ANALYSIS OF THE IMPACT OF INTRODUCING ELECTRIC VEHICLES IN ROMANIA. CURRENT STATUS AND FORECASTS

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ABSTRACT
*Classic cars, fuelled with oil products,, are responsible for approximately 12% of the total carbon dioxide emissions, the main greenhouse gas. For this reason and driven by the desire to encourage the development of alternative fuels, the European Commission has developed a set of measures and recommendations for Member States for the implementation of electric mobility. This paper presents the strategic measures adopted at European level in this regard and analyses the measures initiated by the Romanian state in the development of a national fleet of electric vehicles and the necessary infrastructure. Also, the study brings into question the impact of the evolution of this sector on the energy markets in Romania and on the life of the big cities. (*European Commission, 2013).

KEYWORDS: *electric vehicle, energy markets, electric charging stations, alternative fuels.*

JEL CLASSIFICATION: *Q55, Q43, Q48.*

1. INTRODUCTION

In 2013 the European Commission launched the development strategy of "clean" fuel and noted that the main barriers to accelerating the process are related to low levels of acceptance from the population, the high cost of electric vehicles and the absence of electric charging stations. At that time, the European Commission proposed a set of targets for the installation of electric car charging stations by 2020, according to the data provided in Table 1:

Table 1. Targets for the installation of EV, according to EU in 2013

Members States	Existing infrastructure (charging points) 2011	Proposed targets of publicly accessible infrastructure by 2020[1]	Member States' plans for number of electric vehicles for 2020
Austria	489	12,000	250,000
Belgium	188	21,000	-
Bulgaria	1	7,000	-
Cyprus	-	2,000	-
Czech Republic	23	13,000	-
Germany	1,937	150,000	1,000,000
Denmark	280	5,000	200,000
Estonia	2	1,000	-
Greece	3	13,000	-
Finland	1	7,000	-
France	1,600	97,000	2,000,000

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Members States	Existing infrastructure (charging points) 2011	Proposed targets of publicly accessible infrastructure by 2020[1]	Member States' plans for number of electric vehicles for 2020
Hungary	7	7,000	-
Ireland	640	2,000	350,000
Italy	1,350	125,000	130,000 (by 2015)
Lithuania	-	4,000	-
Luxembourg	7	1,000	40,000
Latvia	1	2,000	-
Malta	-	1,000	-
Netherlands	1,700	32,000	200,000
Poland	27	46,000	-
Portugal	1,350	12,000	200,000
Romania	1	10,000	-
Spain	1,356	82,000	2,500,000
Slovakia	3	4,000	-
Slovenia	80	3,000	14,000
Sweden	-	14,000	600,000
United Kingdom	703	122,000	1,550,000

Source: European Commision (2013)

A year later, however, in March 2014 the European Parliament eliminated those targets, but has obliged Member States to develop policies to implement "an adequate number of electric charging stations for public access" by the end of 2020, with the measures to be reviewed in 2017. (Keating, 2014)
A few months later, in October 2014, Directive 2014/94 / EU established the general framework for development of the power stations. According to this Directive, a number of suitable charging stations must be achieved - in fact, a charging station for not more than 10 electric cars. *(*European Commission, 2013)

2. ELECTRIC CAR IN ROMANIA

According to the official data, sales of hybrid and electric cars in Romania are on a strong upward curve, although in absolute terms the difference is not significant from year to year. Thus, if in 2014 there were 236 such cars sold, last year the figure rose to 495. (http://stirileprotv.ro/stiri/financiar/numarul-masinilor-electrice-si-hibrid-vandute-in-2015-in-romania-dublu-fata-de-anul-anterior-ce-culori-au-preferat.html)
An important contribution to the growth of this figure are the measures undertaken by the Romanian authorities. The most important is the subsidy that the state supported in 2015. Those interested in purchasing a car equipped exclusively with an electric motor could have benefited from a grant of 4,500 euros. The program was limited in 2015 to 100 such acquisitions. Moreover, the customers had the possibility to add vouchers of "Rabla" program, so the grant could reached up to 6000-6500 euros. (Alecu, 2015)
The program continued in 2016, the Ministry of Environment, Water and Forests allocating about 5 million lei - of which 2 million for legal entities and 3 million for individuals. There were also allocated about 70 million lei, by the Environment Fund Administration, for infrastructure development. The results, however, were not as hoped, no registrations being recorded. (Breniuc, 2016)

