“Anticipated Penetration Rate of Electric Vehicles in Greece's Motor Vehicle Market”

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The present condition of the Greek EV market (I)

- In 2017 EV market share increased from 0.06% to 0.19 % with the market almost tripling in volume, achieving a market growth of +243%.
- Consumers turn towards Plug-in Hybrid Electric Vehicles (PHEVs) which accounted for 80.1% of the total sales. (New models: BMW 330e, BMW 225xe Active Tourer, BMW XE 40e and Volkswagen Passat GTE) (20 – 50 km electric driving range)
- Battery Electric Vehicles sales (BEVs) remained stable (-3%)

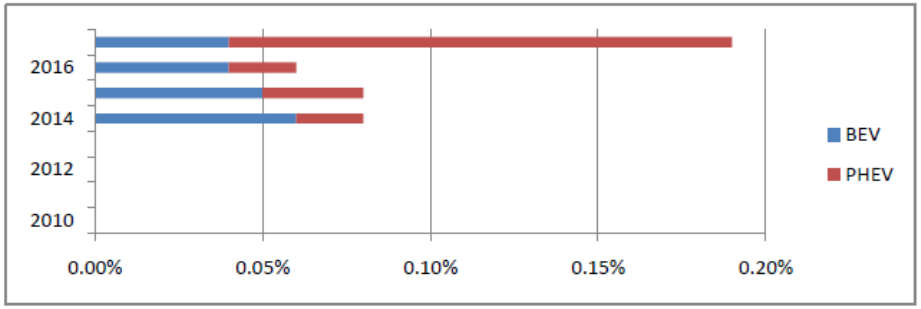

Figure 1 EV market share in Greece 2010-2017 (source: EAFO) [4]

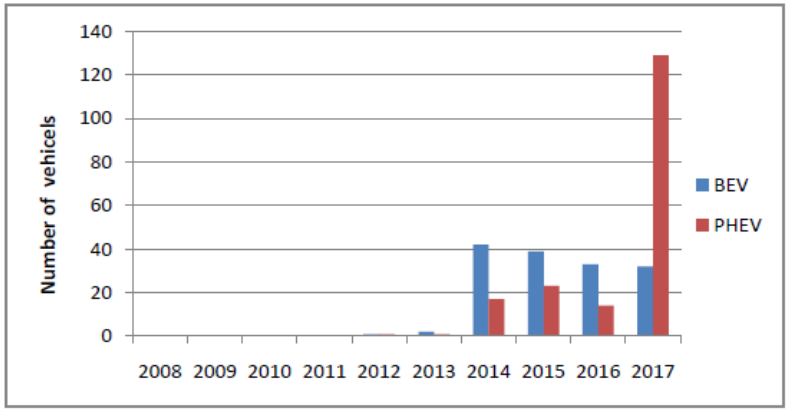

Figure 2 New sales of BEVs and PHEVs in Greece for the last decade (2008-2017) (source: EAFO) [4]

The present condition of the Greek EV market (II)

- International experience has shown that 85% of electric car users charge them in their own residence. However, a small percentage of public charging is a crucial parameter in order to get rid of “electric range anxiety” related to the use of electric cars

- In Greece there are 45 publicly accessible charging stations providing 64 charging positions

- The majority of the public available chargers are also located in Attiki and the Athens Metropolitan Region.

- The charging position availability in Greece is 5.2 EVs per charging position, which is following the European average ratio of 6.7

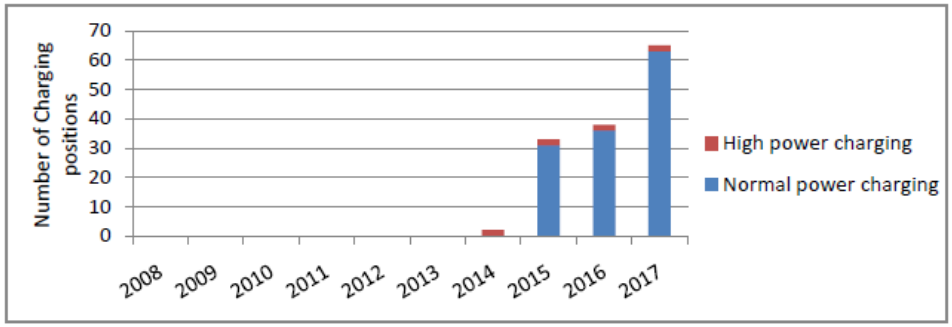

Figure 3 Number of publicly available charging positions (source: PlugShare [14], EAFO [4])

