CORRI-DOOR PROJECT: DID IT REALLY BOOST THE FRENCH ELECTRIC VEHICLE MARKET?

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Overview

Greenhouse gas emissions, especially CO_2 emissions generated from fossil fuel based equipment, have received the attention of worldwide governments in recent years. In 2017, global CO_2 emissions rocketed to 32.5GtCO_2, the highest value recorded in modern history and an increase of 1.4% compared to 2016. Meanwhile, however, the EU's emissions have been gradually decreasing in the past decade. In order to stop the global increase in emissions, 196 countries signed the Paris Agreement in 2015 with a major goal: to stop the increase in the global average temperature. According to the IAE (2016), approximately one third of the CO_2 emissions is related to the transportation sector in the European Union and all over the world. One solution to decarbonize the transportation sector is therefore to move away from fossil-fuel based transportation, and switch to electric forms of transportation, especially when the origin of the electricity produced is itself carbon-free...

In order to facilitate this switch to carbon-free transportation, the EU has installed a car emissions regulation, in which fostering the development of Plug-in Electric Vehicles (PEV) and charging infrastructure are a major transportation priority. Furthermore, the European Commissionis considering extending its vehicle CO_2 regulations to 2025 or 2030 to promote PEVs, among other policy approaches. In this way, the objective is to replace Internal Combustion Engine Vehicles (ICEV) with PEV of various types (pure electric or hybrid) and thereby radically decrease CO_2 emissions and boost air quality especially in urban cities.

In addition to these supply-side regulations, to stimulate PEV sales, governments have also introduced various demand-side measuresto encourage clients to buy these types of vehicles. Norway, for example, which has the highest market share of electric vehicles, has been applying the "Enova" program since 2009. Through this program, it exempted PEVs from all types of taxes, VAT and tolls additionally to offering free access to road ferries and bus lane lines. Generally, European countries will start prohibiting the sales of ICEV by 2030 (Netherlands), 2032 (Scotland) and 2040 (France and the United Kingdom). Despite these measures, range anxiety, orthe fear to have insufficient power to reach one's destination and/or the ability to recharge in comfortable waysis still cited as the main hurdle for PEV adoption. In this paper, our aim is to understand how the roll-out of recharging infrastructure plays a role in PEV adoption.

In order to seek answers to this research question, our starting point is that recharging can operate in different "modes". It is known that, according to IEC 61850: international standard defining communication protocols for intelligent electronic devices at electrical substations, there are three levels (1 for slow, 2 for fast and 3 for extra-fast) of charging points as well as four modes (1 for home, 2 for semi-public locations (supermarket,…), 3 and 4 for public location (corridors)). These modes also differ in thecharging time: depending on the mode, charging time can range from a few minutes to several hours. In France, for example, a consortium of a utility (EDF) and several OEMs (BMW, Nissan, Renault, and Volkswagen) tried to solve the "range anxiety" by launching Corri-door project.The goal of this project is to boost the PEV market share by installing more than 200 fast chargers (mode 4) on corridors (highways) all over France. The target was to encourage drivers to use PEV in their long trips without fear of a black out in the middle of the trajectory. This paper will present a techno-economic literature review about the situation of the electric vehicle market as well as the increase of charging stations number in France based on PEV sales and charging points locations data. Regarding the situation in France, in 2018, the most bought PEV are repectively Renault ZOE, Nissan LEAF and BMW i3. Moreover, a model of the PEV sales will be identified than takes into account all the parameters that may influence on the consumer to purchase this type of technology.