Although in 2015 the Environmental Fund Administration claimed that it can financially support the development of 10,000 charging stations (Mitrea, 2015) - as it was for a period agreed with the European Commission - the 2016 target was reduced to 6,000. So it's desired the development of the infrastructure from 55 charging stations (22 in Bucharest, 33 in the province - in the summer of 2016) to 6,000 substations at the end of the year, an increase of 11.000%). (Carol, 2016)

Funds are available for private companies, local and central authorities and various other public institutions. The spaces in which it's wished to fit such charging stations are airports, railway stations, parking lots or shopping centers.

Although the project initiators state that the public must have guaranteed access to these points and parking spaces must be ensured, necessary urbanist changes are not mentioned. To develop a network of charging stations in the existing parking spaces, it must therefore gave up a number of places that can accommodate the classic cars. Such a problem is essential for the development of electric cars and the solutions must be identified together with local authorities in each city. In Bucharest, however, with the possible exception of parking in commercial areas (shopping malls, supermarkets, stadiums), parking is already a big problem and allocation of spaces dedicated for charging vehicles would aggravate further the situation of other classic car drivers.

3. THE IMPACT IN THE ELECTRICITY MARKET

To analyse the impact of adopting a strategy which aims to encourage the use of electric vehicles, I started from data provided by the Alternative Fuels Data Centre - it was considered an average consumption of 34 kWh for a full charge (10 hours) of a car and with an autonomy of 161 km / load cycle. (http://www.afdc.energy.gov/fuels/electricity_charging_home.html)

The model has analysed a large city of Romania, like Bucharest, with a daily walking distance of 30 km. According to these data, a full charge is required after 5 days of use, resulting in an approximate 6 full charges every month.

It has established a probabilistic graphical demand with a higher concentration of demand at the end of the week (Friday-Sunday) and for night period (hours 10:00 p.m. to 9:00), according to the table beside. For the day period it were considered electric cars belonging to legal persons, which will charge during employee's activity.

Table 2. Probabilities for EV charging

Probabilities	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
	10%	10%	15%	10%	15%	18%	22%
out of: Day (9-22)	2.5%	2.5%	3.8%	2.5%	3.8%	4.5%	5.5%
out of: Night (22-9)	7.5%	7.5%	11.3%	7.5%	11.3%	13.5%	16.5%

Source: Author's analysis

Starting from this chart, the model had three different fleets (1000, 2500 and 5000 vehicles).

Table 3. Electric vehicles' scenario

No. of cars	No. of total charges			Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
1000	6000	No of charges	Day (9-22)	150	150	225	150	225	270	330
			Night (22-9)	450	450	675	450	675	810	990
		Energy demand	Day (9-22) [MWh]	5.1	5.1	7.65	5.1	7.65	9.18	11.22
			Night (22-9) [MWh]	15.3	15.3	22.95	15.3	22.95	27.54	33.66
			TOTAL [MWh]	20.4	20.4	30.6	20.4	30.6	36.72	44.88
			Day average [MWh/h]	0.39	0.39	0.59	0.39	0.59	0.71	0.86
			Night average [MWh/h]	1.39	1.39	2.09	1.39	2.09	2.50	3.06
2500	15000	No of charges	Day (9-22)	375	375	562.5	375	562.5	675	825
			Night (22-9)	1125	1125	1687.5	1125	1687.5	2025	2475
		Energy demand	Day (9-22) [MWh]	12.75	12.75	19.125	12.75	19.125	22.95	28.05
			Night (22-9) [MWh]	38.25	38.25	57.375	38.25	57.375	68.85	84.15
			TOTAL [MWh]	51	51	76.5	51	76.5	91.8	112.2
			Day average [MWh/h]	0.98	0.98	1.47	0.98	1.47	1.77	2.16
			Night average [MWh/h]	3.48	3.48	5.22	3.48	5.22	6.26	7.65
5000	30000	No of charges	Day (9-22)	750	750	1125	750	1125	1350	1650
			Night (22-9)	2250	2250	3375	2250	3375	4050	4950
		Energy demand	Day (9-22) [MWh]	25.5	25.5	38.25	25.5	38.25	45.9	56.1
			Night (22-9) [MWh]	76.5	76.5	114.75	76.5	114.75	137.7	168.3
			TOTAL [MWh]	102	102	153	102	153	183.6	224.4
			Day average [MWh/h]	1.96	1.96	2.94	1.96	2.94	3.53	4.32
			Night average [MWh/h]	6.95	6.95	10.43	6.95	10.43	12.52	15.30

Source: Author's analysis

According to the results, it has been determined the total consumption of electricity in one year for each of the three cases.

