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The Electric Cars, a „Tsunami" of Temptations for the Lovers of Speed

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ABSTRACT

The electric vehicles fascinate through them silent motions, stylish structures, speeds and fiability. The sales concerning the electric cars witnessed a spectacular rises in the previous years and these had in background a miscellaneous „palette" in offers from all the enterpresises which produce electric vehicles. The intent of this paper consists in to hold forth the algorithm of the previsions in the spheres of the worldwide sales regarding the electric vehicles and plug-in hybrid electric vehicles, tradings which will be on the road of success in the next years.

1. Introduction

The seductions of the electric vehicles exert great concentrations in adrenalin for the lovers of speed, style and performance and for these characteristics, the new electric vehicles (EV) and plug-in hybrid models will conquer the hearts of the public and will win new segments of market at worldwide level. In this year, the Hummer Ev model impressed through „streamlined" shape, „offensive" power highlighted off-road and movements similar with the crabs when the model musted to achieve auto detours of the rocks. This original research was achieved with a view to display the augmentations in the near future regarding the worldwide values which have as target the numbers of battery electric vehicles in use, respectively the worldwide sales of plug-in hybrid electric vehicles and as well, the increments concerning the worldwide sales of plug-in light vehicles. In the first display of this research, we can see the technique applied for the achievement of the prognosises regarding the worldwide values of the battery electric vehicles in use. The second exposure introduces us in the „programming" of the manner through we can to prognose the worldwide values of plug-in hybrid electric vehicles in use. The third exposition presents us the method used for to achieve forecasts for the worldwide values of plug-in hybrid electric vehicles which will be selled. The fourth section acknowledges us the „itinerary" though we can to model prognosises which focuse the values for the worldwide sales of the plug-in light vehicles. For to build these purports we introduced the method of the prevision which had in background the „Least Squares Method". The „stream" of the architecture named the „Least Squares Method" has as source a great mathematician, namely Johann Carl Friedrich Gauss.

2. The prognosis highlighted through the structure of the model concerning the values which have as target the worldwide numbers of battery electric vehicles in use

Table 1. The values which put in evidence the number of battery electric vehicles in use at worldwide level

YEARS	THE WORLDWIDE NUMBER OF BATTERY ELECTRIC VEHICLES IN USE (10^3)
2012	112,92
2013	225,50
2014	415,74
2015	736,90
2016	1198,37
2017	1945,78
2018	3290,80

The sourse: „Statistics Portal United States"

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- if the „territorial profile" drawn by the values of the ξ variable, namely the worldwide numbers of battery electric vehicles in use „twinkles" through the $\xi_{t_i} = a + b \cdot t_i$ „mould", *a* and *b* will be [4]:

$$S = \sum_{i=1}^{n} (\xi_i - \xi_{ti})^2 = \min \Leftrightarrow S = \sum_{i=1}^{n} (\xi_i - a - bt_i)^2 = \min$$

$$\begin{cases} \frac{\partial S}{\partial a} = 0 \\ \frac{\partial S}{\partial b} = 0 \end{cases} \Rightarrow \begin{cases} 2\sum_{1=1}^{n} (\xi_i - a - bt_i)(-1) = 0 / (-\frac{1}{2}) \\ 2\sum_{1=1}^{n} (\xi_i - a - bt_i)(-t_i) = 0 / (-\frac{1}{2}) \end{cases} \Rightarrow \quad \begin{cases} na + b\sum_{i=1}^{n} t_i = \sum_{i=1}^{n} \xi_i \\ a\sum_{i=1}^{n} t_i + b\sum_{i=1}^{n} t_i^2 = \sum_{i=1}^{n} \xi_i t_i \end{cases} \Rightarrow$$

$$a = \frac{\begin{vmatrix} \sum_{i=1}^{n} \xi_i & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} \xi_i t_i & \sum_{i=1}^{n} t_i^{\,2} \end{vmatrix}}{\begin{vmatrix} n & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} t_i^{\,2} \end{vmatrix}} = \frac{\sum_{i=1}^{n} \xi_i \sum_{i=1}^{n} t_i^{\,2} - \sum_{i=1}^{n} \xi_i t_i \sum_{i=1}^{n} t_i}{n\sum_{i=1}^{n} t_i^{\,2} - \left(\sum_{i=1}^{n} t_i\right)^2} \qquad b = \frac{\begin{vmatrix} n & \sum_{i=1}^{n} x_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} \xi_i t_i \end{vmatrix}}{\begin{vmatrix} n & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} t_i^{\,2} \end{vmatrix}} = \frac{n\sum_{i=1}^{n} \xi_i t_i - \sum_{i=1}^{n} t_i \sum_{i=1}^{n} \xi_i}{n\sum_{i=1}^{n} t_i^{\,2} - \left(\sum_{i=1}^{n} t_i\right)^2}$$

Table 2. The „recipe of the composition" for the values of the ξ variable, namely the worldwide values concerning the battery electric vehicles in use, if the „profile" has as hypothesis a linear tendency

YEARS	THE WORLDWIDE NUMBER OF BATTERY ELECTRIC VEHICLES IN USE (THOUSANDS UNITS) (ξ_i)	LINEAR TENDENCY				
		t_i	t_i^2	$t_i \xi_i$	$\xi_{t_i} = a + bt_i$	$\lvert \xi_i - \xi_{t_i} \rvert$
2012	**112,92**	-3	9	-338,76	-341,6589283	454,58
2013	**225,50**	-2	4	-451,00	149,6564288	75,84
2014	**415,74**	-1	1	-415,74	640,9717859	225,23
2015	**736,90**	0	0	0	1132,287143	395,39
2016	**1198,37**	+1	1	1198,37	1623,602500	425,23
2017	**1945,78**	+2	4	3891,56	2114,917857	169,14
2018	**3290,80**	+3	9	9872,40	2606,233214	684,57
TOTAL	**7926,01**		28	13756,83	7926,01	2429,98

$$a = \frac{7926,01 \cdot 28}{7 \cdot 28} = 1132,287143$$

$$b = \frac{7 \cdot 13756,83}{7 \cdot 28} = 491,3153571$$

$$v_I = \left[\frac{\sum_{i=-m}^{m} \lvert \xi_i - \xi_{t_i}^I \rvert}{n} : \frac{\sum_{i=-m}^{m} \xi_i}{n} \right] \cdot 100 = \frac{\sum_{i=-m}^{m} \lvert \xi_i - \xi_{t_i}^I \rvert}{\sum_{i=-m}^{m} \xi_i} \cdot 100 = \frac{2429,98}{7926,01} \cdot 100 = 30,66\%$$