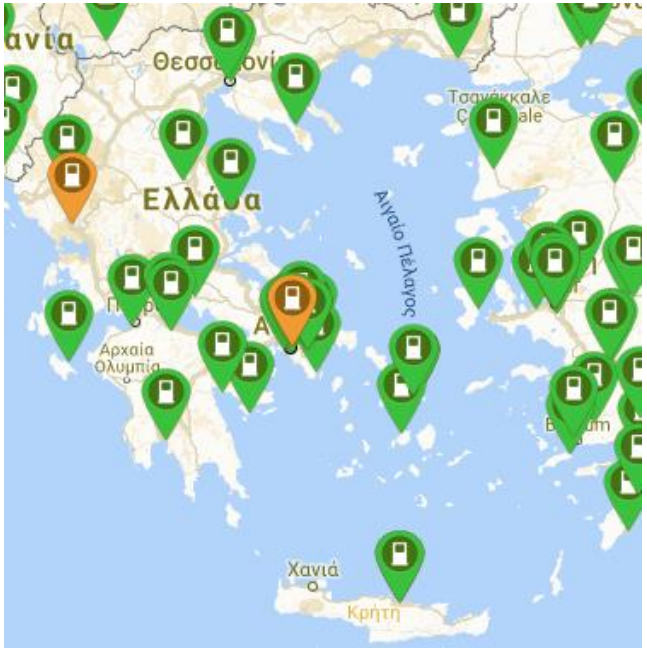

Figure Publicly available charging stations in Greece. (Source: plugshare.com)

Applied and proposed incentives for the EV adoption in the Greek market (I)

Applied Market Incentives for EVs

- 2010 Annual circulation tax – CO_2 Emissions based (below 90 g/km exempt)
- 2013 Exemption of BEVs from luxury and luxury commodity tax – PHEVs receive a 50% discount respectively

National Goals

- Non quantified goals for EV penetration of the local motor vehicle market
- The targets set are based on the EU directive on deployment of alternative fuels infrastructure (2014/94/EU) according to which Greece must reduce its oil dependence in the transport sector while increasing the share of RES in the transport sector by 10% in 2020.

Applied and proposed incentives for the EV adoption in the Greek market (II)

Further Actions to Support the Penetration of Electric Vehicles in the Greek Market

- Investment in development of required infrastructure in the fields of electric power generation and distribution, charging positions etc.
- political action and measures for support, including subsidization of new technologies, coordination of the competent and local authorities for the development of new infrastructure etc.
- development of the available technology from the car manufacturers: new attractive models offering convenience and security, in reduced production and operational cost.
- The standardization and validation of the available technology, introduction of common rules for quality and adaptation. EU must accept the role of the coordinator, setting the direction for all involved parties.
- The familiarization of users with the characteristics and specification of the new vehicles and the potential of this vehicle technology to cover consumers' needs
- The reconfiguration of the cost for purchase, operation (energy cost), and maintenance of EVs

Scenarios for the development of the Greek EV market

Significant market observations

Greek EV market is currently experiencing a vicious cycle fed by the inability of the market to provide sufficient publicly accessible charging infrastructure to tackle the electric driving range anxiety of the consumers.

Significant prospect moves towards EV market development in Greece

Hellenic Electricity Distribution Network Operator (HEDNO), the local DSO, has made a proposal for the development of Greece's first country scale charging network, composed of 1,200 to 1,500 EV charging stations. In addition 100-150 charging stations will be installed on Greek islands and multiple fast charging stations will be placed in the Greek highways.

What would HEDNO proposal's acceptance mean (DSO charging market model) :

- The charging network investment costs will be passed over to the consumers via their electricity bills. A socioeconomic cost allocation scheme for
- EV market initiation.
- Fast charging in Greek highways - enabling the electro mobility for intercity transportation in the continental part of Greece
- Initiate an interest by investors in further expanding the EV charging network - transition to Market model

Parameters influencing EV adoption (I)

- (a) EV Acquisition Cost
  - EV Acquisition reduction through fiscal incentives show significant results in increasing EV adoption in EU markets.
  - Cost parity with ICE vehicles in mid 2020s. Significant indication of cost parity in the market during 2018 is non economically viable. $2,800 – $7,400 losses per vehicle (UBS study in US's EV market)

