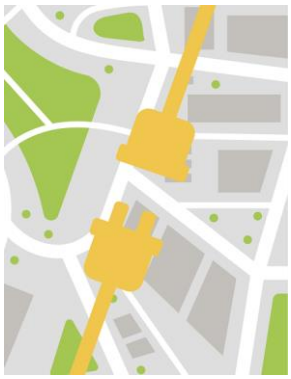

ELECTRIC TRAVELLING

Platform to support the implementation of electromobility in Smart Cities based on ICT applications

Case study for Poland

Table of Contents

1 Executive summary 3

2 Scenario descriptions 3

3 Simulation results 6

4 Comparison of scenarios 7

5 Conclusion and recommendations 12

1 Executive summary

This document presents information about case study results for Silesia region. The results were achieved by using all modules of the ETSys: ETCharge to estimate future charging stations locations, ETSim to simulate travels (by sending queries to ETPlanner module) and collect data about them, ETReport together with internal module ETComparison to select scenarios for comparison and get final summary of the results. This is proof of full integration and the need to use each of the modules.

Full system ETSys allows to compare different of data for current or future scenarios including:

- Origin-Destination matrix
- Charging station location
- Fleet distribution
- Prioritization areas or selected links on transport network
- GTFS – where changes related to schedules, stops locations, line routes could be included

Finally, the case study included changes in the location of charging stations and the distribution of the electric car fleet.

2 Scenario descriptions

Based on data collected during previous Workpackages as scenario to case study Silesia region was selected (19 cities including Sosnowiec City). The following assumptions were made for the implementation of the case study:

- Origin-Destination matrix

Silesia region was divided into 319 zones. Total number of personal car travels by one day is equal 2,546,692.

- Charging station location

To realize case study two different list of charging stations were used – current state and forecast for 2030 year.

Current state includes 102 location of implemented charging stations at Silesia region (Figure 1). For Poland this year is important from the point of view because of Law Act Electromobility

and alternative fuels. This law act describes requirements about minimum number of charging stations for electric vehicles in big cities before end of 2020 year.

Forecast for 2030 year is based on ETCharge module (Figure 2). This module estimated future number of charging stations for six NUTS (PL22B sosnowiecki, PL228 bytomski, PL229 gliwicki, PL22A katowicki, PL22C tyski and PL227 rybnicki) as 19 in total including two outside Silesia region (Figure 3).