- if the „territorial profile" drawn by the values of the ξ variable, namely the worldwide numbers of battery electric vehicles in use „twinkles" through the $\xi_{t_i} = a + b \cdot t_i + ct_i^2$ „mould", *a* and *b* will be [4]:

$$S = \sum_{i=1}^{n} (\xi_i - x_{ti})^2 = \min \Leftrightarrow S = \sum_{i=1}^{n} (\xi_i - a - bt_i - ct_i^2)^2 = \min$$

$$\begin{cases}\frac{\partial S}{\partial a}=0\\ \frac{\partial S}{\partial b}=0\\ \frac{\partial S}{\partial c}=0\end{cases}\Rightarrow\begin{cases}2\sum_{1=1}^{n}(\xi_i-a-bt_i-ct_i^2)(-1)=0/(-\frac{1}{2})\\ 2\sum_{1=1}^{n}(\xi_i-a-bt_i-ct_i^2)(-t_i)=0/(-\frac{1}{2})\\ 2\sum_{i=1}^{n}(\xi_i-a-bt_i-ct_i^2)(-t_i^2)=0/(-\frac{1}{2})\end{cases}\Rightarrow\begin{cases}n\cdot a+b\sum_{i=1}^{n}t_i+c\sum_{i=1}^{n}t_i^2=\sum_{i=1}^{n}\xi_i\\ a\sum_{i=1}^{n}t_i+b\cdot\sum_{i=1}^{n}t_i^2+c\sum_{i=1}^{n}t_i^3=\sum_{i=1}^{n}t_i\cdot\xi_i\\ a\cdot\sum_{i=1}^{n}t_i^2+b\sum_{i=1}^{n}t_i^3+c\sum_{i=1}^{n}t_i^4=\sum_{i=1}^{n}t_i^2\cdot\xi_i\end{cases}$$

$$a=\frac{\sum_{i=1}^{n}t_i^4\sum_{i=1}^{n}\xi_i-\sum_{i=1}^{n}t_i^2\sum_{i=1}^{n}t_i^2\cdot\xi_i}{n\sum_{i=1}^{n}t_i^4-\left(\sum_{i=1}^{n}t_i^2\right)^2};\quad b=\frac{\sum_{i=1}^{n}\xi_i t_i}{\sum_{i=1}^{n}t_i^2};\quad c=\frac{n\cdot\sum_{i=1}^{n}t_i^2\cdot\xi_i-\sum_{i=1}^{n}t_i^2\cdot\sum_{i=1}^{n}\xi_i}{n\sum_{i=1}^{n}t_i^4-\left(\sum_{i=1}^{n}t_i^2\right)^2}$$

Table 3. The „recipe of texture" for the values of the ξ variable, namely the worldwide values concerning the battery electric vehicles in use, if the „profile" has as hypothesis a quadratic tendency

YEARS	THE WORLDWIDE NUMBER OF BATTERY ELECTRIC VEHICLES IN USE (THOUSANDS UNITS) (ξ_i)	*PARABOLIC TENDENCY*					
		t_i	t_i^2	t_i^4	$t_i^2\xi_i$	$\xi_{t_i}=a+bt_i+ct_i^2$	$\lvert\xi_i-\xi_{t_i}\rvert$
2012	**112,92**	-3	9	81	1016,28	207,6666664	94,75
2013	**225,50**	-2	4	16	902,00	149,6564285	75,84
2014	**415,74**	-1	1	1	415,74	311,3764286	104,36
2015	**736,90**	0	0	0	0	692,8266667	44,07
2016	**1198,37**	+1	1	1	1198,37	1294,007143	95,64
2017	**1945,78**	+2	4	16	7783,12	2114,917857	169,14
2018	**3290,80**	+3	9	81	29617,20	3155,558809	135,24
TOTAL	**7926,01**		28	196	40932,71	7926,01	719,04

$$a=\frac{196\cdot 7926{,}01-28\cdot 40932{,}71}{7\cdot 196-28^2}=692{,}8266667$$

$$b=\frac{7\cdot 13756{,}83}{7\cdot 28}=491{,}3153571\quad c=\frac{7\cdot 40932{,}71-28\cdot 7926{,}01}{7\cdot 196-28^2}=109{,}865119$$

$$v_{II}=\left[\frac{\sum_{i=-m}^{m}\left|\xi_i-\xi_{t_i}^{II}\right|}{n}:\frac{\sum_{i=-m}^{m}\xi_i}{n}\right]\cdot 100=\frac{\sum_{i=-m}^{m}\left|\xi_i-\xi_{t_i}^{II}\right|}{\sum_{i=-m}^{m}\xi_i}\cdot 100=\frac{719{,}04}{7926{,}01}\cdot 100=9{,}07\%$$