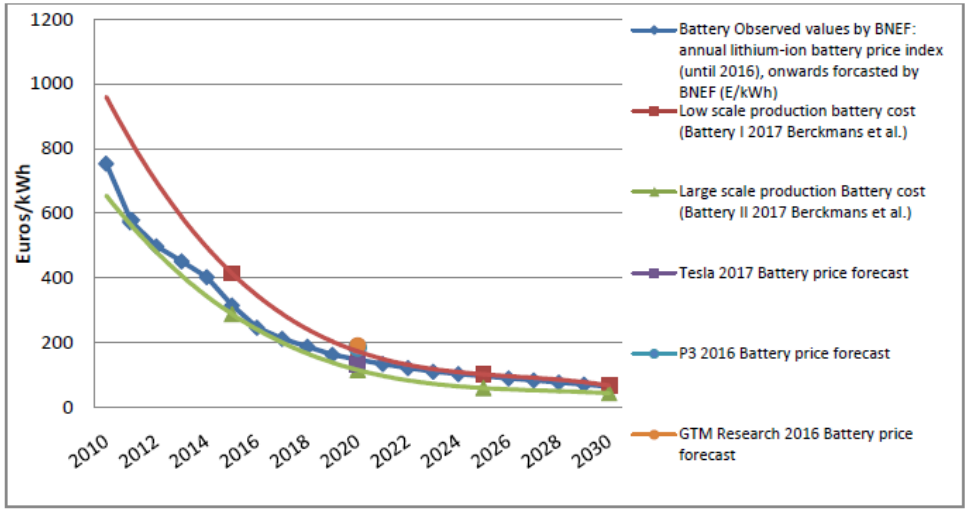

Figure 5 Battery price development and forecasting (sources: BNEF, Berckmans et al.)

  - Lithium-ion EV batteries will drop below €100/kWh in 2025. Predictions of market analysts converge in a single trend which assumes a learning rate of 19% per cumulative doubling of manufacturing installed capacity.
  - Market manipulation of sensitive metals like lithium and cobalt could create a bottleneck in the reduction of EV acquisition cost.

Parameters influencing EV adoption (II)

- (b) Total Cost of Ownership
  - The total cost of ownership considers the capital Acquisition costs (including the vehicle and battery cost) and the battery terminal cost as well as the variable operation and maintenance costs, annual tax, subsidies and the battery replacement cost.

- (c) Policies and Incentives
  - Policies affecting the acquisition cost (purchase rebates and subsidies, subsidization of scrapping of conventional ICE vehicles and their substitution with BEV or PHEV, purchase penalties on emission intensive vehicles and purchase tax exemptions)
  - Policies affecting the annual operation and maintenance, therefore the total cost of ownership. (annual circulation tax exemptions, road toll exemptions, free parking, bus lane access, subsidization of EVSE etc.)
  - Policy making based on mandatory levels for the average CO_2 emissions of the vehicle fleet nationwide. These are the Emission targets of 95 g/km set by the European Commission for 2020 and the anticipated 68-78g/km for 2025.

Parameters influencing EV adoption (III)

- (d) Public Charging Position availability
  - Market observations indicate strong influence between charging infrastructure availability and deployment of EVs.
- (e) EVs' Electric Range
- (f) Economic Situation
  - Influences, the capability of each economy to provide fiscal incentives for the development of the EV market
  - Influences consumer's willingness to pay for EVs. (GDP/capita and average household income).

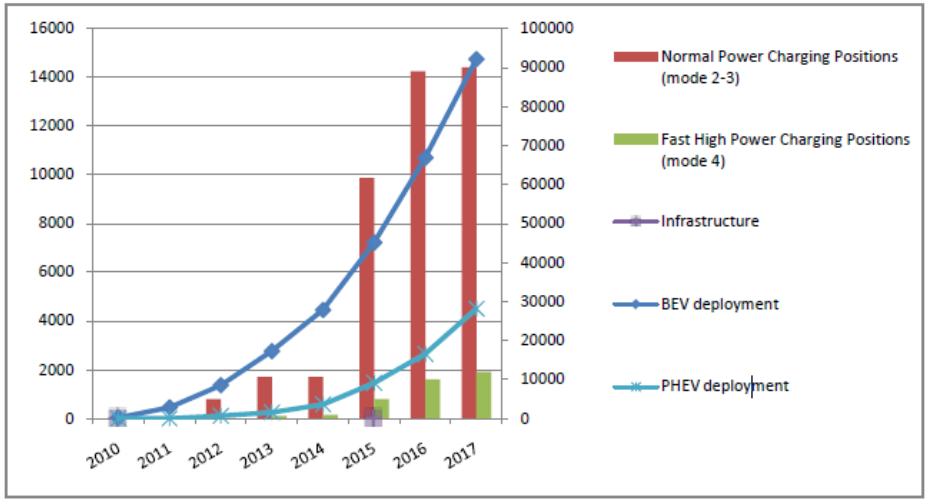

Figure 7 development of public charging position availability - the study case of France
Note: + Denotes the infrastructure framework change in 2010 making the charging infrastructure mandatorily included in public parking spaces and the 2015 Announcement of various municipalities investing in their publicly accessible local charging infrastructure. (Data derived from EAFO [4])