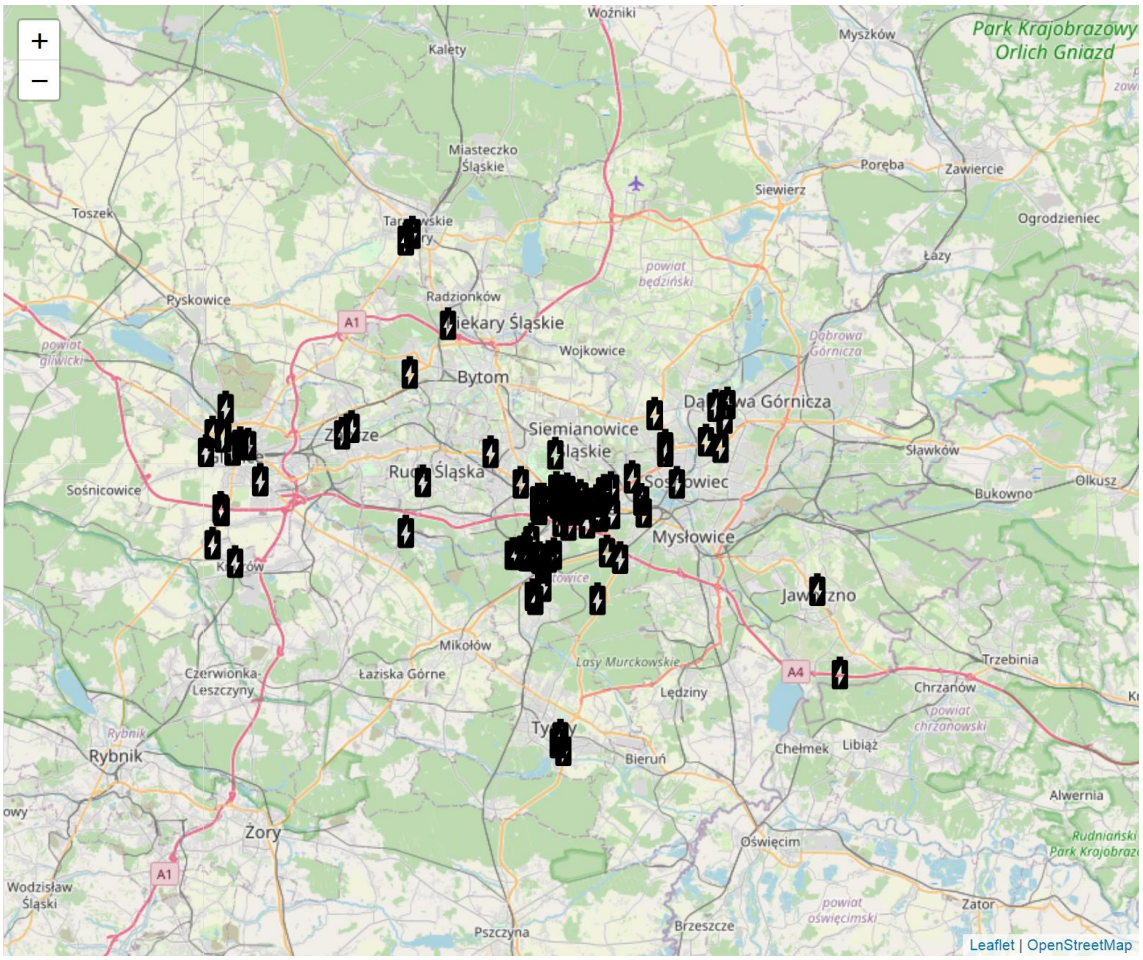

Fig. 1. Existing 102 charging stations at Silesia region

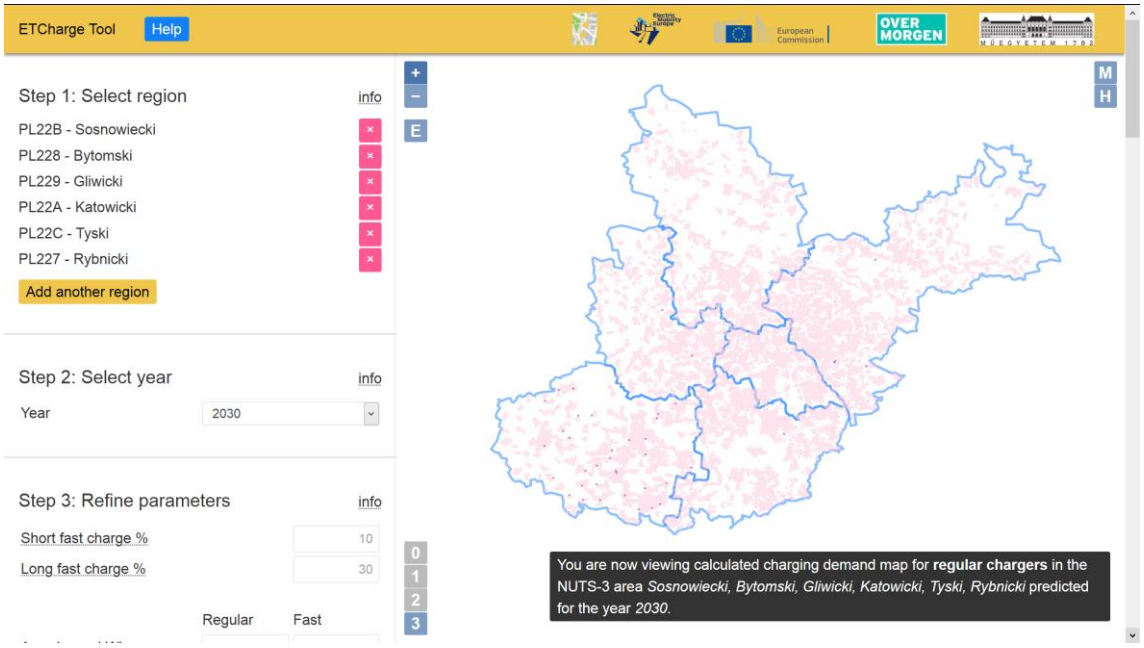

Fig. 2. Results from ETCharge tool visualization

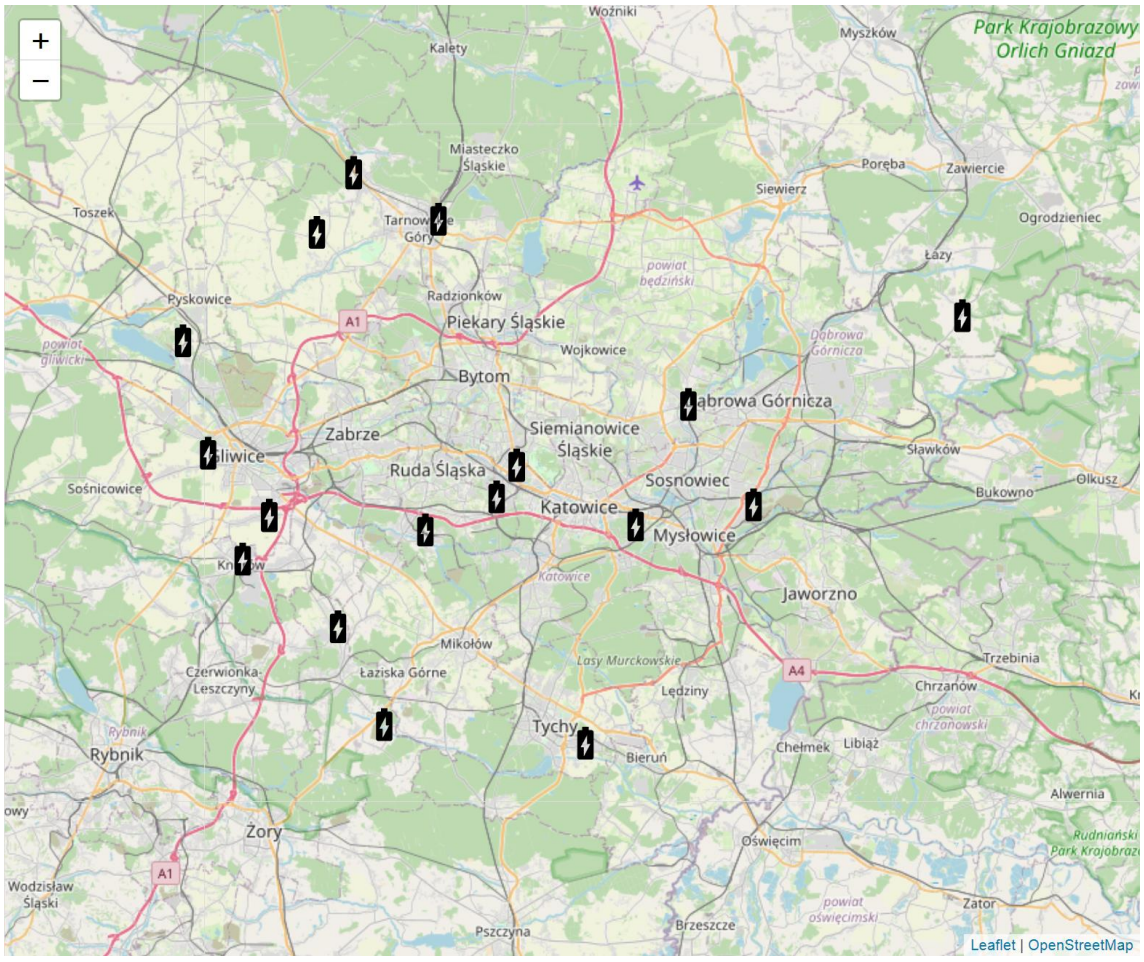

Fig. 3. Charging stations forecast as result from ETCharge

- Fleet distribution

Three scenario were prepared for Silesia region (Table 1). Actual is estimation of current state of personal car distribution. Two scenarios for 2030 were adopted, one optimistic, assuming an intensive increase in the share of electric and hybrid cars in Poland, and the other determining the real growth resulting from the data so far.

Table 1 Fleet distribution scenarios for Silesia region (Poland)

	Actual	Future_1	Future_2
Personal Cars (PC)	**100,00%**	**100,00%**	**100,00%**
PETROL: "PC/PC petrol Euro-5"	40,00%	0,00%	14,00%
PETROL: "PC/PC petrol Euro-6ab"	15,00%	18,00%	33,00%
DIESEL: "PC/PC diesel Euro-5"	20,00%	0,00%	8,00%
DIESEL: "PC/PC diesel Euro-6a"	11,00%	15,00%	22,00%
BEV: "PC/PC BEV"	0,02%	33,00%	4,52%
CNG: "PC/PC CNG/petrol Euro-6_(CNG)"	0,16%	2,00%	0,16%
LGP: "PC/PC LPG/petrol Euro-6_(LPG)"	13,80%	10,00%	13,80%
PH: "PC/PC PHEV diesel Euro-6ab_(El)"	0,02%	20,00%	4,52%
FC: "PC/PC FuelCell"	0,00%	2,00%	0,00%

3 Simulation results

