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Editorial

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1 Introduction

Today, electromobility is no longer a hypothesis in a set of prospective scenarios on the transformation of the automotive industry. It is an economic, technological and political reality based on the emergence and structuring of a business ecosystem comprising many actors dealing with energy transition, original equipment manufacturers (OEMs), public policies, electricity network managers, mobility service providers and consumers. This reality is a part of the transformation of society stimulated by the convergence of multiple

decisions in international negotiations on climate change (the Kyoto Protocol and the subsequent conference of parties), on pro-active national public policies to foster the decarbonisation of personal road transport (see Table 1) and on regional regulation towards the reduction of CO₂ emissions (such as in Europe and California). Imprecise and often non-aligned with one another in the past years, these political decisions are nowadays becoming more determined and focused, thanks to the initial perceived benefits of electric vehicles (EVs¹). Therefore, mayors of large cities who want to decrease noise levels and improve the air quality (as electricity-generating plants are typically located some distance away) do not hesitate to restrict the use of thermal cars in city centres. Such decisions have a direct impact on the economy of electromobility. For example, the decision to restrict access to the city of Paris during peak pollution days seems to be positively correlated with the 2017 growth sales of EVs (e.g., Renault EV Zoe) both in the Paris area and at the country level. Beyond these environmental concerns, changes in the lifestyles of urban area inhabitants and the general development of the internet of things considerably favour the emergence of electromobility (Donada and Perez, 2015, 2016).

Table 1 BEV and PHEV incentive developments in selected countries, 2016 (see online version for colours)

Country	2015 vs. 2016 policy developments		2015 vs. 2016 sales growth		2016 sales	
	BEV	PHEV	BEV	PHEV	BEV	PHEV
China	~		75%	30%	257,000	79,000
USA	~		22%	70%	86,731	72,885
Norway	~	↗	6%	164%	29,520	20,660
UK	~		4%	42%	10,509	27,403
France	~		26%	36%	21,758	7,749
Japan	~		48%	-34%	15,461	9,390
Germany	~		-6%	20%	11,322	13,290
Netherlands	~	↘	47%	-50%	3,737	20,740
Sweden	~	↘	0%	86%	2,951	10,464
Canada	~		19%	147%	5,220	6,360
Denmark	↘		-71%	-49%	1,218	182
Korea	~		75%	-40%	5,099	164

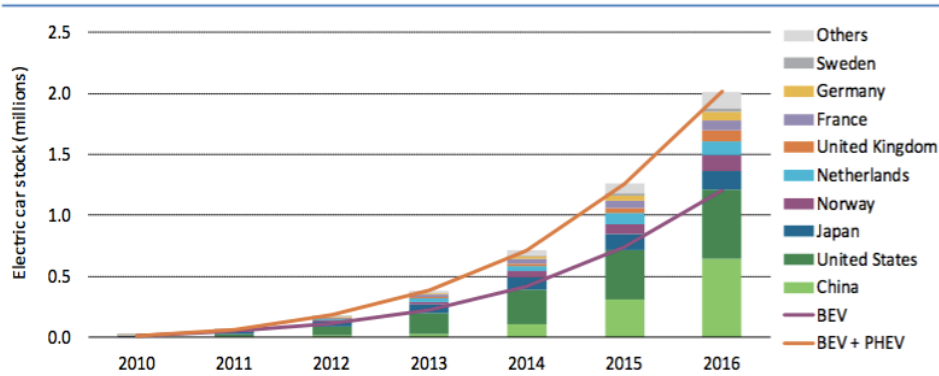
Notes: The symbol ~ indicates no major observed change in electric car support incentives between 2015 and 2016, an upward arrow indicates an increase in electric car support incentives; a downward arrow indicates a drop in electric car support incentives. The green and red colours indicate a probable correlation between the developments in electric car support incentives and BEV and PHEV sales in 2016 compared to the previous year. Greater details on the policy context are available in the main text. PHEV sales in Denmark and Korea are available from primary data sources in conjunction with hybrid and electric vehicles (HEVs). Consequently, PHEV sales shown in this table for Denmark and Korea rely primarily on estimations based on the sources listed below and may be underestimated.

Source: International Energy Agency (2017), IHS Polk (2016) and Markit and Marklines (2017)

In this context, the market for electromobility is growing. Sales are steadily increasing, as evidenced by the latest statistics from the Global EV Outlook (see Figure 1).

