Editorial: Electromobility at the crossroads

Carole Donada*

ESSEC Business School,
Av Bernard Hirsch, CS 50105,
95021 Cergy Pontoise Cedex, France
Email: donada@essec.edu
*Corresponding author

Yannick Perez

Centrale Supélec,
3 Rue Joliot Curie, Plateau de Moulon,
91190 Gif-sur-Yvette, France
and
RITM,
University Paris-Sud,
15 Rue Georges Clemenceau,
91400 Orsay, France
and
Department of Economics,
Helmholtz-Zentrum für Umweltforschung,
Yannick Perez 28 janvier 2016 10:36,
Permoserstraße 15, D-04318 Leipzig, Germany
Email: yannick.perez@u-psud.fr

Biographical notes: Carole Donada is a Professor of Strategy and the Head of the Armand Peugeot Chair at ESSEC Business School. She obtained her PhD from HEC, Paris. Her research interests focus on collaborative strategy, buyer-supplier relationships, and industry transformation. She is also working on the challenges facing by the automotive industry in the context of 'Electromobility 2.0'.

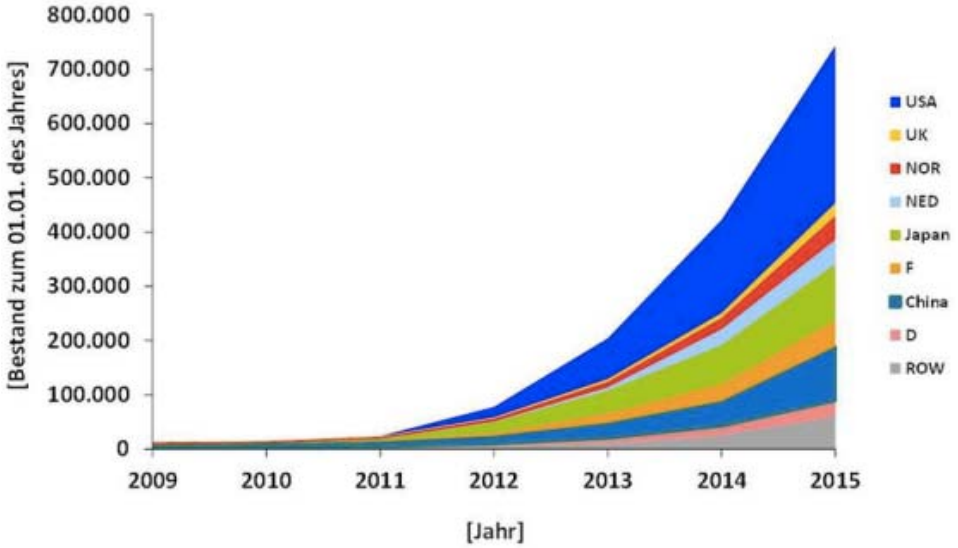
Yannick Perez is an Associate Professor in Economics, Research Fellow of the Armand Peugeot Chair (CentraleSupélec and ESSEC Business School) and Visiting Professor at Helmholtz-Zentrum für Umweltforschung, Department of Economics, Germany. He obtained his PhD in Economic from Sorbonne University in 2002. His research interests are on energy markets, electromobility and regulatory challenges.

1 Introduction

A recent study from the Centre for Solar Energy and Hydrogen Research Baden Württemberg (ZSW), reports that in early 2015 over 740,000 electric cars were on the road throughout the world (Figure 1). This is a drop in the ocean compared to the

74 million ICE cars sold last year. However, latest statistics on the sale of electric cars indicate that the market is booming with no less 320,000 vehicles registered in one year, as well as an exponential growth rate of sales worldwide.