The simulation consisted in sending queries between the ETSim module and the ETPlanner module. In response, the course of the route was obtained for each travel with the resulting parameters specifying the travel time, distance, energy used, cost, emission volume, etc.

The simulation concerned the scenarios discussed in the earlier chapter. Thus, six unique sets of simulation results were created:

- A1 - Current state of charging stations and current fleet scenario
- A2 - Current state of charging stations and future (optimistic for electromobility development) fleet scenario
- A3 - Current state of charging stations and future (realistic) fleet scenario
- B1 - Future charging stations list (from ETCharge) and current fleet scenario
- B2 - Future charging stations list (from ETCharge) and future (optimistic for electromobility development) fleet scenario

- B2 - Future charging stations list (from ETCharge) and future (realistic) fleet scenario

Later in the report, short names for each dataset will be used.

4 Comparison of scenarios

Using the ETReport module, this chapter presents comparisons of individual data sets. Two types of comparative analyzes have been adopted - numerical in relation to specific parameters and graphic, showing the distribution of phenomena in space.

During numerical comparisons the value for the current state was assumed as 100%. In this way, future scenarios show an increase (above 100%) or a decrease (below 100%) of a given parameter.

Simulated results from current state (A1) are as follow:

- Global direct cost (total amount of emissions), gCO2 = 3013000676
- Global direct cost, MJ = 3080230129
- Energy used, kWh = 34511341
- Total travel time, s = 123496023

Tables 2 and 3 shows comparison between current fleet distribution and the assumed in future for current charging stations location (Table 2) and the future one (Table 3).

Table 2 Results comparison for current state of charging stations for Silesia region (Poland)

Simulated scenario	Global direct cost	Global indirect cost	Global energy used	Total travel time
A1	100,00%	100,00%	100,00%	100,00%
A2	64,18%	131,08%	85,08%	102,88%
A3	94,44%	110,00%	130,62%	100,85%

Table 3 Results comparison for forecast from ETCharge module charging stations location for Silesia region (Poland)

Simulated scenario	Global direct cost	Global indirect cost	Global energy used	Total travel time
B1	100,00%	100,00%	100,00%	100,00%
B2	71,19%	152,95%	90,25%	162,86%
B3	94,80%	112,52%	124,21%	108,68%

Comparison between A1 and B1 shows almost the same values. In B1 scenario values are not higher than 2 %.