Despite the obvious growth in EV sales, however, differences in growth rate forecast remain significant over the longer term (see Figure 2). These differences are related to variances in the perceptions of the uncertainties created by three main obstacles.

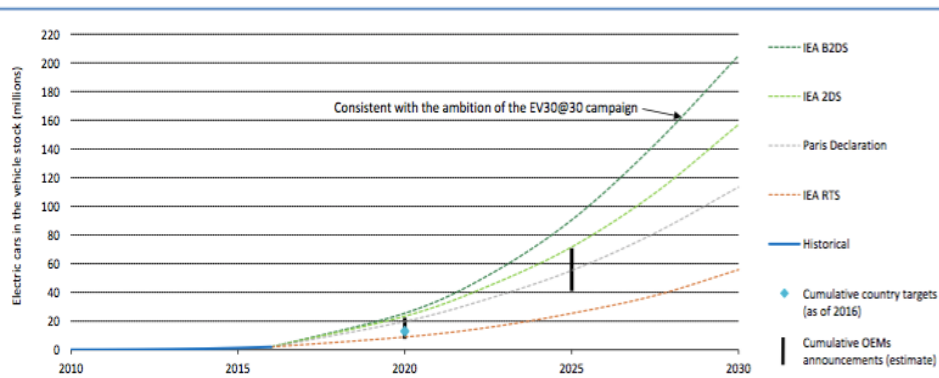
Figure 1 EV sales in select countries and regions (see online version for colours)



Notes: The electric car stock shown here is primarily estimated on the basis of cumulative sales since 2005. When available, stock numbers from official national statistics have been used, provided good consistency with sales evolutions.

Source: IEA (2017)

Figure 2 Comparison of the historical and projected EV market evolution (see online version for colours)



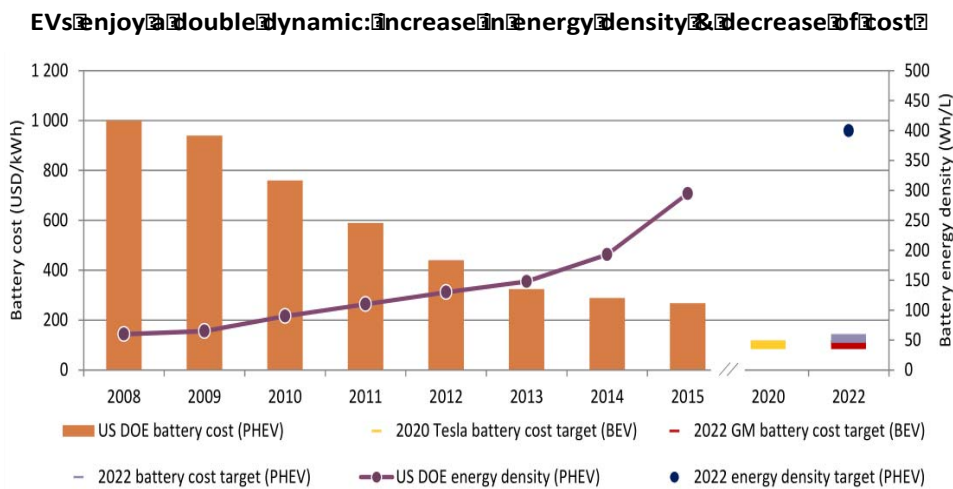
Source: IEA (2017)

The first obstacle is related to energy transition policies. Most public authorities encourage that EVs (from micro-hybrid technology to full EVs) participate in the reduction of greenhouse gas emissions. However, these reductions depend critically on the technology used to produce the electricity and the components of the vehicle itself. If most of the electricity can be produced using renewable energy sources (solar, wind, etc.) the reductions in greenhouse gases will be high, and decision makers will continue to

sponsor electromobility growth. Contrarily, if the dominant technologies are coal and oil, the reduction will not happen² (Eurelectric, 2015), and we can assume that subsidies to develop the market will decrease.