- if the „territorial profile" drawn by the values of the ξ variable, namely the worldwide numbers of battery electric vehicles in use „twinkles" through the $\xi_{t_i}=ab^{t_i}$ „mould", a and b will be [4]:

$$S=\sum_{i=1}^{n}(\lg\xi_i-\lg\xi_{t_i})^2=\min\Leftrightarrow S=\sum_{i=1}^{n}(\lg\xi_i-\lg a-t_i\lg b)^2=\min$$

$$\begin{cases}\frac{\partial S}{\partial\lg a}=0\\ \frac{\partial S}{\partial\lg b}=0\end{cases}\Rightarrow\begin{cases}2\sum_{1=1}^{n}(\lg\xi_i-\lg a-t_i\lg b)(-1)=0/(-\frac{1}{2})\\ 2\sum_{1=1}^{n}(\lg\xi_i-\lg a-t_i\lg b)(-t_i)=0/(-\frac{1}{2})\end{cases}\Rightarrow\begin{cases}n\cdot\lg a+\lg b\cdot\sum_{i=1}^{n}t_i=\sum_{i=1}^{n}\lg\xi_i\\ \lg a\sum_{i=1}^{n}t_i+\lg b\cdot\sum_{i=1}^{n}t_i^2=\sum_{i=1}^{n}t_i\cdot\lg\xi_i\end{cases}$$

$$\lg a = \frac{\begin{vmatrix} \sum_{i=1}^{n} \lg \xi_i & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} t_i \lg \xi_i & \sum_{i=1}^{n} t_i^{\,2} \end{vmatrix}}{\begin{vmatrix} n & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} t_i^{\,2} \end{vmatrix}} = \frac{\sum_{i=1}^{n} \lg \xi_i \sum_{i=1}^{n} t_i^{\,2} - \sum_{i=1}^{n} t_i \lg \xi_i \sum_{i=1}^{n} t_i}{n\sum_{i=1}^{n} t_i^{\,2} - \left(\sum_{i=1}^{n} t_i\right)^2}$$

$$\lg b = \frac{\begin{vmatrix} n & \sum_{i=1}^{n} \lg \xi_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} t_i \lg \xi_i \end{vmatrix}}{\begin{vmatrix} n & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} t_i^{\,2} \end{vmatrix}} = \frac{n \cdot \sum_{i=1}^{n} t_i \lg \xi_i - \sum_{i=1}^{n} \lg \xi_i \sum_{i=1}^{n} t_i}{n\sum_{i=1}^{n} t_i^{\,2} - \left(\sum_{i=1}^{n} t_i\right)^2}$$

Table 4. The „recipe of the mix" for the values of the ξ variable, namely the worldwide values concerning the battery electric vehicles in use, if the „profile" has as hypothesis an exponential trend

YEARS	THE WORLDWIDE NUMBER OF BATTERY ELECTRIC VEHICLES IN USE (THOUSANDS UNITS) (ξ_i)	EXPONENTIAL TENDENCY				
		$\lg \xi_i$	$t_i \lg \xi_i$	$\lg \xi_{t_i} = \lg a + t_i \lg b$	$\xi_{t_i} = ab^{t_i}$	$\lvert \xi_i - \xi_{t_i} \rvert$
2012	**112,92**	2,052770869	-6,158312608	2,101527491	126,3361073	13,42
2013	**225,50**	2,353146546	-4,706293092	2,342786610	220,1844324	5,32
2014	**415,74**	2,618821812	-2,618821812	2,584045729	383,7476500	31,99
2015	**736,90**	2,867408557	0	2,825304848	668,8132186	68,09
2016	**1198,37**	3,078590928	3,078590928	3,066563967	1165,638724	32,73
2017	**1945,78**	3,289093735	6,578187470	3,307823187	2031,529752	85,75
2018	**3290,80**	3,517301489	10,55190447	3,549082205	3540,643535	249,84
TOTAL	**7926,01**	19,77713394	6,755255352			454,41

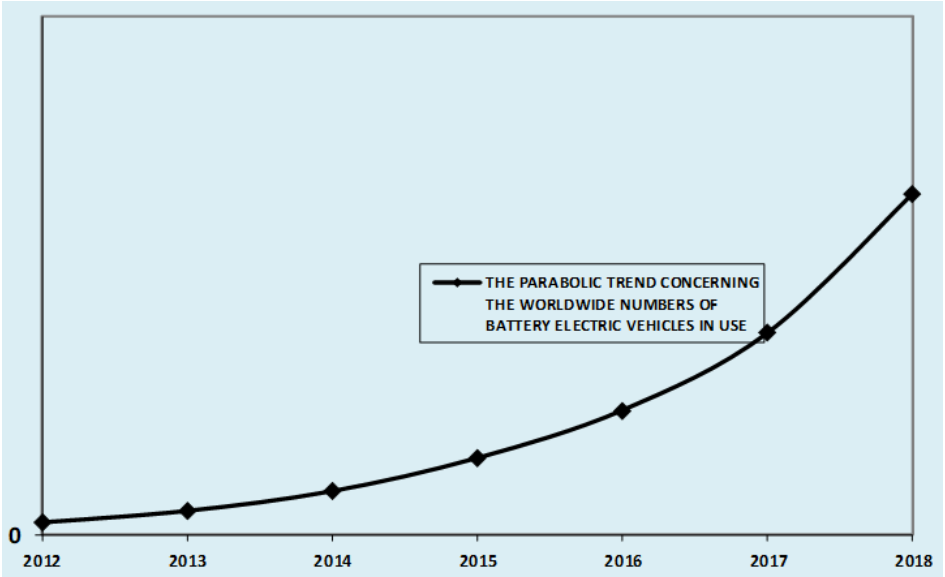
$$\lg a = \frac{19{,}77713394 \cdot 28}{7 \cdot 28} = 2{,}825304848$$

$$\lg b = \frac{7 \cdot 6{,}755255352}{7 \cdot 28} = 0{,}241259119$$

$$v_{\exp} = \left[\frac{\sum_{i=-m}^{m} \left| \xi_i - \xi_{t_i}^{\exp} \right|}{n} : \frac{\sum_{i=-m}^{m} \xi_i}{n} \right] \cdot 100 = \frac{\sum_{i=-m}^{m} \left| \xi_i - \xi_{t_i}^{\exp} \right|}{\sum_{i=-m}^{m} \xi_i} \cdot 100 = \frac{454{,}41}{7926{,}01} \cdot 100 = 5{,}73\%$$

$$v_{\exp} = 5{,}73\% < v_{II} = 9{,}07\% < v_I = 30{,}66\%$$

The look regarding the progress reflected by ξ variable, namely the worldwide values concerning the battery electric vehicles, is moulded by the $\xi_{t_i} = ab^{t_i}$ exponential contour.



