



An Econometric Analysis of the Automotive Industry in Germany – Drivers of Sales of Electric Vehicles



Econometrics 2020-2021

Group Mambo No.6

(16461)

Content



Challenges in automotive



Conclusion

Market analysis



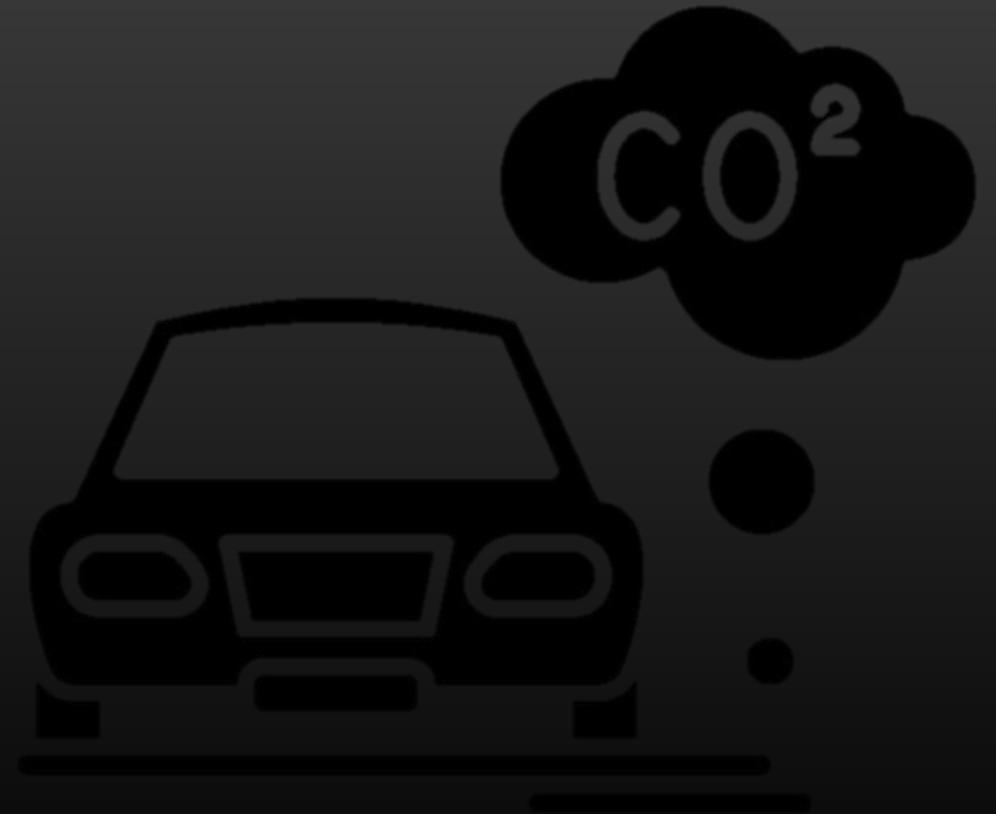
Data evaluation





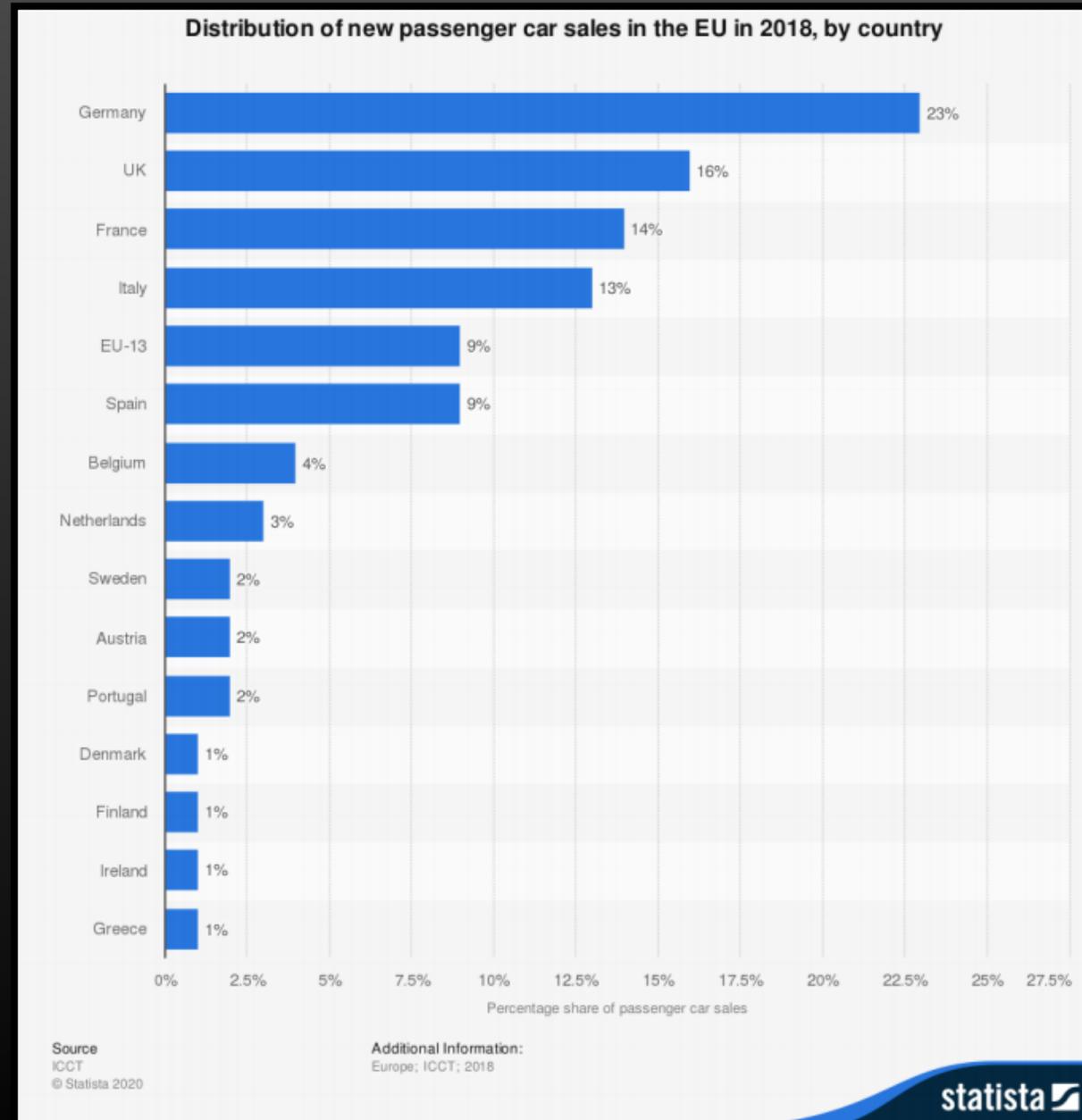
Challenges in Automotive

- Environmental pressure & fuel dependency
- Rise of car sharing
- Electric vehicles
- Connected Vehicles