On the other hand, graphical comparisons were made using heat maps generated directly in the ETReport module.

Figures 4-15 present comparison of heat maps of estimated global values of direct emission, indirect emission and energy used for Silesia region for six simulated scenario.

Fig. 4. Heat map with total direct emission – scenario comparison A1 and A2 (for Silesia region)

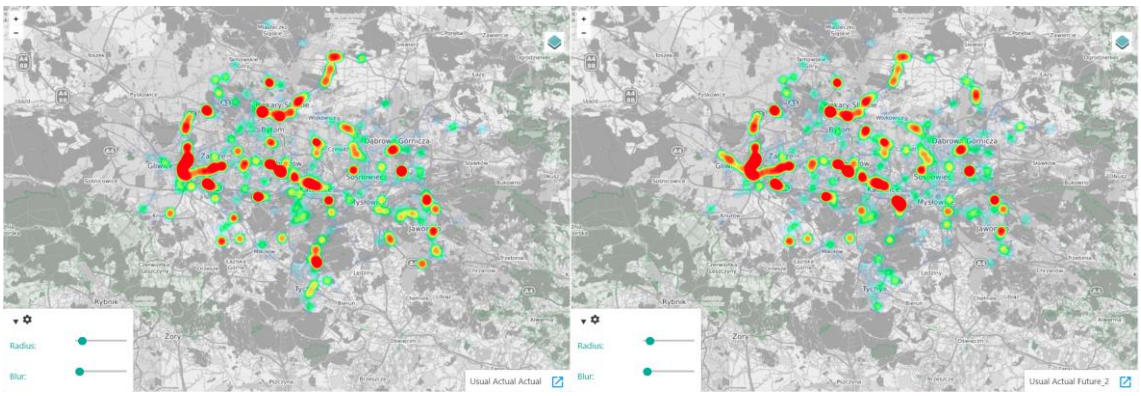

Fig. 5. Heat map with total direct emission – scenario comparison A1 and A3 (for Silesia region)

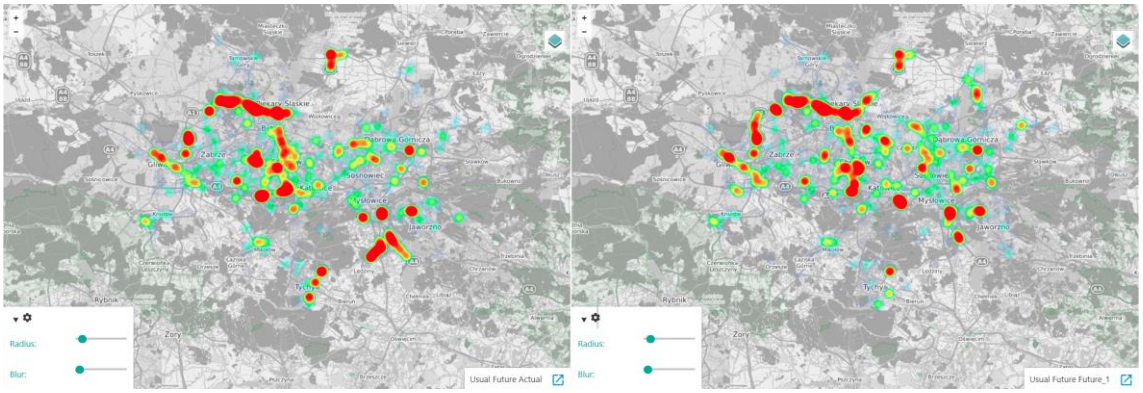

Fig. 6. Heat map with total direct emission – scenario comparison B1 and B2 (for Silesia region)