Graph 1. The quadratic countenance concerning the worldwide values

of battery electric vehicles in use

$$\xi_{2020}^{WORLDWIDE\_BATTERY\_ELECTRIC\_VEHICLES\_IN\_USE} = 668{,}8132186 \cdot 1{,}742846421^{5} = 10754{,}75\_thousands\_units$$

$$\xi_{2021}^{WORLDWIDE\_BATTERY\_ELECTRIC\_VEHICLES\_IN\_USE} = 668{,}8132186 \cdot 1{,}742846421^{6} = 18743{,}88\_thousands\_units$$

3. The forecasts exhibited through the texture of the model regarding the values which focuse the worldwide numbers of plug-in hybrid electric vehicles in use

Table 5. The values which put in evidence the number of plug-in hybrid electric vehicles in use at worldwide level

YEARS	THE WORLDWIDE NUMBER OF PLUG-IN HYBRID ELECTRIC VEHICLES IN USE (millions units)
2016	**0,81**
2017	**1,20**
2018	**1,82**

The sourse: „Statistics Portal United States"

- if the „territorial profile" drawn by the values of the ω variable, namely the worldwide number of plug-in hybrid electric vehicles in use, „twinkles" through the $\omega_{t_i} = a + b \cdot t_i$ „mould", *a* and *b* will be [4]:

Table 6. The „recipe of the composition" for the grouping of the values regarding the ω variable, namely the worldwide number of plug-in hybrid electric vehicles in use, if the „profile" has as hypothesis a linear tendency

YEARS	THE WORLDWIDE NUMBER OF PLUG-IN HYBRID ELECTRIC VEHICLES IN USE (MILLIONS UNITS) (ω_i)	LINEAR TENDENCY				
		t_i	t_i^2	$t_i\omega_i$	$\omega_{t_i} = a + bt_i$	$\lvert\omega_i - \omega_{t_i}\rvert$
2016	**0,81**	-1	1	-0,81	0,771666666	0,04
2017	**1,20**	0	0	0	1,276666667	0,08
2018	**1,82**	+1	1	1,82	1,781666667	0,04
TOTAL	**3,83**		2	1,01	3,83	0,16

$$a = \frac{3{,}83 \cdot 2}{3 \cdot 2} = 1{,}276666667 \;;\; b = \frac{3 \cdot 1{,}01}{3 \cdot 2} = 0{,}505$$

$$v_I = \left[\frac{\sum_{i=-m}^{m} \lvert\omega_i - \omega_{t_i}^I\rvert}{n} : \frac{\sum_{i=-m}^{m} \omega_i}{n} \right] \cdot 100 = \frac{\sum_{i=-m}^{m} \lvert\omega_i - \omega_{t_i}^I\rvert}{\sum_{i=-m}^{m} \omega_i} \cdot 100 = \frac{0{,}16}{3{,}83} \cdot 100 = 4{,}18\%$$

- if the „territorial profile" drawn by the values of the ω variable, namely the worldwide number of plug-in hybrid electric vehicles in use, „twinkles" through the $\omega_{t_i} = a + b \cdot t_i + ct_i^2$ „mould", *a* and *b* will be [4]:

Table 7. The „recipe of the texture" for the grouping of the values regarding the ω variable, namely the worldwide number of plug-in hybrid electric vehicles in use, if the „profile" has as hypothesis a quadratic tendency

YEARS	THE WORLDWIDE NUMBER OF PLUG-IN HYBRID ELECTRIC VEHICLES IN USE (MILLIONS UNITS) (ω_i)	*PARABOLIC TENDENCY*					
		t_i	t_i^2	t_i^4	$t_i^2\omega_i$	$\omega_{t_i} = a + bt_i + ct_i^2$	$\lvert\omega_i - \omega_{t_i}\rvert$
2016	**0,81**	-1	1	1	0,81	0,81	0
2017	**1,20**	0	0	0	0	1,20	0
2018	**1,82**	+1	1	1	1,82	1,82	0
TOTAL	**3,83**		2	2	2,63	3,83	0

$$a = \frac{2 \cdot 3{,}83 - 2 \cdot 2{,}63}{3 \cdot 2 - 2^2} = 1{,}2 \qquad b = \frac{3 \cdot 1{,}01}{3 \cdot 2} = 0{,}505$$

$$c = \frac{3 \cdot 2{,}63 - 2 \cdot 3{,}83}{3 \cdot 2 - 2^2} = 0{,}115$$

$$v_{II} = \left[\frac{\sum_{i=-m}^{m} \left| \omega_i - \omega_{t_i}^{II} \right|}{n} : \frac{\sum_{i=-m}^{m} \omega_i}{n} \right] \cdot 100 = \frac{\sum_{i=-m}^{m} \left| \omega_i - \omega_{t_i}^{II} \right|}{\sum_{i=-m}^{m} \omega_i} \cdot 100 = \frac{0}{3{,}83} \cdot 100 = 0\%$$

- if the „territorial profile" drawn by the values of the ω variable, namely the worldwide number of plug-in hybrid electric vehicles in use, „twinkles" through the $\omega_{t_i} = ab^{t_i}$ „mould", *a* and *b* will be [4]:

Table 8. The „recipe of the mix" for the grouping of the values regading the ω variable, namely the worldwide number of plug-in hybrid electric vehicles in use, if the „profile" has as hypothesis an exponential tendency

