



POLITECNICO
MILANO 1863

E-MOBILITY IN IRELAND

Group:

Benedetta Maria Argenio
Alberto Caverzeran
Andrea Pasotti
Federica Principe
Maria Rombolotti

In collaboration with:

Marta Galvani
Agostino Torti

1. INTRODUCTION

DISCUSSION

Government to invest €20m in electric vehicle charging points

«Irish Times ~ 5.04.2019»

58 public car charging points now operational in Cork

«TheCork.IE ~ 29.03.2019»

22 public car charging points now operational in Mayo

«Connaught Telegraph ~ 20.03.2019»

Keeping apace with electric development

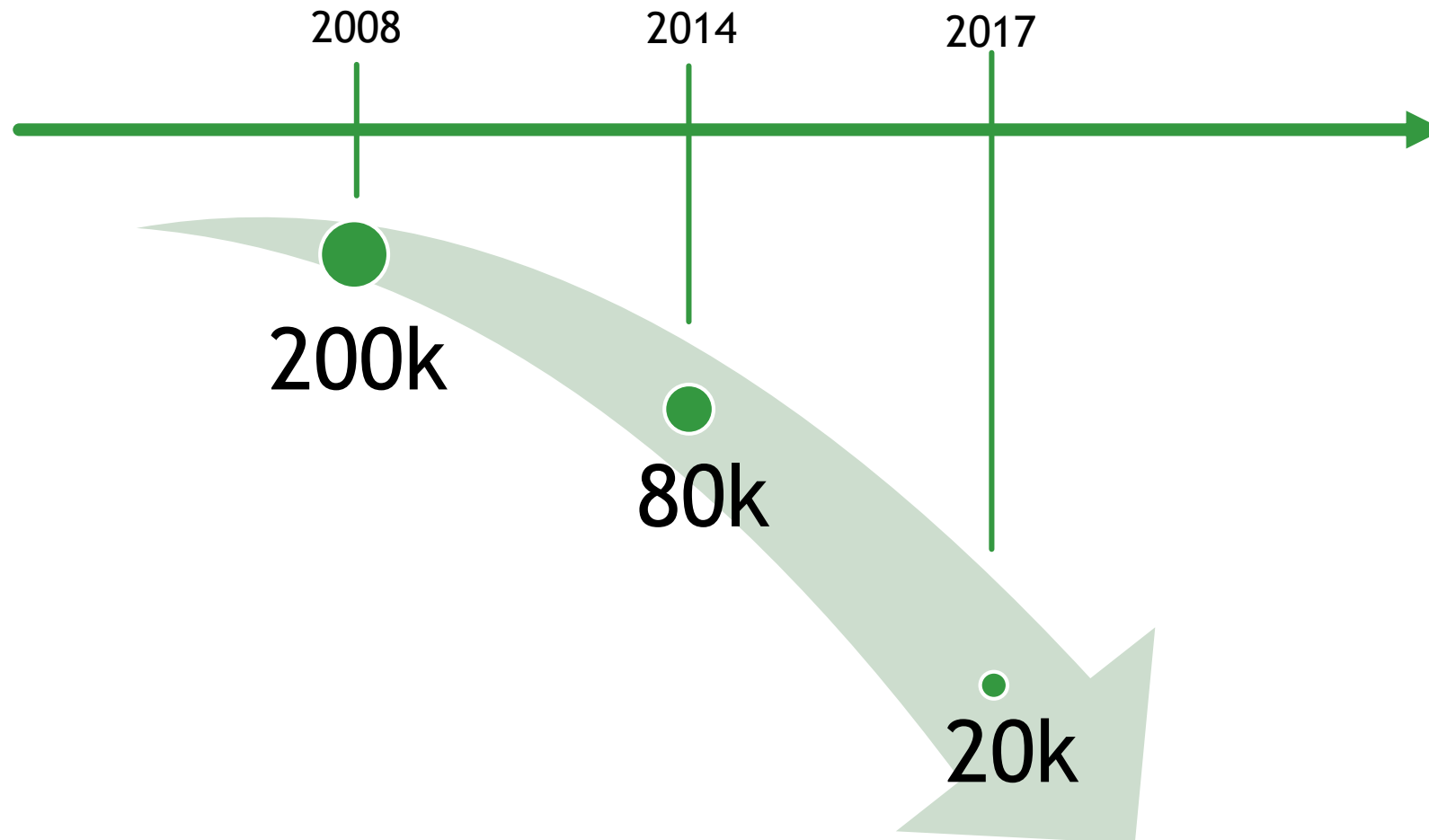
«Leinstner Express ~ 24.03.2019»