Results

Statistical Observations of the Greek EV market - statistical method assessment

- Multi-regression analysis failed to show cross-country similarity of statistical correlations of EV deployment with the tested parameters (based on the historical data sets of various EU markets) (indicating influence of extra parameters with focus in mobility choices)
- Advanced econometric forecasting tools and large data sets of more advanced EV markets are necessary to determine correlations between EV deployment and the tested parameters.
- A simplified approach shows that the EV market in Greece is:
  - Very volatile with non identifiable trends in the introduction of EVs.
  - 2017 was the only year that a significant increase in EV introduction can be observed

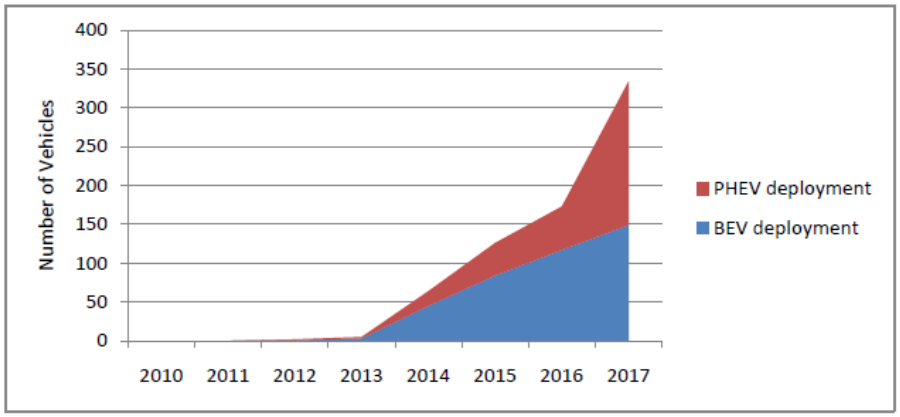

Figure 8 Plug-in Electric Vehicle Deployment in Greece.

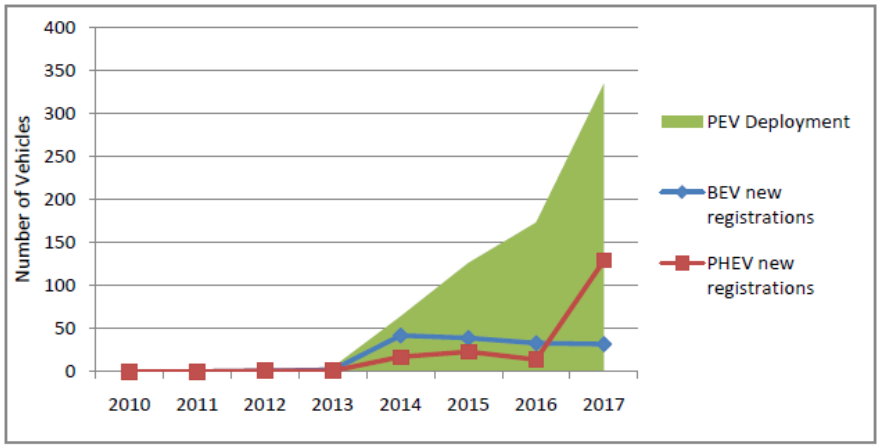

Figure 9 New registration of plug in electric vehicles in Greece.

Discussion and Conclusions

The Development Greek EV Market

- 2021 is a landmark year for Greek EV market as we expect the rapid increase of the number of installed charging stations nationwide following the implementation of the HEDNO's plan for the installation of EV charging network nationwide.
- Greece is also expected to proceed further with the establishment of the legal framework for EV charging that is expected to prompt new opportunities for investment and to increase the interest towards electric mobility.

Forecasting EV penetration rate in Greece's Motor vehicle Market

- Greek EV market has not been well established, therefore none trends can be extracted from its current performance.
- For future related work and the betterment of local policy formulation, the implementation of consumer behavior and driving behavior studies are deemed crucial. These, will enable us to include valid data for the mobility preferences of the consumers both in forecasting as well as in policy national policy formulation.

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