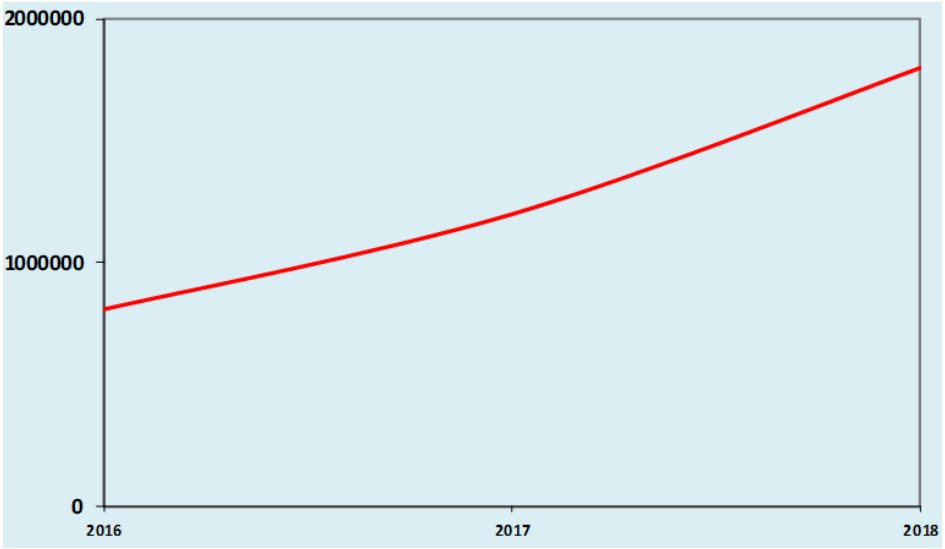
YEARS	THE WORLDWIDE NUMBER OF PLUG-IN HYBRID ELECTRIC VEHICLES IN USE (MILLIONS UNITS) (ω_i)	*EXPONENTIAL TENDENCY*				
		$\lg \omega_i$	$t_i \lg \omega_i$	$\lg \omega_{t_i} = \lg a + t_i \lg b$	$\omega_{t_i} = ab^{t_i}$	$\left\| \omega_i - \omega_{t_i} \right\|$
2016	**0,81**	-0,091514981	0,091514981	-0,093213967	0,806837421	0,003
2017	**1,20**	0,079181246	0	0,082579217	1,209425767	0,009
2018	**1,82**	0,260071388	0,260071388	0,258372398	1,812893943	0,007
TOTAL	**3,83**	0,247737653	0,351586369			0,019

$$\lg a = \frac{0{,}247737653 \cdot 2}{3 \cdot 2} = 0{,}082579217 \qquad \lg b = \frac{3 \cdot 0{,}351586369}{3 \cdot 2} = 0{,}175793184$$

$$v_{\exp} = \left[\frac{\sum_{i=-m}^{m} \left| \omega_i - \omega_{t_i}^{\exp} \right|}{n} : \frac{\sum_{i=-m}^{m} \omega_i}{n} \right] \cdot 100 = \frac{\sum_{i=-m}^{m} \left| \omega_i - \omega_{t_i}^{\exp} \right|}{\sum_{i=-m}^{m} \omega_i} \cdot 100 = \frac{0{,}019}{3{,}83} \cdot 100 = 0{,}50\%$$

$$v_{II} = 0\% < v_{\exp} = 0{,}50\% < v_I = 4{,}18\%$$

The look concerning the progress for ω factor, which records the worldwide number of plug-in hybrid electric vehicles in use, is a $\omega_{t_i} = a + b \cdot t_i + ct_i^2$ quadratic contour.



Graph 2. The quadratic countenance regarding the worldwide values of plug-in hybrid electric vehicles in use

$$\omega_{2020}^{WORDLWIDE\_PLUG-IN\_HYBRID\_ELECTRIC\_VEHICLES\_IN\_USE} = 1{,}2 + 0{,}505 \cdot 3 + 0{,}115 \cdot 3^2 = 3{,}75\_millions\_units$$

$$\omega_{2021}^{WORLDWIDE\_PLUG-IN\_HYBRID\_ELECTRIC\_VEHICLES\_IN\_USE} = 1{,}2 + 0{,}505 \cdot 4 + 0{,}115 \cdot 4^2 = 5{,}06\_millions\_units$$

4. The previsions unveiled through the structure of the model concerning the values which have as target the worldwide sales of plug-in hybrid electric vehicles

Table 9 The values concerning the number of plug-in hybrid electric vehicles worldwide sales

YEARS	THE NUMBER OF PLUG-IN HYBRID ELECTRIC VEHICLES WORLDWIDE SALES (1000 units)
2012	**60,48**
2013	**91,82**
2014	**134,80**
2015	**222,78**
2016	**288,49**
2017	**420,12**
2018	**630,16**

The sourse: „Statistics Portal United States"

- if the „territorial profile" drawn by the values of the $\wp$ variable, namely the number of plug-in hybrid electric vehicles worldwide sales, „twinkles" through the $\wp_{t_i} = a + b \cdot t_i$ „mould", a and b will be [4]:

Table 10 The „recipe of the composition" for the grouping of the values concerning the $\wp$ variable, namely the number of plug-in hybrid electric vehicles worldwide sales, if the „profile" has as hypothesis a linear tendency

YEARS	THE NUMBER OF PLUG-IN HYBRID ELECTRIC VEHICLES WORLDWIDE SALES (10^3) ($\wp_i$)	LINEAR TENDENCY				
		t_i	t_i^2	$t_i \wp_i$	$\wp_{t_i} = a + bt_i$	$\lvert \wp_i - \wp_{t_i} \rvert$
2012	**60,48**	-3	9	-181,44	-47,04821429	107,53
2013	**91,82**	-2	4	-183,64	42,92785714	48,89
2014	**134,80**	-1	1	-134,80	132,9039286	1,90
2015	**222,78**	0	0	0	222,88	0,10
2016	**288,49**	+1	1	288,49	312,8560714	24,37
2017	**420,12**	+2	4	840,24	402,8321429	17,31
2018	**630,16**	+3	9	1890,48	492,8082143	137,35
TOTAL	**1560,16**	0	28	2519,33	1560,16	337,45

$$a = \frac{1560,16 \cdot 28}{7 \cdot 28} = 222,88 \quad b = \frac{7 \cdot 2519,33}{7 \cdot 28} = 89,97607143$$

$$v_I = \left[\frac{\sum_{i=-m}^{m} \lvert \wp_i - \wp_{t_i}^I \rvert}{n} : \frac{\sum_{i=-m}^{m} \wp_i}{n} \right] \cdot 100 = \frac{\sum_{i=-m}^{m} \lvert \wp_i - \wp_{t_i}^I \rvert}{\sum_{i=-m}^{m} \wp_i} \cdot 100 = \frac{337,45}{1560,16} \cdot 100 = 21,63\%$$