Officials back away from 2020 electric car target

«The Times ~ 11.06.2017»

PROBLEM PRESENTATION

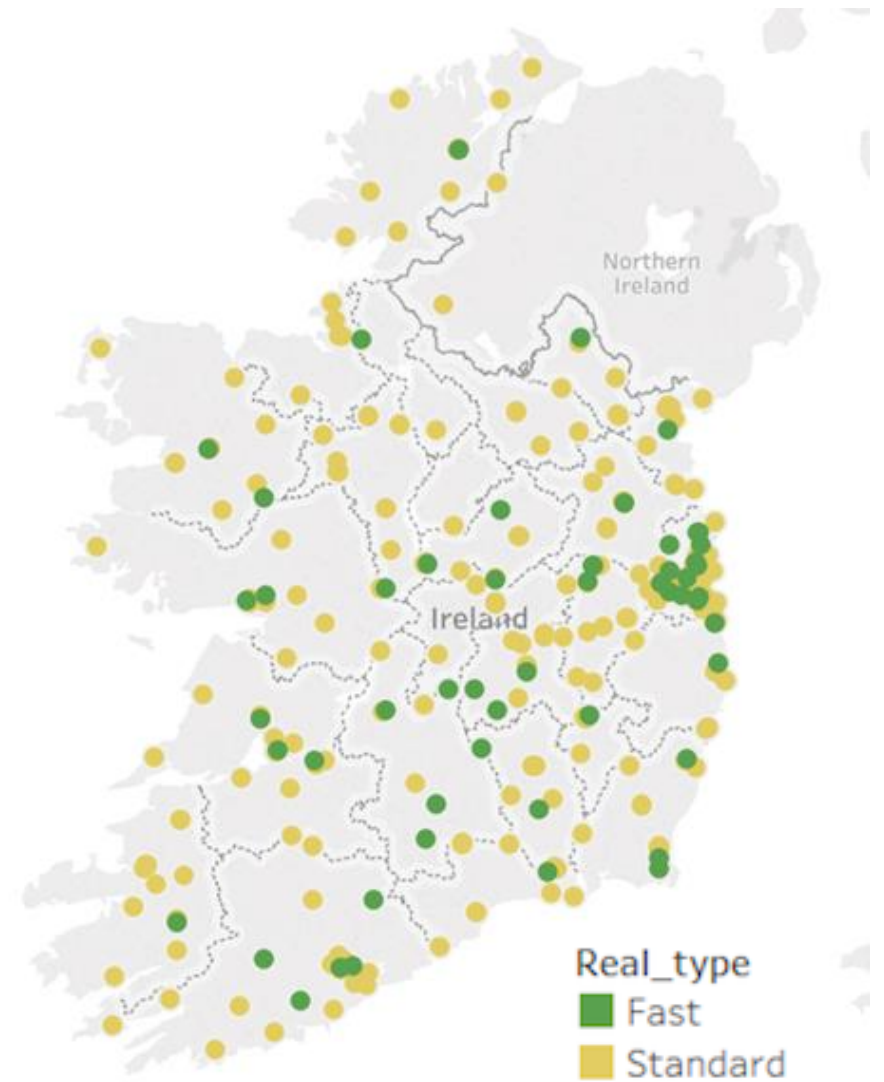
- ▶ Ireland's government target for the number of Electric Vehicles by 2020:



2. DATASETS

CHARGE POINTS

- ▶ Located every 50 km on all the major urban routes.
- ▶ The status of each charge points is monitored every 5 minutes.
- ▶ Fast/Standard



NEW DATASETS (ACTIVE CHARGE POINTS)

Organized by active charge points:

- ▶ ID
- ▶ Type (Standard, Fast)
- ▶ Latitude, Longitude
- ▶ County and Town
- ▶ Position and Area
- ▶ Position Details
- ▶ Percentage of use (2018)

	ID	Real_type	Latitude	Longitude	County	Town	Position	Area	Position.Details	Percentage_Use
1	CP:C23BF-A/B	Standard	51.91976	-8.482733	Cork	Cork City	Urban	City	Commercial	0.0300799087
2	CP:C248J	Fast	53.28220	-9.065258	Galway	Galway City	Urban	City	Motorway	0.0050799087
3	CP:C24JY	Fast	53.62560	-7.466100	Westmeath	Ballinalack	Rural	Country	Motorway	0.0034817352
4	CP:C256J	Standard	53.94129	-8.100110	Roscommon	Carrick-on-Shannon	Urban	Town	Residencial	0.0229452055
5	CP:C2CWB-A/B	Standard	53.14636	-7.181829	Laois	Portarlinton	Urban	Town	Residencial	0.0096461187
6	CP:C2D7M	Fast	53.41278	-6.216111	Dublin	Dublin 17	Urban	City	Residencial	0.0756278539
7	CP:C2G96-A/B	Standard	53.72392	-7.795273	Longford	Longford town	Urban	Town	Commercial	0.0136986301
8	CP:C2GS3-A/B	Standard	53.18506	-6.808063	Kildare	Newbridge	Urban	Town	Residencial	0.0150114155

NEW DATASETS (IRELAND COUNTIES)

Organized by counties:

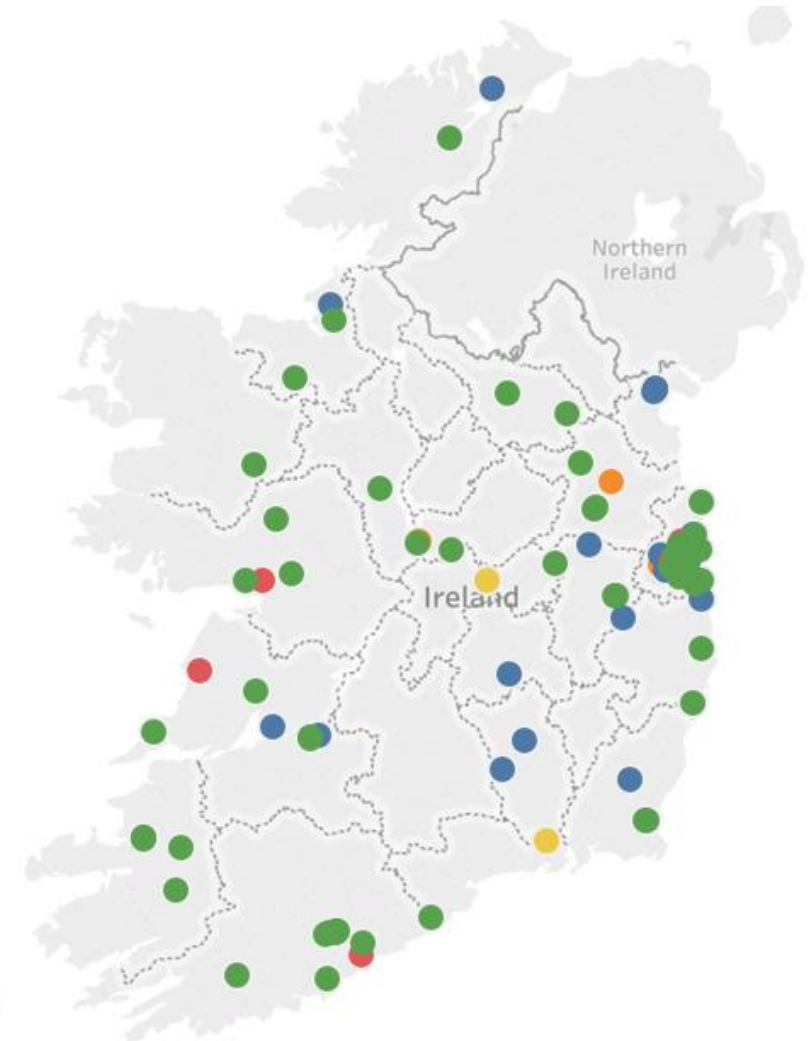
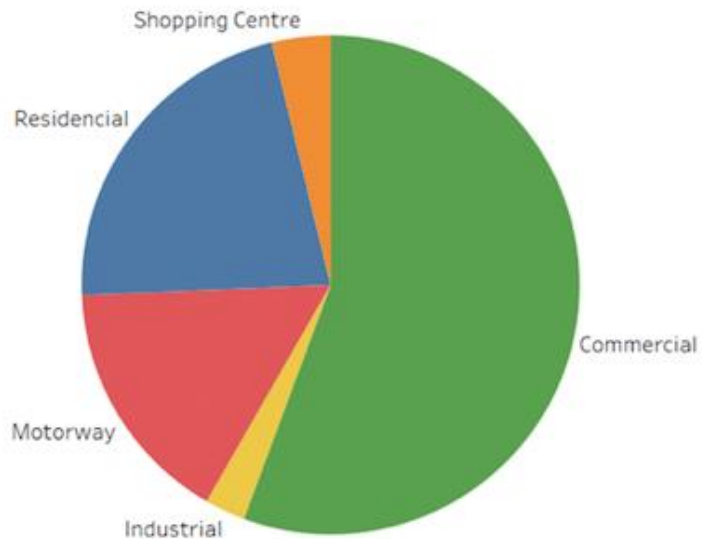
- ▶ County
- ▶ Population
- ▶ Income
- ▶ Number of CPs (All, Fast, Slow)
- ▶ Number of Commuting Vehicles
- ▶ Distance and Time to Work
- ▶ Average percentage use (2018)

	County	Population	Income	ChargeP_N	ChargeP_FastN	ChargeP_SlowN	Commuting_Vehicles	Distance_Work	Time_Work	Avg_Percentage_Use
1	Carlow	56875	19.862	7	1	6	14400	20.43	28.50	0.019381931
2	Cavan	76092	18.761	5	0	5	19900	20.63	28.50	0.110034247
3	Clare	118627	18.584	10	2	8	34100	17.96	24.50	0.061033105
4	Cork	542196	20.899	29	5	24	153400	15.87	25.56	0.093778539
5	Donegal	158755	16.099	16	2	14	37600	17.09	22.10	0.027026256
6	Dublin	1345402	24.061	65	12	53	283000	8.11	30.51	0.136649104

WHICH ARE THE MOST USED STATIONS?