Figure 1 Exponential growth of sales of EVs (see online version for colours)



These results came as no surprise to researchers from the Armand Peugeot Chair, who held the Second International Conference in Paris in December 2014. A previous issue of the *International Journal of Automotive Technology and Management* ('Electromobility challenging issues', Vol. 15, No. 2, 2015) called attention to the fact that the emergence of electromobility has generated three critical challenges for the markets, the industrial processes and the business models of the traditional automotive industry. More specifically, it discussed issues regarding innovation and service transition, issues regarding grid-integration and service-aggregator actions, and lastly issues regarding supportive public policies (Donada and Perez, 2015). How have these challenges evolved one year later, a year during which this new electromobility industry has been booming? This special edition presents five emblematic researches on the issues raised during the sessions of this 2014 conference.

2 Despite spectacular growth rates, the small size of the market remains the primary challenge for the industry

It is indisputable that electric vehicles (EVs) markets are expanding very quickly, with average growth rates exceeding 300%. This evolution, which is seen across all geographic areas, primarily benefits the historical manufacturers from the chain, such as Renault-Nissan, General Motors or Mitsubishi, who now cover nearly half the global market. This seems to indicate that the 'first-mover advantage' – a topic which has been developed extensively in existing marketing literature (Robinson and Fornell, 1985; Carpenter and Nakamano, 1989; Gómez-Villanueva and Ramírez-Solís, 2013) – plays a

determining role in this success. This is all the more true in the case of hybrid vehicles, a market dominated by Toyota market for nearly 20 years. Alongside, these historical automotive manufacturers, a new entrant and California-based start-up, Tesla Motors, is gradually gaining significant market shares, with nearly 57,000 electric cars sold in only three years. The success of this EV only company has been analysed and researched in depth (Mangram, 2012; Bohnsack et al., 2014; Weiller et al., 2015; Chen and Perez, 2015). Marketing and consumer-behaviour specialists attribute this success primarily to its bold product policy on the premium segment. The exterior design of the vehicle, which is both sober and stylish, attracts wealthy, environmentally-aware, conservative buyers, whereas its interior design, with the large flat screen integrated in the dashboard, seduces wealthy young, technophile buyers. For scholars in strategy and industrial economics, success of the start-up can be explained by its strategic choice of a fully mastered vertical integration, a policy of alliances to find the right financial, productive and technological resources, and most importantly, its disruptive innovation strategy. Researchers also attribute its success to the fact that Tesla Motors was able to develop its ecosystem and mobilise evangelists, who do not hesitate to promote its position as a central shaper in the industry of the mobility of the future. To go a step further, Carole Donada and Jan Lepoutre conducted research into the Tesla Motors case, which is published in this special issue.

Despite the spectacular growth in sales of EVs, we should not forget the actual size of the market, which represents less than 1% of all car sales in 2014 worldwide. This limited size is the greatest challenge to the development of electromobility. This challenge is all the more strategic in that EV business models that are all defined based on breakeven calculations requiring large volumes sales. This is the case of automotive manufacturers, of course, but also for manufacturers of charging infrastructures and batteries (Bohnsack et al., 2014; Donada and Attias, 2015). In this context of uncertainty in terms of volumes and due to the financial risks linked to the considerable investments required to develop EVs, there has not yet been any return on investments. It appears that the manufacturers who are most successful are car-battery suppliers who shared a global market of approximately €2 billion in 2014.[1] This is in part due to the fact that these suppliers belong to large industrial, multi-activity groups, whose business units dedicated to EVs benefits from scale and scope economies on their entire business portfolio. In such a context, then, Tesla Motors' strategic choice for vertical integration upstream production confirms the relevance of the positioning and the legitimacy of their being a part of the industry.

For automotive manufacturers and charging-infrastructure manufacturers, the situation however is quite different. Only those incumbents with sufficient cash reserves can take the risk of waiting for the market to be large enough to reach acceptable breakeven points for EVs. When will this happen? When will the mismatch between supply and demand in EVs be overcome? These are the questions explored by Heike Proff and Thomas Martin Fojcikin an article which we selected for this special issue. Policies to support demand are an important market driver, and this point will be developed in our third section dedicated to the challenge of public policies. However, as underlined by Proffand Folcik, there is a mismatch between supply and buyers' needs, and therefore for the demand for EVs by consumers. We agree with these authors that manufacturers need to change the way they design their offers, by moving away from 'push strategies' and favouring 'pull strategies'.