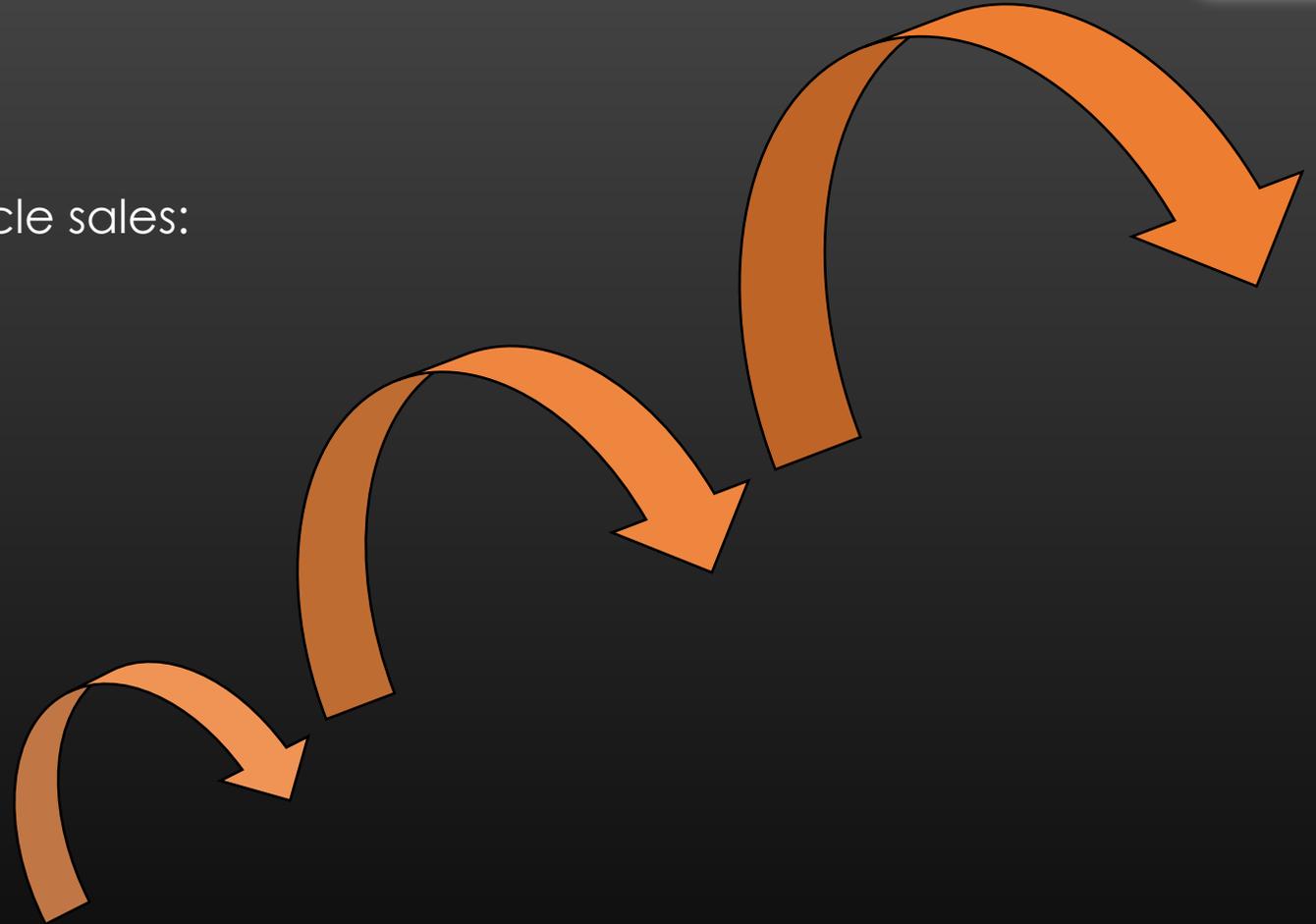
Importance of the automotive industry in Germany





Market analysis

- Reasons for the growth of electric vehicle sales:
 - Environmental pressure
 - Price decrease
 - Charging network
 - Incentives
 - More alternatives
 - Potentially the better technical solution