The second obstacle is the purchasing cost of an EV. Although the total costs of EVs, including their lower cost of usage, are not as significant as those of internal combustion engine vehicles (Kempton et al., 2014), their upfront cost of acquisition remains higher. The main cause of the high price levels of EVs is the high cost of a cell battery pack, which represents 50% of the total costs. Ensuring a competitive purchase price therefore largely depends on the evolution of battery costs. To get around this obstacle, some companies are beginning to spread the cost of the battery, which is being granted under lease or the creation of shared EV services. They are also financing massive research programs on less-expensive technological options. From their findings, battery experts estimate the pursuit of significant cost reductions in the coming years. From \$1,000 per kWh in 2008 to \$100 in 2020 (see Figure 3), a major breakthrough is taking place in this technology and should facilitate market penetration (IEA, 2016). However, for the time being, the cost of batteries remains a bottleneck to the massive adoption of EVs. As such, electromobility companies continue to ask for subsidies not only for those who invest in battery R&D and manufacturing but also for those buyers who are ready to purchase EVs.

Figure 3 Evolution of the cost and performance of EV batteries (see online version for colours)



Source: IEA Global EV Outlook (2016)

The third obstacle in the massive diffusion of electromobility solutions is the limited range of autonomy compared with that in internal combustion cars. This issue induces range anxiety in vehicle owners who fear not being able to reach a charging point before their car battery becomes empty. This obstacle is mainly due to two bottlenecks that threaten the entire electromobility ecosystem: the low energy density of batteries and the lack of recharging infrastructure. Some car and battery OEMs are competing to solve the battery bottleneck. They invest in new resources and competencies, and they innovate to transform technical challenges into business opportunities. The bottleneck caused by the relative slow development of adapted recharging networks can be overcome with the

rollout of dedicated infrastructure. Although in some cities (such as London, Rome and Berlin), small networks exist for quickly recharging vehicles, the spread of such national or international networks is still rather slow, and the role of public authorities to support investments is obvious. Again, some incumbent firms have chosen not to wait for public spending decisions to materialise and have opted for direct investments in the charging system bottlenecks at a very large-scale (e.g., Nissan or Tesla). Besides, more and more charging points are being installed in private houses; however, these are low power, and not all EV buyers can benefit from the privilege of having their own charging station at home. Finally, interoperability between systems is difficult to implement because each firm attempts to impose its technology, and public regulation and standard definition are clearly necessary.

The last two obstacles (the high purchasing cost and the limited range of EVs) are linked and create a chicken and egg dilemma: without the massive deployment of EVs, charging infrastructure is unnecessary, but without charging infrastructure, the sales of EVs are hindered by the lack of charging solutions, and the actual limited range of EVs will only dedicate them as the second car of the family or as one component in commercial fleets. Without volume, no scale effects and low cost reduction will occur, and purchasing prices will remain too high.

Researchers of the Armand Peugeot Chair on electromobility have been working for several years on this chicken and egg dilemma. Over the years, their work has identified ways to better measure its impact or to provide a workaround for certain issues. In previous special volumes of the *International Journal of Automotive Technology and Management* about electromobility (Donada and Perez, 2015, 2016), we dealt with various issues about niche markets (Marrero et al., 2015; Codani et al., 2015), business models (Donada and Attias, 2015; Weiller et al., 2015; Donada and Lepoutre, 2016; Proff and Fojcik, 2016), industry dynamics (Gentzoglanis and Dumont-Lefrançois, 2015), consumer preferences (Chevalier and Lantz, 2015) or national or local policies dimensions (Haugneland and Kvisle, 2015; Hildermeier, 2016).

2 The contents of this special issue

The papers selected in this additional special issue attempt to open new directions of research by investigating complementary solutions to mitigate the chicken and egg dilemma in the electromobility industry. They are therefore in the dynamics of the previous special issues (Donada and Perez, 2015, 2016).

The first paper by Vazquez, Hallack and Perez, ‘The dynamics of institutional and organisational change in emergent industries: the case of electric vehicles’, questions the kind of dominant organisational design that favours the evolution of the EV industry. The authors show that as in many other industries, several organisational structures compete for survival in the emergent phase of the EV industry. Firms must choose among competing architectures, and Vazquez, Hallack and Perez analyse this issue in terms of the modularity versus integrality choice. The authors consider that regulatory institutions emerge from the interaction between firms’ organisational choices and rule makers’ beliefs. To understand the main elements involved, the authors use the institutional analysis and development (IAD) framework. In the IAD, the main driver for regulatory change is the evaluative criteria or the rule makers’ simplified model against which

outcomes are evaluated. Using this model, Vazquez, Hallack and Perez seek insights that allow us to understand the organisational dynamics of an emergent industry.