The strongest push strategy in the history of the automotive industry was the strategy developed by Henry Ford, with his famous word 'Any colour, so long as it's black!' Today, no manufacturer would admit to pushing products. Instead, they underline their dedication to the needs and demands of consumers, illustrated by the significant resources they allocate to advanced marketing and prospective R&D cells. However, the study conducted by Proff and Folcik demonstrates that in Germany the models offered do not match demand, and that greater research on customers would provide better grounds to implement pull strategies, and therefore enhance sales prospects. Here again, the pull strategy implemented by Tesla Motors is in line with this movement because the product meets a very specific and very real demand for "a future where cars and computers coexist in seamless harmony"[2]: "The screen is the hero. We are in the midst of that transition toward a new way of thinking. For me, it's that iPhone moment."[3]

3 Above and beyond the challenge of the vehicle: the challenge of energy and charging

One of the greatest impediments to the development of electromobility is the issue of the range of EVs, and by corollary, the existence of adapted charging infrastructures, or rather the lack thereof. This issue has been discussed by a number of researchers (Kempton et al., 2014; Marrero et al., 2015; Codani, et al., 2015). This particular challenge is pledged by a 'chicken or the egg' dilemma: without the massive deployment of EVs, there is no need for charging infrastructures; but without charging infrastructures, the sales of EVs are hindered by the lack of charging solutions and the limited range of EV's.

The impediments derived from energy and charging issues, though very real, are, to a large extent, perceptual. Recent research, conducted in 2014 by Avere/Ipsos[4] on the case of France, demonstrates that 78% of French motorists drive an average daily distance of 31 km. For 54% of them, an electric car, whose distance range has now reached approximately 120–150 km, would be perfectly suited. Despite this, and out of a conservative reflex, or fear of breaking down and due to 'range anxiety', buyers demand vehicles with a range equivalent to the autonomy provided by traditional ICEs.

Faced with this paradox, and due to the lack of an acceptable technical and economical solution, EV manufacturers have developed two very different answers. On the one hand, some manufacturers organise targeted information campaigns insisting on the fact that the need for greater range is grossly overrated. Their goal is to help align consumer demands with actual consumption needs as opposed to notional consumption. On the other hand, other actors, like Elon Musk, the head of Tesla Motors, want to shift the emphasis and attention onto the customer, through a pull marketing approach. The Californian manufacturer promises to 'end range anxiety' with cars having up to 400 km driving range, and applications which will make it 'effectively impossible to run out of range unintentionally' and, most importantly, a very developed network of ultra fast-charging infrastructures (20 minutes), where users can charge their vehicles freely. Nissan also takes this matter seriously, and is now presenting itself as the largest investor in charging stations in the world throw an agreement with the Spanish energy provider Endesa.

The choices made by manufacturers who have chosen to invest in digital infrastructures (data platforms and applications) and in physical infrastructures (charging

stations) are of great interest to researchers. First of all, these choices challenge the vertical integration strategies and the value chains of the traditional automotive industry. The perfect distribution of business between car manufacturers and companies providing the petrol required for the mobility of these cars has disappeared. Companies like Tesla Motors or Nissan made the strategic decision to integrate a complementary business line. This would indicate that investments in charging infrastructures call for further research into the diversification strategies implemented by companies and their potential, trade-off and strategic decisions.