- ▶ The 80% of the total usage is given by 99 charge points out of 343

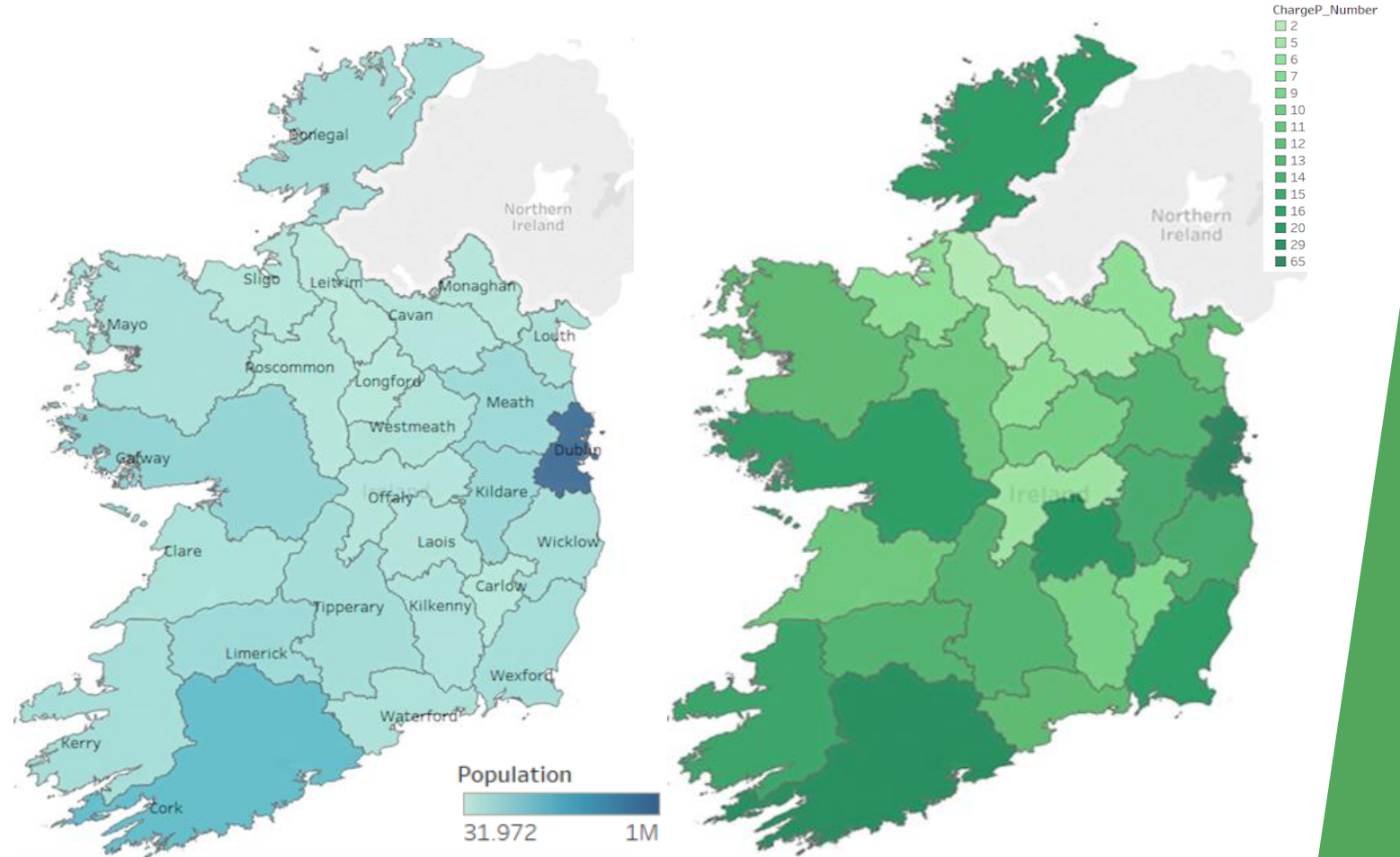
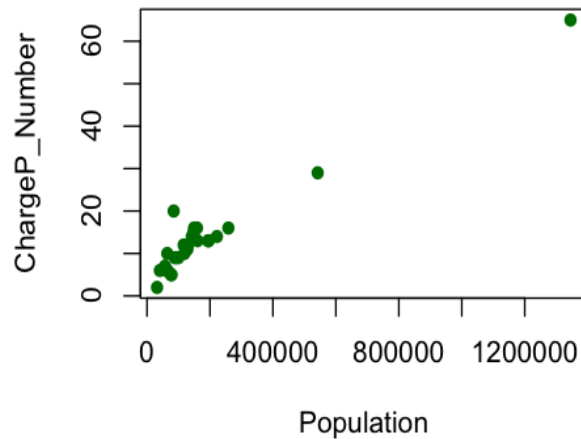
Piechart of the global positions



ARE THE CHARGE POINTS WELL LOCATED?