Table 4. Total energy consumption per scenario

Scenario	Total annual consumption [TWh]	Total consumption 2015 [TWh]	Share of scenarios in 2015 total consumption
I	0.01	58.84	0.018%
II	0.026		0.045%
III	0.053		0.09%

Source: Oprea (2016), Author's analysis

The analysis results indicate that during weekdays (Monday-Friday) the electricity surplus will be taken generally from the marginal technology, which in Romania is represented by the coal producers. For the ranges of the day or night, during the days of the weekend, extra demand for energy can be taken from other technologies than fossil fuel.

And because of this, the solution offered by vehicle-to-grid technology can be a good solution. In this situation, electric cars are permanently connected to the network and can be used in a double

way. When demand is high in the system, the machine can inject electricity into the grid, and when demand is low and, therefore, prices are affordable, the car is charged. In this respect it is searched a more efficient energy costs. (https://en.wikipedia.org/wiki/Vehicle-to-grid)

An interesting analysis can be done on the CO2 emissions saved through the introduction of electric cars, and excess emissions of greenhouse producers of electricity produced from coal.

Thus, if instead of a classic car, a user buys an electric car, then he avoids approximately 1.90 tonnes of CO2 (for a car petrol, with a consumption of 7 l / 100 km and an annual distance traveled of 10,000km). (http://www.climatecare.org/home.aspx)

To power an electric car similar to the one considered in the previous analysis (6 monthly full charges every 34 KWh), the equivalent needed in a year is 2.448 MWh of electricity.

If you start from the premise that this energy surplus is always taken by power coal producers, as for example, CE Oltenia, that will produce 0.915 tonnes of CO2 per MWh, then the producer will produce extra 2.23 tonnes of CO2 annually. (http://www.bizenergy.ro/destinatieromaniagorj-complexul-energetic-oltenia-cel-mai-mare-producator-de-energie-pe-baza-de-carbune-din-tara/#.V-GJgoh97IW, 2014)

3. RECOMMENDATIONS. CONCLUSION

Authorities' efforts to implement and develop the network of electrical chargers and encouraging the policies (grant) for those who want to buy an electric car and must represent sustained efforts and a strategy based on medium and long term.

The development of the network of electric chargers should be done through active participation of local and public authorities and institutions interested in the electric mobility policy

For this reason, the infrastructure development plan for electric cars must be part of the urban plans of major cities, so there is coordination and harmonisation between them, primarily in terms of dedicated parking spaces that need to be available, in the view of the new strategies.

Impact in final consumption and total annual electricity is tiny if adopting a policy favourable to electric mobility.

If the owners of electric vehicles, be they individuals or juridical persons, will opt to charge cars during the day then, in most cases, this surplus energy demand will be taken over by the marginal technology in the merit order, therefore by producers of electricity from coal. This does not, therefore, permit significant "savings" significant in terms of greenhouse gases with emissions. The amount of emissions avoided by introducing a number of electric cars is largely similar to what producers of electricity from fossil fuels produce for responding for this energy surplus.

Taking into account the aforementioned, the authorities should encourage charging electric cars at night or during Saturdays and Sundays, when consumption is reduced and the surplus electricity can be taken over by other technologies than those based on fuels fuels.

A dynamic and constantly updated electricity prices during the day, available for consultation even at the electric chargers, could be a first step in this direction. When a new charge during the day would mean the production of electricity from fossil sources, this may be so indicated by a higher price of electricity, which will remove as much as possible, consumers and educate them to charge their cars off-peak hours.

Also, an extensive analysis to implement the system of vehicle-to-grid must be made for further development of the network of chargers.

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