Similarly, EVs also challenge the development strategies implemented by electric network operators who invest in smart grid environments. Traditionally, the owners and administrators of power grids benefited from a de facto exclusivity in the development and technical management of electric grid infrastructures for a demand that was both known and predictable. But with the development of EV fleets (cars, buses, bikes, etc.), these grids now have to face three new demands (Codani et al., 2015). The first is a demand for energy because electromobility is a source of additional electrical consumption, although this does not yet represent a significant volume due to the limited size of the battery. A second demand, which is more complex to address, has to do with the instantaneous maximum capacity issues within electric distribution networks to host new charging stations which, depending on the intensity (i.e., the speed) of the charging capacities could, in turn, lead to congestion, or worse still, have a negative impact on the quality of electricity in some soft point of the electrical grid. Finally, EVs entail a demand for innovation and new energy services, either the level of households (VtoH), buildings (VtoB), or the grid (VtoG).

If the rules of electric grid operators were open and adapted to this new situation, then the fleets of EVs could then actively participate in the management of electrical transmission and distribution networks. An innovative solution to reducing the total cost of ownership (TCO) of an EV is to use it as a storing resource for the management of the electrical grids. Note that, theoretically, EVs can be connected to the network in order to charge for up to 95% of the time, which is more than sufficient. These vehicles, which are not running and are connected to the network, are referred to as a grid-integrated vehicles (GIV). Of course, in order for them to be mobilised by the grid operators, GIV must have specific communication means and variable charging regimes, and they must also be able to re-inject energy into the grid (V2G).

The issues raised by the integration of vehicles within the network do not only concern engineers. They also call for decisions to be made in terms of product innovation which involve automotive manufacturers and grid operators in very specific strategies. Therefore, among the many services which EVs could offer to grids on a competitive basis, Kempton and Tomić (2005) demonstrate that the best suited solutions, both from an economic and technical viewpoint, are spinning reserves (primary and secondary) in order to regulate frequency. The technical (Sortomme and El-Sharkawi, 2012; Vandael et al., 2013) and economical (Dallinger et al., 2011; Han et al., 2012) aspects of this solution have already been studied at length in existing scientific literature, and a number of experiments have already been implemented in the USA (California and Delaware), in Europe (Denmark) and in Asia (South Korea). In this special issue, we have selected a paper which provides greater insight into the work conducted in this line of research by analysing how fleets of EVs could contribute to the very sensitive management of the intermittent nature of renewable energies.

4 Greater dependency to public policies

All these challenges for the growth of markets and energy-related issues manifest the need for changes which can only be considered on a very large scale, and with the appropriate public policies supporting the deployment of these innovations and electromobility. During the EVS 28[5] Symposium in Korea, speakers on this topic reminded representatives of public organisations that all actors involved were still highly dependent on this support. The dominant discourse insisted on the fact that even if the EV market seemed to be taking off, it was imperative that public subsidies be maintained. The most-quoted reference during recent academic or corporate events on EVs is, of course, the case of Norway, where the spectacular success of electromobility can be explained to a great extent by the bold political stance adopted by the country (Figenbaum et al., 2015; Haugneland and Kvisle, 2015; Holtsmark and Skonhoft, 2014). The Norwegian success story has inspired many governments who are currently working to refine their actions to support the demand and the supply of EVs, and to help structure a sustainable business network.

Actions designed to support demand focus on two levels. The first consists in demand size action by supporting the purchase of EVs, by means of one-off benefits, such as one-off purchasing bonuses (e.g., in France, Ireland, Italy, Portugal, the UK, China, and the USA), tax benefits for re-selling (e.g., in Norway, Netherlands, Portugal, China, and Japan), or tax benefits when registering an EV (e.g., in Austria, Denmark, France, Ireland, and Norway). On top of these bonuses, there are also recurring advantages. Among other things, they come in the form of road tax benefits (e.g., in Germany, Italy, Netherland, and the UK), preferential parking rates (e.g., in Norway, Portugal, France, and China), privileged access to electricity (e.g., in Italy and China), or dedicated accesses in transport areas (e.g., in Norway, Portugal, and China). The second level consists in supporting action for recharging possibilities throw a national network. For example, there are subsidies for the setting up of charging stations in private and public locations, or coordination operations between the owners and managers of charging infrastructures and cars in need of charging stations.