- if the „territorial profile" drawn by the values of the $\wp$ variable, namely the number of plug-in hybrid electric vehicles worldwide sales, „twinkles" through the $\wp_{t_i} = a + b \cdot t_i + ct_i^2$ „mould", a and b will be [4]:

Table 11. The „recipe of the texture" for the grouping of the values concerning the $\wp$ variable, namely the number of plug-in hybrid electric vehicles worldwide sales, if the „profile" has as hypothesis a quadratic tendency

YEARS	THE NUMBER OF PLUG-IN HYBRID ELECTRIC VEHICLES WORLDWIDE SALES (10^3) ($\wp_i$)	PARABOLIC TENDENCY					
		t_i	t_i^2	t_i^4	$t_i^2 \wp_i$	$\wp_{t_i} = a + bt_i + ct_i^2$	$\lvert \wp_i - \wp_{t_i} \rvert$
2012	**60,48**	-3	9	81	544,32	98,55714287	38,08
2013	**91,82**	-2	4	16	367,28	42,92785716	48,89
2014	**134,80**	-1	1	1	134,80	45,54071430	89,26
2015	**222,78**	0	0	0	0	106,3957143	116,38
2016	**288,49**	+1	1	1	288,49	225,4928572	63,00
2017	**420,12**	+2	4	16	1680,48	402,8321429	17,29
2018	**630,16**	+3	9	81	5671,44	638,4135715	8,25
TOTAL	**1560,16**	0	28	196	8686,81	1560,16	381,15

$$a=\frac{196\cdot 1560{,}16-28\cdot 8686{,}81}{7\cdot 196-28^2}=106{,}3957143 \quad b=\frac{7\cdot 2519{,}33}{7\cdot 28}=89{,}97607143$$

$$c=\frac{7\cdot 8686{,}81-28\cdot 1560{,}16}{6\cdot 196-28^2}=29{,}12107143$$

$$v_{II}=\left[\frac{\sum_{i=-m}^{m}\left|\wp_i-\wp_{t_i}^{II}\right|}{n}:\frac{\sum_{i=-m}^{m}\wp_i}{n}\right]\cdot 100=\frac{\sum_{i=-m}^{m}\left|\wp_i-\wp_{t_i}^{II}\right|}{\sum_{i=-m}^{m}\wp_i}\cdot 100=\frac{381{,}15}{1560{,}16}\cdot 100=24{,}43\%$$

- if the „territorial profile" drawn by the values of the $\wp$ variable, namely the number of plug-in hybrid electric vehicles worldwide sales, „twinkles" through the $\wp_{t_i}=ab^{t_i}$ „mould", a and b will be [4]:

Table 12. The „recipe of the mix" for the grouping of the values concerning the $\wp$ variable, namely the number of plug-in hybrid electric vehicles worldwide sales, if the „profile" has as hypothesis an exponential tendency

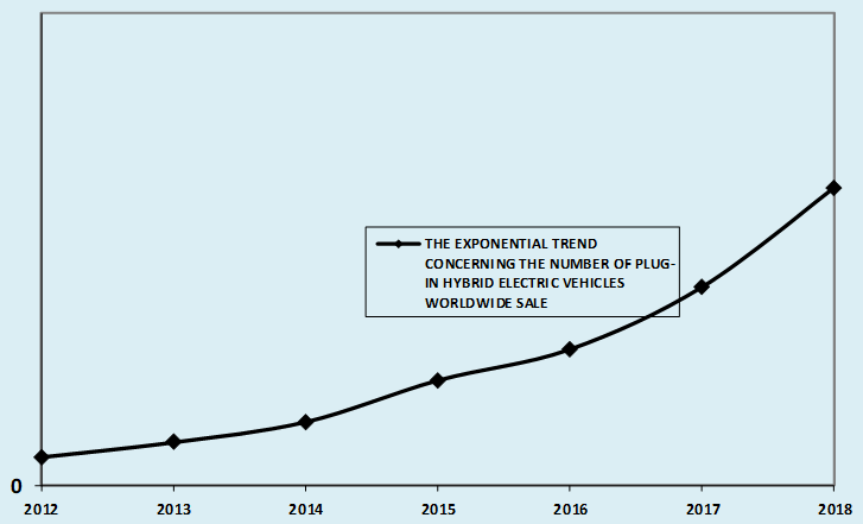
YEARS	THE NUMBER OF PLUG-IN HYBRID ELECTRIC VEHICLES WORLDWIDE SALES (10^3) ($\wp_i$)	EXPONENTIAL TENDENCY				
		$\lg \wp_i$	$t_i \lg \wp_i$	$\lg \wp_{t_i}=\lg a+t_i \lg b$	$\wp_{t_i}=ab^{t_i}$	$\left\|\wp_i-\wp_{t_i}\right\|$
2012	**60,48**	1,781611782	-5,344835347	1,796635379	62,60879987	2.13
2013	**91,82**	1,962937288	-3,925874577	1,964665020	92,18601038	0,37
2014	**134,80**	2,129689892	-2,129689892	2,132694661	135,7358794	0,94
2015	**222,78**	2,347876200	0	2,300724302	199,8592724	22,92
2016	**288,49**	2,460130764	2,460130764	2,468753943	294,2753894	5,79
2017	**420,12**	2,623373357	5,246746714	2,636783584	433,2949067	13,17
2018	**630,16**	2,799450832	8,398352497	2,804813225	637,9890502	7,83
TOTAL	**1560,16**	16,10507012	4,704829966			53,15

$$\lg a=\frac{16{,}10507012\cdot 28}{7\cdot 28}=2{,}300724302 \quad \lg b=\frac{7\cdot 4{,}704829966}{7\cdot 28}=0{,}168029641$$

$$v_{\exp}=\left[\frac{\sum_{i=-m}^{m}\left|\wp_i-\wp_{t_i}^{\exp}\right|}{n}:\frac{\sum_{i=-m}^{m}\wp_i}{n}\right]\cdot 100=\frac{\sum_{i=-m}^{m}\left|\wp_i-\wp_{t_i}^{\exp}\right|}{\sum_{i=-m}^{m}\wp_i}\cdot 100=\frac{53{,}15}{1560{,}16}\cdot 100=3{,}41\%$$

$$v_{\exp}=3{,}41\%<v_I=21{,}63\%<v_{\exp}=24{,}43\%$$

The look regarding the progress reflected by $\wp$ variable, namely the number of plug-in hybrid electric vehicles worldwide sales, is moulded by the $\wp_{t_i}=ab^{t_i}$ exponential contour.



