario

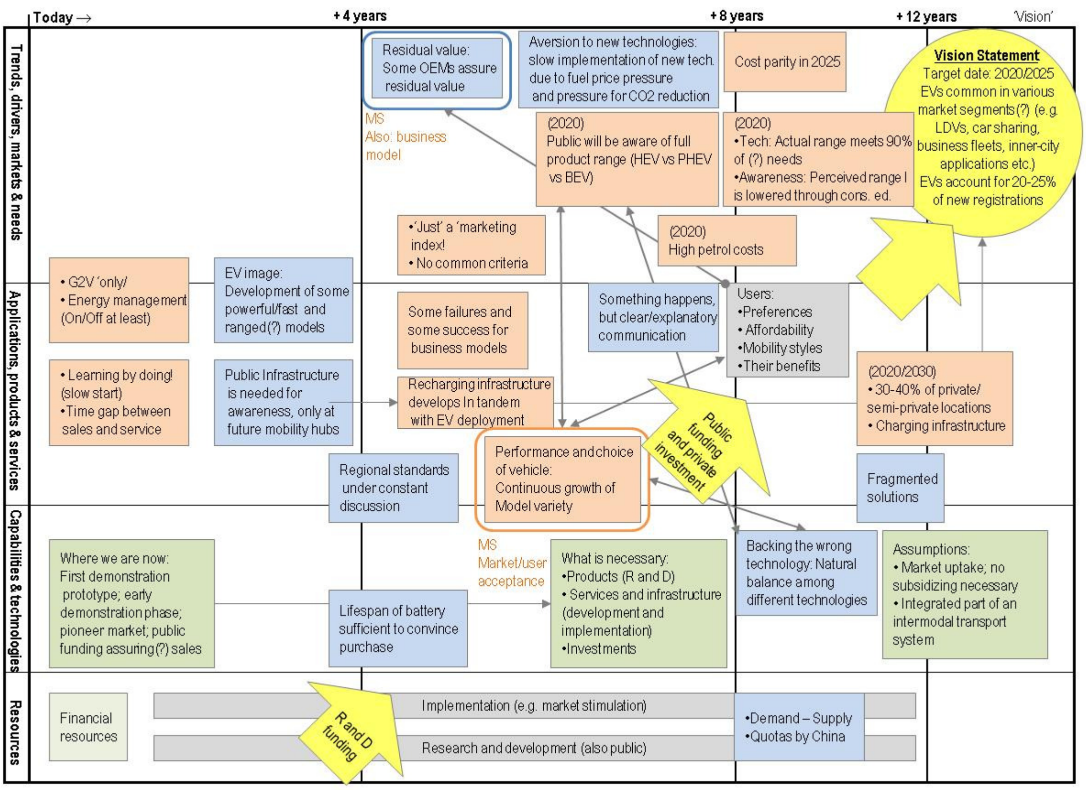

Figure 5: Group analysis of the probable scenario

The probable scenario foresees that EVs will be successful in certain market segments, with growth in adoption supported by multiple manufacturers offering an attractive range of vehicles. Increased levels of adoption are also encouraged by new business models that take into account the residual value of EVs.

The scenario recognises that the market of today is largely made up of large-scale demonstration projects and pioneer adopters. It is also characterised by a dependence on public subsidies and incentives. Moving beyond this requires improvements in products and a variety of offerings to customers. It also requires substantial investments. Key areas include the development of new technology, manufacturing facilities to scale-up production and provision of necessary recharging infrastructure.

It is anticipated that public funding for research, development and demonstration of EV technologies will decrease over the next four years. However, it is expected that investments in activities to stimulate markets will increase over the same period. This will be jointly funded by public and private organisations.

Links between EVs and smart grids progress incrementally. In the first wave of deployment there are no measures to influence or control charging behaviours. However, greater levels of adoption place a strain on local grids. While the overall capacity of the grid is sufficient, “adoption clusters” form seeing three to four vehicles simultaneously plugging in on individual streets at times of peak electricity demand. This creates a need for greater control over charging behaviours.

Public recharging infrastructure is steadily deployed with the primary purpose of providing reassurance against perceived needs for charging. Realising that this is essentially a confidence issue sharpens the focus on promotion and awareness raising. Coordinated communication and education campaigns ensure that the public are well informed about how and where they can charge an EV.

These communications initiatives also prove valuable in managing a series of negative incidents which may otherwise have seriously affected public confidence in EVs.

Finally, the probable scenario foresees that there will be steady decreases in the cost of batteries and EVs. However, cost parity with equivalent ICE vehicles is not reached until between 2020 and 2025.

5 Conclusion

The ranked list of priority barriers clearly identifies that, in the opinion of the workshop participants, the high purchase costs and lack of suitable business models for the provision of vehicles and recharging infrastructure are the main factors that will impact EV adoption. Interestingly, the top six of the eight priority barriers identified in Table 1, all directly affect a consumer's ability to purchase an EV. These relate to issues such as affordability (e.g. purchase cost, business models), practicality (e.g. lifespan of batteries, performance and choice of vehicles) and knowledge (e.g. public understanding, ability to value whole-life costs). However, all of the factors in Table 2 that are frequently identified as barriers but were not considered priorities in the workshop have a less direct impact on purchase decisions. This includes factors such as range anxiety and the green credentials of EVs, which are often cited by the media and commentators as problem areas for EVs.

The three scenarios developed in the workshop highlight the consequences of failing to address the factors identified in the analysis of priority barriers. For example, the best-case and probable scenarios predict that EVs will eventually reach cost parity with ICE vehicles. However, this does not happen in the worst-case scenario. Furthermore, the worst-case scenario highlights the dangers of failing to address concerns about residual values and educating consumers to value whole-life costs.

Each scenario draws attention to the importance of communication and education activities to increase levels of knowledge and understanding amongst the general public. The importance of this is also underlined by the predicted occurrence of "negative incidents" which if left unabated could seriously damage public confidence.

A key lesson that can be drawn from the scenarios is that it is far from certain that EVs will achieve mainstream market acceptance. The scale and rate of adoption of EVs is subject to a number of factors, some of which are outside the direct control of industry and policymakers. Nevertheless, the analysis undertaken in the workshop does provide a structured way to evaluate these issues and offers insights on the factors that may have the biggest influence in supporting future markets for EVs.

E: info@urbanforesight.org

W: www.urbanforesight.org

Urban Foresight Limited
Registered in England and Wales No.7705420
8 The Crescent | Newcastle upon Tyne | NE7 7ST | United Kingdom

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