The second paper by Marcocchia and Maniak, 'Managing 'proto-ecosystems' – two smart mobility case studies', considers how to manage common systemic, disruptive innovation-based research projects for building seamless customer experience and for hybridising and connecting offers for successful innovation deployments. Such projects regroup heterogeneous organisations that co-invest upfront and share uncertainties and benefits to demonstrate the short and long-term business viability for all additional contributors who join the initiative. The study is based on a literature review of innovation management, ecosystem, public-private partnership and two European Commission-funded research projects aiming at the development of smart mobility infrastructure. The results show that co-innovation-based research projects are both critical and disappointing for their actors. Marcocchia and Maniak explain this paradox by showing that partners need such ecosystem projects to go forward and update their competencies and roadmaps. However, the benefits are limited by the management routine, which hampers the collective learning and evolution of the strategic agenda of each partner. As a contribution, the authors propose the notion of a proto-ecosystem as an intermediary management object for innovation management. They also emphasise several implications of managing such projects to unfold their full potential for mobility projects.

The third article selected is Donada's, 'Leadership in the electromobility ecosystem: integrators and coordinators', which analyses the strategic options in the EV nascent business ecosystem. In this setting, the position of firm leadership is not assigned *per se*. The study shows how firms differ according to their strategic choices and ability to align their business model with their resources and skills, as well as with the collective imperatives of the ecosystem. Based on resource-based, innovation and strategic management theories, the study suggests the following hypotheses: first, the stakeholders that master the greatest number of resources and skills required to offer sale bundles (i.e., integrators) are best positioned in the race to leadership because of their capacity and ability to control resources; second, and by contrast, those stakeholders that are best able to coordinate with the community as a whole (i.e., coordinators) may take precedence. Finally, the study ends with an open research area, and even the in-depth analysis of the strategic paths of several organisations within the electromobility ecosystem offered here does not provide sufficient evidence to choose between the hypotheses.

The fourth is the paper by Fournier, Baumann, Gasde and Kilian-Yasin, 'Innovative mobility in rural areas – the case of the Black Forest'. It explores the potential of EVs to limit exodus in rural areas in Germany. These zones lack well-structured local public transport systems, and the study analyses if the German energy transition, with 1 million EVs on German roads by 2020, will be a solution to this problem. The aim of the study is to analyse how innovative forms of EV-based mobility can better meet the needs of rural communities and contribute to the German energy transition in a sustainable way. Specific mobility concepts are tested according to sustainability criteria within a government-funded pilot project in four small communities in the Black Forest. The collected data are used to calculate energy consumption, carbon footprint and the costs of local projects, as well as to compare them with those of fossil-fuelled propulsion systems. Fournier, Baumann, Gasde and Kilian-Yasin's study proves that EVs already represent socially and environmentally promising perspectives in rural areas. However, they also

show that the economic drawbacks of the presented mobility solution are currently still hindering the extensive spread of EVs.

The last paper by Izadkhast, Garcia-Gonzalez, Frías, Bauer and Ramírez-Elizondo, ‘Evaluation of aggregate models of plug-in electric vehicles for primary frequency control’, summarises and evaluates the models of plug-in EVs for the primary frequency control literature. A basic aggregate model is introduced by the authors, and then they gradually develop their study in the following steps: first, the technical characteristics of plug-in EVs are analysed; second, the technical characteristics of distribution networks are added; and, lastly, a strategy is described to design the technical controller of plug-in EVs for primary frequency control. The authors also discuss this issue from an economic perspective and propose a method to assess the benefits which could result from plug-in EVs for primary frequency control. Finally, the authors present some simulation results to show that aggregate plug-in EVs have a great potential not only to improve frequency response but also to save on some costs associated with primary frequency control.

Many contributions in the form of papers, workshops and conferences are expected in the future to complete and challenge our works. We are pleased to see that the community of researchers working on this topic is growing and that interdisciplinary research is being enriched with new theoretical frameworks and empirical analyses.

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Notes

- 1 EVs are both battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs).
- 2 Some debates also exist on the maximum battery capacity, and in the case of a personal car, more than 90–100 kWh seems to be the upper limit with actual technologies to achieve CO₂ reduction when the car is in use.