Graph 3. The exponential countenance concerning the values of the worldwide sales of plug-in hybrid electric vehicles

$$\wp_{2020}^{WORLDWIDE\_PLUG-IN\_ELECTRIC\_VEHICLES\_SALES} = 199{,}8592724 \cdot 1{,}472412993^{5} = 1383{,}16\_thousands\_units$$

$$\wp_{2021}^{WORLDWIDE\_PLUG-IN\_ELECTRIC\_VEHICLES\_SALES} = 199{,}8592724 \cdot 1{,}472412993^{6} = 2036{,}58\_thousands\_units$$

5. The predictions exposed through the texture of the model regarding the values which focuse the worldwide sales of plug-in light vehicles

Table 13. The values regarding the number of plug-in light vehicles worldwide sales, between 2015-2019

YEARS	THE NUMBER OF PLUG-IN LIGHT VEHICLES WORLDWIDE SALES (million units)
2015	**0,55**
2016	**0,80**
2017	**1,28**
2018	**2,02**
2019	**2,21**

The sourse: „Statistics Portal United States"

- if the „territorial profile" drawn by the values of the γ variable, namely the number of plug-in light vehicles worldwide sales, „twinkles" through the $\gamma_{t_i} = a + b \cdot t_i$ „mould", a and b will be [4]:

Table 14. The „recipe of the composition" for the grouping of the values concerning the γ variable, namely the number of plug-in light vehicles worldwide sales, if the „profile" has as hypothesis a linear tendency

YEARS	THE NUMBER OF PLUG-IN LIGHT VEHICLES WORLDWIDE SALES (million units) (γ_i)	LINEAR TENDENCY				
		t_i	t_i^2	$t_i\gamma_i$	$\gamma_{t_i} = a + bt_i$	$\lvert\gamma_i - \gamma_{t_i}\rvert$
2015	**0,55**	-2	4	-1,10	0,464	0,09
2016	**0,80**	-1	1	-0,80	0,918	0,12
2017	**1,28**	0	0	0	1,372	0,09
2018	**2,02**	+1	1	2,02	1,826	0,19
2019	**2,21**	+2	4	4,42	2,280	0,07
TOTAL	**6,86**	0	10	4,54	6,86	0,56

$$a = \frac{6{,}86 \cdot 10}{5 \cdot 10} = 1{,}372 \ ; \ b = \frac{5 \cdot 4{,}54}{5 \cdot 10} = 0{,}454$$

$$v_I = \left[\frac{\sum_{i=-m}^{m} \lvert\gamma_i - \gamma_{t_i}^I\rvert}{n} : \frac{\sum_{i=-m}^{m} \gamma_i}{n} \right] \cdot 100 = \frac{\sum_{i=-m}^{m} \lvert\gamma_i - \gamma_{t_i}^I\rvert}{\sum_{i=-m}^{m} \gamma_i} \cdot 100 = \frac{0{,}56}{6{,}86} \cdot 100 = 8{,}16\%$$

- if the „territorial profile" drawn by the values of the γ variable, namely the number of plug-in light vehicles worldwide sales, „twinkles" through the $\gamma_{t_i} = a + b \cdot t_i + ct_i^2$ „mould", a and b will be [4]:

Table 15. The „recipe of the texture" for the grouping of the values concerning the γ variable, namely the number of plug-in light vehicles worldwide sales, if the „profile" has as hypothesis a quadratic tendency

YEARS	THE NUMBER OF PLUG-IN LIGHT VEHICLES WORLDWIDE SALES (million units) (γ_i)	PARABOLIC TENDENCY					
		t_i	t_i^2	t_i^4	$t_i^2\gamma_i$	$\gamma_{t_i} = a + bt_i + ct_i^2$	$\lvert\gamma_i - \gamma_{t_i}\rvert$
2015	**0,55**	-2	4	16	2,20	0,484	0,07
2016	**0,80**	-1	1	1	0,80	0,908	0,11
2017	**1,28**	0	0	0	0	1,352	0,07
2018	**2,02**	+1	1	1	2,02	1,816	0,20
2019	**2,21**	+2	4	16	8,84	2,300	0,09
TOTAL	**6,86**	0	10	34	13,86	6,86	0,54

$$a = \frac{34 \cdot 6{,}86 - 10 \cdot 13{,}86}{5 \cdot 34 - 10^2} = 1{,}352 \quad b = \frac{5 \cdot 4{,}54}{5 \cdot 10} = 0{,}454 \quad c = \frac{5 \cdot 13{,}86 - 10 \cdot 6{,}86}{5 \cdot 34 - 10^2} = 0{,}01$$

$$v_{II}=\left[\frac{\sum_{i=-m}^{m}\left|\gamma_i-\gamma_{t_i}^{II}\right|}{n}:\frac{\sum_{i=-m}^{m}\gamma_i}{n}\right]\cdot 100=\frac{\sum_{i=-m}^{m}\left|\gamma_i-\gamma_{t_i}^{II}\right|}{\sum_{i=-m}^{m}\gamma_i}\cdot 100=\frac{0{,}54}{6{,}86}\cdot 100=7{,}87\%$$

- if the „territorial profile" drawn by the values of the γ variable, namely the number of plug-in light vehicles worldwide sales, „twinkles" through the $\gamma_{t_i}=ab^{t_i}$ „mould", *a* and *b* will be [4]:

Table 16 The „recipe of the mix" for the grouping of the values concerning the γ variable, namely the number of plug-in light vehicles worldwide sales, if the „profile" has as hypothesis an exponential tendency

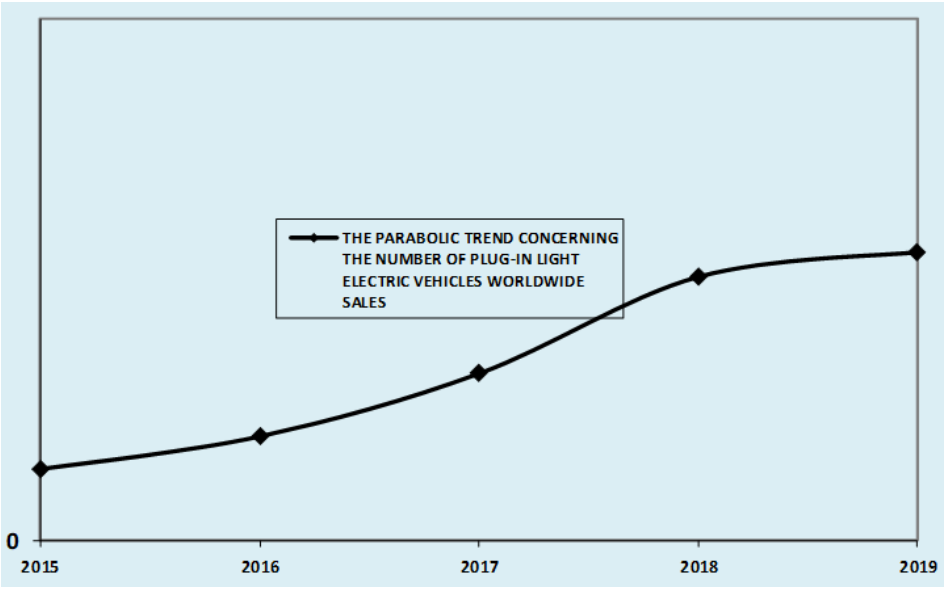
YEARS	THE NUMBER OF PLUG-IN LIGHT VEHICLES WORLDWIDE SALES (10^6) (γ_i)	EXPONENTIAL TENDENCY				
		$\lg\gamma_i$	$t_i\lg\gamma_i$	$\lg\gamma_{t_i}=\lg a+t_i\lg b$	$\gamma_{t_i}=ab^{t_i}$	$\left\|\gamma_i-\gamma_{t_i}\right\|$
2015	**0,55**	-0,259637310	0,519274621	-0,241982853	0,572818646	0,02
2016	**0,80**	-0,096910013	0,096910013	-0,080950798	0,829944788	0,03
2017	**1,28**	0,107209969	0	0,080081257	1,202489401	0,08
2018	**2,02**	0,305351369	0,305351369	0,241113312	1,742261388	0,28
2019	**2,21**	0,344392273	0,688784547	0,402145367	2,524325573	0,31
TOTAL	**6,86**	0,400406288	1,610320550			0,72

$$\lg a=\frac{0{,}400406288\cdot 10}{5\cdot 10}=0{,}080081257 \qquad \lg b=\frac{5\cdot 1{,}61032055}{5\cdot 10}=0{,}161032055$$

$$v_{\exp}=\left[\frac{\sum_{i=-m}^{m}\left|\gamma_i-\gamma_{t_i}^{\exp}\right|}{n}:\frac{\sum_{i=-m}^{m}\gamma_i}{n}\right]\cdot 100=\frac{\sum_{i=-m}^{m}\left|\gamma_i-\gamma_{t_i}^{\exp}\right|}{\sum_{i=-m}^{m}\gamma_i}\cdot 100=\frac{0{,}72}{6{,}86}\cdot 100=10{,}50\%$$

$$v_{II}=7{,}87\%<v_I=8{,}16\%<v_{\exp}=10{,}50\%$$

The look concerning the progress for γ factor, which records the number of plug-in light vehicles worldwide sales, is a $\gamma_{t_i}=a+b\cdot t_i+ct_i^2$ quadratic contour.



Graph 4. The quadratic countenance for the values of the worldwide sales of plug-in light vehicles

$$\gamma_{2020}^{WORLDWIDE\_PLUG-IN\_LIGHT\_VEHICLES\_SALES}=1{,}352+0{,}454\cdot 3+0{,}01\cdot 3^2=2{,}80\_millions\_units$$

$$\gamma_{2021}^{WORLDWIDE\_PLUG-IN\_LIGHT\_VEHICLES\_SALES}=1{,}352+0{,}454\cdot 4+0{,}01\cdot 4^2=3{,}33\_millions\_units$$

5. Conclusions

We can see that in 2020, respectively in 2021, the worldwide values of the battery electric vehicles in use rise at 10754,75 thousands units, respectively 18743,88 thousands units, which it means in relative

sizes an increase with 226,81 % in 2020 comparative to 2018, respectively with 469,58 % in 2021 comparative with 2018. As well, we can observe that in 2020, respectively in 2021, the worldwide values of the plug-in hybrid electric vehicles in use grow up at 3,75 millions units, respectively at 5,06 millions units and in dynamics, these values highlight a rise with 106,04 % in 2020 reported at 2018, respectively with 178,02 % in 2021 comparable with 2018. Likewise, we can evaluate that in 2020, respectively in 2021, the values of the worldwide sales of plug-in hybrid electric vehicles swell at 1383,15 thousands units in 2020, respectively 2036,58 thousands units in 2021 and in relative sizes, these increases signify a rise with 119,49 % in 2020 compared to 2018, respectively with 223,18 % in 2021 compared with 2018. Also, we can treasure that in 2020, respectively in 2021, the worldwide values of the plug-in light vehicles in use jump at 2,80 millions units in 2020, respectively at 3,33 millions units in 2021, values which display rises in relative sizes with 26,70 % in 2020 comparable with 2019, respectively with 50,68 % in 2021 „face to face" with 2019.

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