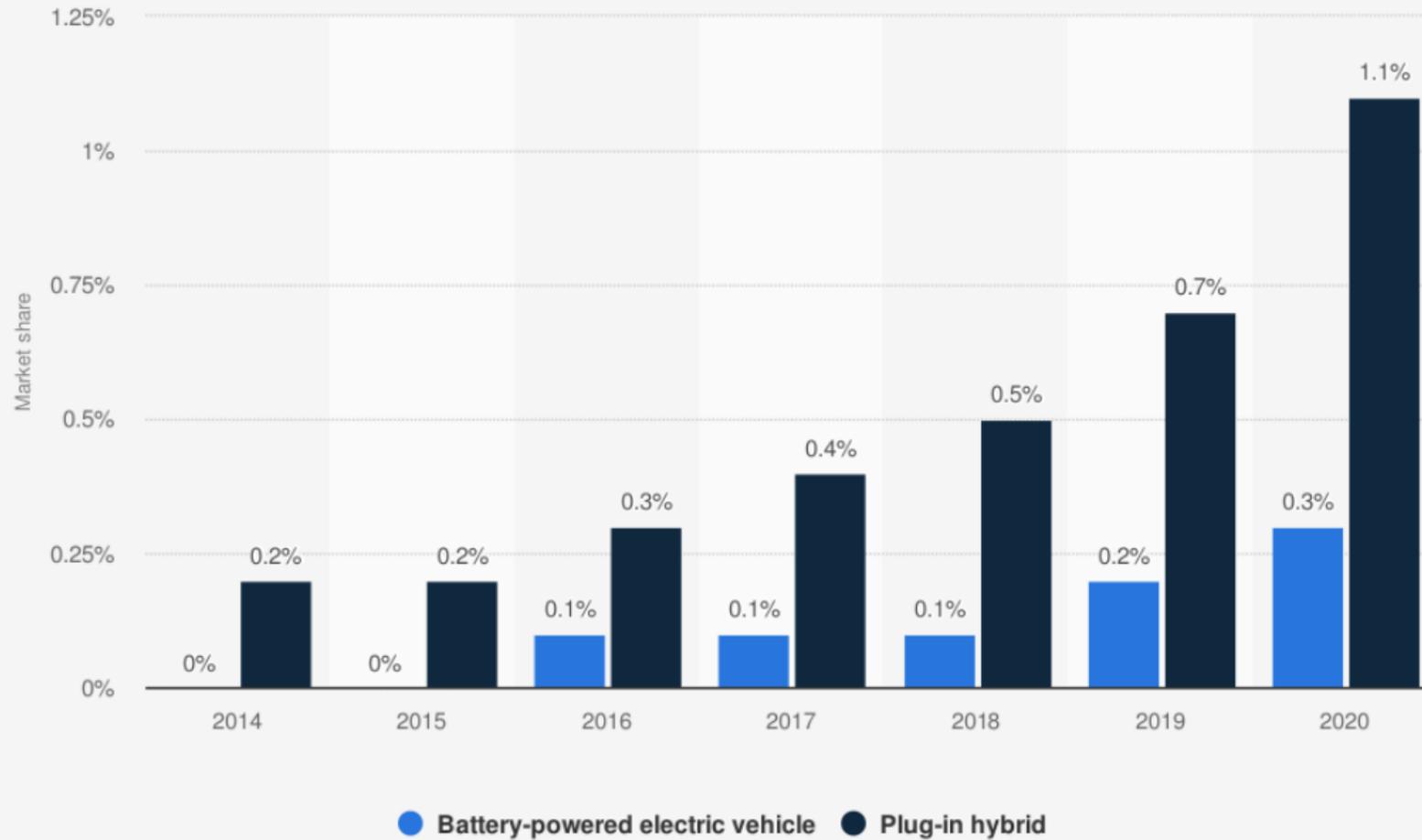
Market analysis

- Challenges for the electric vehicle:
 - Charging infrastructure
 - Range
 - High price
 - Quality issues





Market share of electric vehicles in Germany from 2014 to 2020



Source
KBA
© Statista 2020

Additional Information:
Germany; 2014 to 2020



What are the
drivers of sales
of electric
vehicles?





Data evaluation

Linear Regression Model

$$Y = \beta_1 + \beta_2 X + \varepsilon$$

Quarters	charging_station	battery_pack_price	electric_vehicles
2012 Q1	1.500	721	817
2012 Q2	1.500	721	954
2012 Q3	1.500	721	1362
2012 Q4	1.500	721	1408
2013 Q1	2.400	663	1282
2013 Q2	2.400	663	1494
2013 Q3	2.400	663	2134
2013 Q4	2.400	663	2205
2014 Q1	2.606	588	2188
2014 Q2	2.606	588	2553
2014 Q3	2.606	588	3647
2014 Q4	2.606	588	3768
2015 Q1	4.587	381	3412
2015 Q2	4.587	381	3979
2015 Q3	4.587	381	4684
2015 Q4	4.587	381	5874
2016 Q1	16.266	293	4590
2016 Q2	16.266	293	5355
2016 Q3	16.266	293	7651
2016 Q4	16.266	293	7906
2017 Q1	22.213	219	6124
2017 Q2	22.213	219	7145
2017 Q3	22.213	219	10207
2017 Q4	22.213	219	10547
2018 Q1	23.112	180	9695
2018 Q2	23.112	180	11311
2018 Q3	23.112	180	16158
2018 Q4	23.112	180	16697
2019 Q1	28.382	156	14972
2019 Q2	28.382	156	17467
2019 Q3	28.382	156	24953
2019 Q4	28.382	156	25784