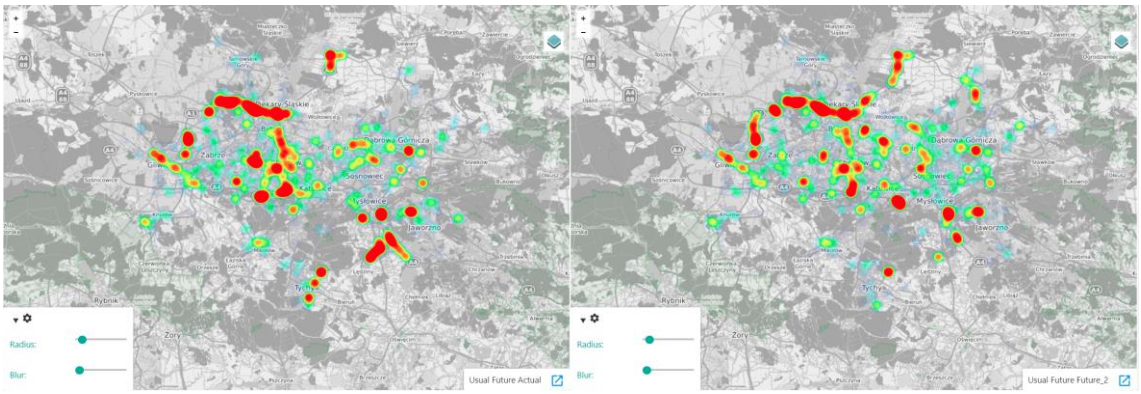

Fig. 7. Heat map with total direct emission – scenario comparison B1 and B3 (for Silesia region)

Fig. 8. Heat map with total indirect emission – scenario comparison A1 and A2 (for Silesia region)

Fig. 9. Heat map with total indirect emission – scenario comparison A1 and A3 (for Silesia region)

Fig. 10. Heat map with total indirect emission – scenario comparison B1 and B2 (for Silesia region)

Fig. 11. Heat map with total indirect emission – scenario comparison B1 and B3 (for Silesia region)

Fig. 12. Heat map with total energy used – scenario comparison A1 and A2 (for Silesia region)

Fig. 13. Heat map with total energy used – scenario comparison A1 and A3 (for Silesia region)

Fig. 14. Heat map with total energy used – scenario comparison B1 and B2 (for Silesia region)

Fig. 15. Heat map with total energy used – scenario comparison B1 and B3 (for Silesia region)

5 Conclusion and recommendations

The ETSys tool, prepared as part of the Electric Traveling project, allows for complex analyses of the current and future scenarios of the transport system functioning in the selected area. The tool takes into account: changes in infrastructure (different locations of charging stations) and changes in travel needs (journey matrix) and changes in vehicle fleet (distribution of fleet types). ETReport allows to compare simulation results by using heat maps. By using this functionality is possible to analyse traffic distribution on transport network and their impact for environment.

The comparison of the results obtained in the simulation process allows to define the conclusion that the optimistic variant of the scenario of the future distribution of the passenger car fleet significantly reduces emissions.

Shift some part of personal car fleet from Euro-5 to Euro-6 increasing global indirect cost. According to HBEFA, diesel and petrol EURO-6 cars are more polutan than EURO-5 cars. From that point of view electromobility is better, because the emissions to create these fuels are bigger than to create electricity.

The longer total travel time in the scenarios with a higher share of electric cars (for the B2 and B3 scenarios) is due to an insufficient number of charging stations (for future option). This proves that each scenario should be considered separately in the whole ETSys system (including the input assumptions for the ETCharge module).

It should be added that the case study does not exhaust all the possibilities of the built ETSys tool, and future applications, due to the possibilities of individual modules, may include, for example:

- prioritization of specific ways of traveling in selected areas or sections of the transport network,
- taking into account the current volume of traffic in the case of areas with advanced ITS,
- changes in the timetable, the routing of public transport routes, the location of stops,
- taking into account the current location of available vehicles in the sharing service
- changes in travel costs depending on the means of transport,
- preferences for individual users (i.e. the acceptable distance of the walking route during travel)
- the use of specific models of electric cars in determining energy consumption
- and many others.