Actions designed to support the supply of EVs and to help structure a sustainable business ecosystem for the development of electric mobility are even more widespread. They come into play at a variety of levels, ranging from local government (for example, the provision of public space for car-pooling in a municipality) to international programs on standardisation agreements, protocols of data or standardisation rules. Finally, structuring actions consist in facilitating exchanges and collective work by integrating all the stakeholders of electromobility: companies from the automotive industry, companies from the energy and transport industries, urban planning and the management of spaces, connected services or personal services, and financial or insurance companies.

Despite important public efforts in recent years, the detailed analysis of all these actions in the work of Leurent and Windisch (2011, 2013), reveal there is still a very marked disparity of practices, and significant challenges to coordinate them at the scale of broader or extended territories.[6]

These three main challenges were discussed by researchers at the Second International Conference of the Armand Peugeot Research Chair on electromobility, held in December 2014 in Paris. With this special issue, we wish to share the results of some of our discussions with the rest of the research community involved in electromobility. The first two papers enrich discussions on the first business challenge outlined in this

editorial. The third provides new elements for discussion on the energy challenge. The two last contributions focus more explicitly on the challenges of public policies, be it in North America or in Europe. Each of these five contributions are summarised in the following paragraphs

The paper by Carole Donada and Jan Lepoutre is the first one of our special issue. The authors start by defining the topic of their research, i.e., Electromobility 2.0, which they analyse through the lens of three dimensions: a technological dimension, a relational and behavioural dimension and a business model dimension. The authors then go on to analyse the extent to which the electromobility industry presents all the characteristics of a nascent industry. This leads them to reflect on potential shapers of this industry and the role of start-ups which display strong activism in favour of developing electromobility. In order to explore this, the authors analyse the development of two start-up companies, Tesla Motors and Better Place, using the theoretical framework provided by Santos and Eisenhardt (2009) on the shapers of nascent industries. The analysis of these cases highlights how the construction of legitimacy is the starting point of any adventure in a nascent industry such as electromobility. Secondly, the construction of a reputation is the anchor point for taking part in the design of the frontiers of competitive territories, and consequently for establishing strategic alliances without which demarcating and controlling the market would not be possible. Thirdly, the case study analysis clearly pinpoints the importance of all the efforts designed to provoke change and in particular entrepreneurial and communal activism.

The paper by Heike Proff, Thomas Thomas and Martin Fojcik's discusses the pricing and commercialisation of EVs in a context of high market uncertainty. This research highlights the mismatch between supply and demand in EVs in Germany and examines how better information about customers can be acquired by car manufacturers in order to define future offers. After convincingly demonstrating that the pricing and commercialisation policies of EVs are not adequate in Germany, the authors go on to describe the specificity of EVs, i.e., the fact that they are really new products whose distribution success is still very uncertain. They also provide a comprehensive analysis of existing literature on the limitations of traditional methods to reduce uncertainty; which leads them to offering an original method of 'information acceleration' in order to improve the knowledge base of and about customers for really new products. We believe the primary contribution of this research is the relevance of the empirical study which was developed based on a 'test studio methodology'. The authors set up a 'car clinic' where they undertook to examine the behaviour of test populations selected through research. The observations and data gathered from interviews collected during the experiment highlighted "a positive relationship between giving information to the customer and having better information about customers and thereby broadening the decision-makers' knowledge base for really new products". This contribution echoes our comment above on the limitations of 'push' marketing strategies and the need to think in terms of 'pull' strategies in the case of electromobility.