Data evaluation

The screenshot displays the RStudio environment. The top-left pane shows the R script with the following code:

```
1 Mambo<-lm(electric_vehicles~charging_station+battery_pack_price, data = DataCars)
2 summary(Mambo)
3 anova(lm(electric_vehicles~charging_station, data = DataCars))
4 res.lm<-Mambo$residuals
5 haty.lm<-Mambo$fitted.values
6 plot(haty.lm,res.lm)
7 abline(h=0,col="blue")
8 scatter.smooth(x=DataCars$electric_vehicles, y=DataCars$charging_station+DataCars$battery_pack_price, main="electric_vehicles~charging_station+battery_pack_price")
9
```

The bottom-left pane shows the console output:

```
charging_station 1 1056958020 1056958020 87.394 2.145e-10 ***
Residuals      30 362826730 12094224
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
> res.lm<-Mambo$residuals
> haty.lm<-Mambo$fitted.values
> plot(haty.lm,res.lm)
> abline(h=0,col="blue")
> scatter.smooth(x=DataCars$electric_vehicles, y=DataCars$charging_station+DataCars$battery_pack_price, main="electric_vehicles~charging_station+battery_pack_price")
>
```

The top-right pane shows the Environment window with the following table:

Name	Type	Length	Size	Value
DataCars	tbl_df	4	4 KB	32 obs. of 4 variables
haty.lm	numeric	32	2.5 KB	Named num [1:32] 1452 145...
Mambo	lm	12	25 KB	List of 12
res.lm	numeric	32	2.5 KB	Named num [1:32] -635.1 -...

The bottom-right pane shows a scatter plot titled "electric_vehicles~charging_station+battery_pack_price". The x-axis is labeled "DataCars\$electric_vehicles" and ranges from 0 to 25000. The y-axis is labeled "DataCars\$charging_station + DataCars\$battery_pack_price" and ranges from 0 to 20000. The plot displays a scatter of data points with a smooth curve fitted to the data, showing a positive correlation between the variables.



Data evaluation

The screenshot shows an RStudio session with the following R code and output:

```
1 Mambo<-lm(electric_vehicles~charging_station+battery_pack_price, data = DataCars)
2 summary(Mambo)
```

Call:
lm(formula = electric_vehicles ~ charging_station + battery_pack_price, data = DataCars)

Residuals:

Min	1Q	Median	3Q	Max
-6645.1	-1791.5	-67.1	1413.8	9496.3

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	-663.9045	5096.2159	-0.130	0.897249
charging_station	0.5879	0.1602	3.671	0.000971 ***
battery_pack_price	1.7118	7.8123	0.219	0.828097

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3534 on 29 degrees of freedom
Multiple R-squared: 0.7449, Adjusted R-squared: 0.7273
F-statistic: 42.33 on 2 and 29 DF, p-value: 2.5e-09

> |

The yellow box highlights the following t-value and p-value for the 'charging_station' variable:

t value	Pr(> t)
-0.130	0.897249
3.671	0.000971 ***
0.219	0.828097



Data evaluation

The screenshot shows the RStudio interface with the following components:

- Source Editor:** Contains R code for fitting a linear model and performing an ANOVA test.
- Environment:** Lists objects in the Global Environment: 'DataCars' (tbl_df, 4 columns, 4 KB, 32 observations) and 'Mambo' (lm, 12 rows, 25 KB).
- Console:** Displays the output of the R code, including coefficients, residual standard error, R-squared values, and an ANOVA table.

R Code in Source Editor:

```
1 Mambo<-lm(electric_vehicles~charging_station+battery_pack_price, data = DataCars)~
2 summary(Mambo)~
3 anova(lm(electric_vehicles~charging_station, data = DataCars))~
4 |
```