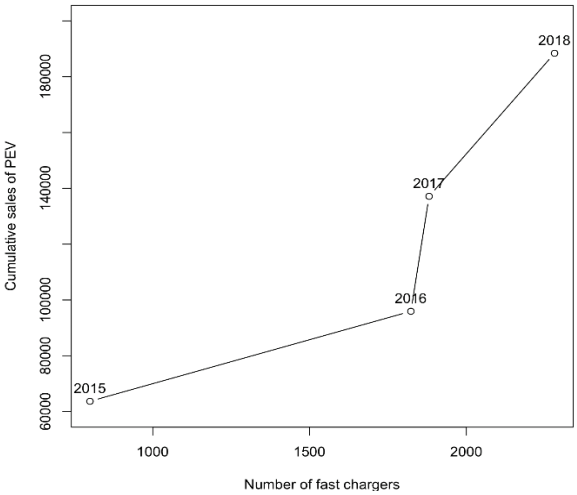

Figure 1 Relation between numbers of PEV and the number of fast chargers in France (Data from Groupe PSA)

Methods

To begin with, we identified the input data that will be used in this paper:

1. PEV model, year of manufacturing, sales (Data from Groupe PSA) and other data which will be added such as type (BEV, PHEV), battery capacity and autonomy, socket type adaptability (CCS, ChaDeMo, etc.)
2. Charging points: normal (< 22 kW) and fast (> 22 kW) (Data from European Alternative Fuels Observatory)

Using this software, we concluded about a primarily linear model. We tried to identify the significant variables. Thus, this section will elaborate three main models:

Model 1: $Number\ of\ PEV = a + b * (Number\ of\ Fast\ Chargers)^4$

Model 2: $Number\ of\ PEV = a + b * (Number\ of\ Normal\ Chargers)^4$

Model 3: $Number\ of\ PEV = a + b * (Number\ of\ Normal\ Chargers) + c * (Number\ of\ Fast\ Chargers)$

Electric vehicles sales data additionnaly to the charging points data will be analysed from 2015 to 2018 using R Studio ©. It can be seen from Figure 1, that the number of PEV suddenly rose between 2016 and 2017 regardless of the slight incease in the number of fast chargers in France. Therefore, the number of fast chargers could not be the only factor that help the PEV market to boost.

Results

	Intercept			**Number of Fast chargers**			**Number of Normal chargers**			**R-squared**
Model	Estimate Std.	Pr(>|t|)	Significancy	Estimate Std.	Pr(>|t|)	Significancy	Estimate Std.	Pr(>|t|)	Significancy	
Model 1	6.067e+4	0.0517	.	4.751e-9	0.0343	*	-	-	-	93.27%
Model 2	5.83e+4	0.0539	.	-	-	-	5.086e-13	0.0208	*	95.88%
Model 3	-17513	0.932		45.864	0.933		3.427	0.956		78.86%
Signif. Codes : 0 '*' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1**										

Table 1 Econometrical study of the different models using R Studio

As a primarily result, we can conclude about the significancy of the number of chargers whatever their type is: Normal or Fast. However, model 3, which combines these two variables, has no significant variables. Thus, it is obvious to include more PEV variables or specifications. Nevertheless, this paper will present a detailed econometric study on all factors that can influence on the client to purchase a PEV, especially the input data on EV and charging points, and other factors as mentioned above: PEV model, type, year of manufacturing, battery capacity, autonomy, and socket type adaptability, etc.

Conclusions

One of the main problems for the EV driver is to find a charger to fuel his battery with electric energy in order to avoid blackout in the middle of this trip. This is a psychological problem called "Range Anxiety". On one hand, people do not want to buy electric vehicle because the charging infrastructure is not mature enough. On the other hand, charging infrastructure operators will not invest in charging stations based on a low EV market share; especially that an EV is usually the second car of the family. Theoritically, Corri-door project should boost the PEV market since the range anxiety is solved by installing public fast chargers. This paper analyzes the driver's willingness to purchase a PEV before and after the Corri-door project, and what are the factors that push the driver to use a PEV. Thus, a conclusion about the "Chicken and Egg Dilemma" situation in France is given. Based on the first results that will be detailed in the paper, we can conclude that fast chargers are not the only explanatory factor of the increase in electric vehicles sales.

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