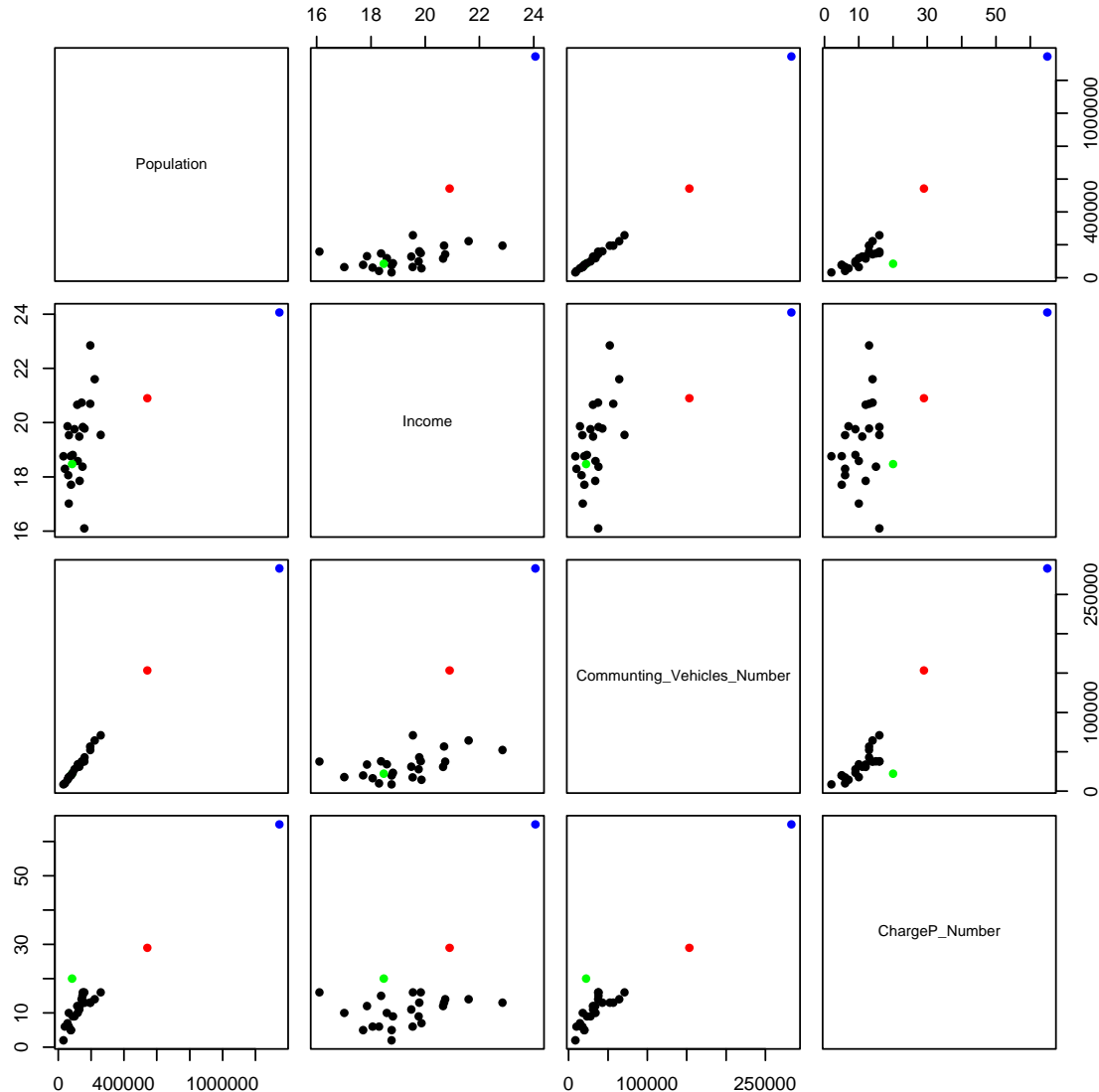
The number of charge-points is linked to the number of the county's inhabitants:

→ Dublin, Cork, Galway: higher population and higher number of charge points



3. LINEAR REGRESSION

PAIRS OF THE DATA



Data exploration:

Comparison of the number of charge points in each county with respect to its population, the number of commuting vehicles and the average income of its inhabitants.