Console Output:

```
~/Mambo No.6/
Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)   -663.9045   5096.2159  -0.130  0.897249
charging_station    0.5879    0.1602   3.671  0.000971 ***
battery_pack_price  1.7118    7.8123   0.219  0.828097
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3534 on 29 degrees of freedom
Multiple R-squared:  0.7449,    Adjusted R-squared:  0.7273
F-statistic: 42.33 on 2 and 29 DF,  p-value: 2.5e-09

> anova(lm(electric_vehicles~charging_station, data = DataCars))
Analysis of Variance Table

Response: electric_vehicles
              Df      Sum Sq   Mean Sq F value    Pr(>F)
charging_station  1 1056958020 1056958020  87.394 2.145e-10 ***
Residuals       30  362826730  12094224
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
> |
```

Environment Panel:

Name	Type	Len...	Size	Value
DataCars	tbl_df	4	4 KB	32 obs. of 4 v...
Mambo	lm	12	25 KB	List of 12

ANOVAs Table (from console):

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
charging_station	1	1056958020	1056958020	87.394	2.145e-10 ***
Residuals	30	362826730	12094224		

Highlighted ANOVA Results:

Pr(>F)
2.145e-10 ***



Data evaluation

Mambo No.6

```
1 Mambo<-lm(electric_vehicles~charging_station+battery_pack_price, data = DataCars)
2 summary(Mambo)
3 anova(lm(electric_vehicles~charging_station, data = DataCars))
4 res.lm<-Mambo$residuals
5 haty.lm<-Mambo$fitted.values
6 plot(haty.lm,res.lm)
7 abline(h=0,col="blue")
```

Environment History Connections

Global Environment

Name	Type	Length	Size	Value
DataCars	tbl_df	4	4 KB	32 obs. of 4 variables
haty.lm	numeric	32	2.5 KB	Named num [1:32] 1452 1...
Mambo	lm	12	25 KB	List of 12
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Files Plots Packages Help Viewer

Zoom Export Publish

7:23 (Top Level) R Script

Console Terminal Jobs

~/Mambo No.6/

Analysis of Variance Table

Response: electric_vehicles

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
charging_station	1	1056958020	1056958020	87.394	2.145e-10 ***
Residuals	30	362826730	12094224		

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```
> res.lm<-Mambo$residuals
> haty.lm<-Mambo$fitted.values
> plot(haty.lm,res.lm)
> abline(h=0,col="blue")
>
```



Conclusion

- E-Mobility is on the rise
- Charging station-network is a significant factor in E-mobility
- Yet, internal combustion still reigns supreme in personal transportation



Sources

- <https://www.statista.com/>
- https://www.bing.com/images/search?view=detailV2&ccid=5IS3ITxF&id=9D2672128F9CF6C1CF57C6A91E00E536B927720B&thid=OIP.5IS3ITxF0CW4_KVhrhNA7gHaEK&mediurl=http%3a%2f%2fimages.car.bausercontent.com%2fpagefiles%2f78015%2ftesla_roadster_05.jpg&exph=956&expw=1700&q=tesla+roadster&simid=608007875870721664&ck=1B3F3537D27736F4AEA6FD9F75335C93&selectedIndex=16&FORM=IRPRST&ajaxhist=0
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- https://www.bing.com/images/search?view=detailV2&ccid=vMm3vRT6&id=EB245C918064A277F4719025D0A7DED7F28EDD84&thid=OIP.vMm3vRT6-TMN8ymGeWRKgAHaH_&mediurl=https%3a%2f%2fcdn5.vectorstock.com%2fi%2f1000x1000%2f45%2f04%2fmotor-vehicle-pollution-black-icon-sign-on-vector-23014504.jpg&exph=1080&expw=1000&q=environment+pollution+car+icon&simid=607993062578458621&ck=8267102D7767C5434DED725DE4628E4D&selectedIndex=54&FORM=IRPRST&ajaxhist=0
- https://www.bing.com/images/search?view=detailV2&ccid=fEPn%2bzIG&id=A2D008CA203F43BAAC3954A1191268AF1B415E10&thid=OIP.fEPn-zlGmXKWpPtDh5fn4wHaHa&mediurl=https%3a%2f%2fwww.nauticawebshop.com%2fimage%2fcache%2fdata%2fosculati%2findicatore_cromato_osculati-500x500.jpg&exph=500&expw=500&q=indicatore+stato+benzina+nero&simid=608003546547947809&ck=1D00B5210098130D9948B50703954D61&selectedIndex=85&FORM=IRPRST&ajaxhist=0

Thank you for listening