The paper by Paul Codani, Pierre Louis Le Portz, Pierre Claverie, Yannick Perez, and Marc Petit explores the potential of EVS fleets to run with a 100% green charging ratio in France in 2020. The authors build their work on the combination of two evolutions perceived as a risk by network operators. First, there is the continuously increasing share of intermittent and unpredictable renewable energy sources in the production of energy mixes, especially in the case of photovoltaic panels and wind farms. Similarly, the

expected strong development of battery EVs is seen as a threat for the distribution grids management. Undoubtedly, these two new innovations could trigger local security issues on electrical grids. One way to mitigate these problems could be to combine the charging periods of the EVs with the local renewable energy sources (RES) production and to combine these two dangers intelligently so they can compensate one another. Their paper aims at analysing the possibility of implementing this type of smart-charging strategy in France by 2020, taking account of the wide diversity of local energy mixes in France and their seasonal dependencies. Their results show the maximum achievable green-charging ratio for the EV fleet per season and per region, with and without a smart charging strategy, thereby demonstrating the extent to which EV fleets could represent a significant contribution to grid stability in the presence of massive RES.

In their paper, authors Anastassios Gentzoglanis and Philipe Dumont-Lefrançois tackle the paradox of the increasing trend in the demand for EVs but with limited consumer choice compared to the gamut of conventional cars. The demand for the latter is still growing, despite their negative impact on the environment and government policies to incentivise the reduction of their use. The authors examine the consumption patterns of the Canadian commuters who travel by car. They estimate the demand for car transportation services for the province of Quebec and make simulations to predict the evolution of this demand through to 2040. The estimations of the 'baseline scenario' are made using some key variables such as car price, annual kilometres driven, and the price of substitutes such as public transit. In their first simulation, there is no government intervention to modify the consumption patterns of drivers. A second model is used to investigate the impact of the pollution permits on the demand for vehicles. Finally, they provide an analysis of the new Quebec-California Caps and Trade (C&T) market and provide an empirical estimation of its impact on the demand for cars and on the environment.

Julia Hildermeier raises the question: 'Which role should the electric car play in Europe's cities?' An analysis of publicly funded demonstration projects between 2007 and 2013 will close our special issue. In this paper, the paradox of the European car market is analysed. Despite considerable public investments in electric-vehicle development and demonstration, no mass market is apparent yet. Many European governments struggle to fulfil their national objectives set for 2020. One reason for this is that there are no clear patterns of how EVs will be used. In this paper, Julia Hildermeier explores the assumption that in those cases where 'demand-pull' is lacking, publicly-funded demonstration projects play a major role in shaping EV use and acceptance. Based on a first explorative study, the author compares all EV projects co-funded by the European Union between 2007 and 2012. The results show that most EU projects 'think' of the electric cars as a mere substitute of ICT vehicles. Few demonstration projects have created alternative mobility patterns such as e-car-sharing or intermodal integration with public transport and bikes in cities.

Of course, our second special issue of the *International Journal of Automotive Technology and Management* on electromobility is by no means comprehensive and fails to address a number of issues, and many contributions in the form of papers, workshops and conferences are to be expected in the future. Last year, our aim was to pave the way for diverse and timely scientific works with a view to improving our understanding of the challenges inherent to electromobility. The community of researchers working on this topic is growing every day and research is being enriched with new theoretical frameworks and empirical analyses. For that reason, we hope to continue to pursue this

undertaking with renewed interest, and hope to be able to continue furthering this goal in the future.

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Notes

1 According to the ZSW.

2 http://www.businessinsider.com/consumer-reports-tesla-model-s-best-overall-car-2014-2#ixzz3fIcR8znU.

3 http://www.bloomberg.com/bw/articles/2013-07-18/the-tesla-electric-cars-creators-chase-their-iphone-moment.

4 Ipsos survey 'French people and electric mobility', 2014. See more at: http://www.mobiviagroupe.com/fr/sondage-avere-et-mobivia-groupe-2014-resultats-de-lenquete-sur-les-francais-et-la-mobilite-electrique/#sthash.UIHffvQw.dpuf.

5 EVS 28: Symposium for Electric Vehicles – May 2015, Korea [online] http://www.evs28.org/.

6 This strategic issue is tackled by Julia Hildermeier then by Anastassios Gentzoglanis and Philipe Dumont-Lefrançois in two papers which have been included in this special issue.