Identification of the Outliers:

- Cork
- Dublin
- Laois

LINEAR REGRESSION

Linear regression after the elimination of the 'outliers':

```
Call:
lm(formula = ChargeP_Number ~ Population + Income + Communting_Vehicles_Number)

Residuals:
    Min       1Q   Median       3Q      Max
-3.2790 -1.1014  0.1491  0.8697  3.3094

Coefficients:
                Estimate Std. Error t value Pr(>|t|)
(Intercept)      5.852e+00  6.136e+00   0.954  0.35224
Population        2.087e-04  5.981e-05   3.489  0.00246 **
Income           -1.813e-01  3.329e-01  -0.545  0.59240
Communting_Vehicles_Number -5.321e-04  2.183e-04  -2.438  0.02478 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.914 on 19 degrees of freedom
Multiple R-squared:  0.8117,    Adjusted R-squared:  0.782
F-statistic: 27.3 on 3 and 19 DF,  p-value: 4.252e-07
```

We proceed applying a stepwise method till the optimal outcome.

LINEAR REGRESSION

```
Call:
lm(formula = ChargeP_Number ~ Population + Communting_Vehicles_Number)

Residuals:
    Min       1Q   Median       3Q      Max
-3.1060 -1.2596  0.2927  0.9521  3.6578

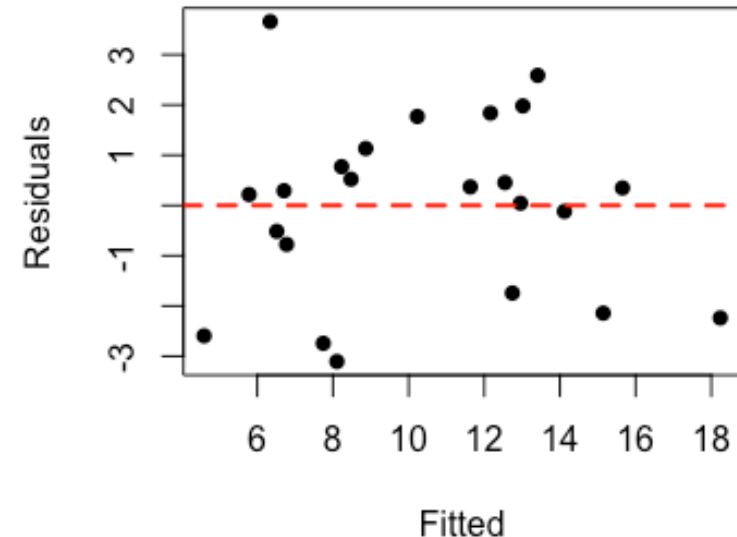
Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.552e+00  9.426e-01  2.707 0.013571 *
Population    2.196e-04  5.538e-05  3.965 0.000764 ***
Communting_Vehicles_Number -5.786e-04  1.973e-04 -2.933 0.008217 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.88 on 20 degrees of freedom
Multiple R-squared:  0.8087,    Adjusted R-squared:  0.7896
F-statistic: 42.29 on 2 and 20 DF,  p-value: 6.547e-08
```

Shapiro-Wilk normality test

```
data: fit2$residuals
W = 0.9626, p-value = 0.5179
```

Residuals vs Fitted Values



This proves that the number of Charge Point per County is indeed linked to the Population and the number of Commuting Vehicles.

4. WHAT'S NEXT

GOALS

- ▶ Cluster analysis of the counties to better understand the pattern of charge point usage in Ireland
- ▶ Further spatial analysis of the dataset
- ▶ Individuate the strategic position for new charging stations
- ▶ Predict the charge point demand in the future

THANKS FOR THE ATTENTION!