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E.3 – Transport and Energy

Methodological report - Recharging Stations: Distribution and Density

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Acronyms

AFIR	Alternative Fuels Infrastructure Regulation
API	Application Programming Interface
BE	Belgium
EAFO	European Alternative Fuels Observatory
EU	European Union
JRC	Joint Research Centre
MS	Member States
NL	Netherlands
NUTS	Nomenclature of Territorial Units for Statistics
OSM	Open Street Map
SK	Slovakia

Executive summary

The exponential growth of new data sources, including privately held data, in recent years has significantly accelerated the shift toward utilizing innovative data sources in the field of transport statistics. Consequently, to harness the potential of this data revolution, Eurostat is actively considering ways to complement traditional statistical methods and data sources with innovative approaches.

The aim of this report is to describe the innovative data sources that have been identified and provide the methodological background for applying these to identify statistical indicators relating to the distribution and density of recharging stations.

Three possible statistical indicators were identified to measure: (a) the recharging infrastructure density, (b) the recharging infrastructure network capacity, and (c) the recharging infrastructure distribution.

For the calculation of the statistical indicators the European Alternative Fuels Observatory (EAFO) / Eco-Movement data – a commercial data source – was used which was then complemented by the open-source OpenStreetMap (OSM) data and combined with the NUTS raw data.

The current work was piloted on a small number of Member States (MS) and promising indicators were thoroughly assessed. The methodology indicated some limitations, mostly relating to the use of the r5r package for addressing the recharging infrastructure distribution (Indicator 3).

The next phase of the project will involve the further refinement and adjustment of the methodology, as we all as the implementation of the statistical indicators to more MS.

1 INTRODUCTION

Eurostat's Traffic and Mobility project, which concluded in 2024, included an exploratory study ([1]) to identify potentially suitable new/non-traditional data sources that can have an application in the transport and mobility statistics domain, as well as the development of a methodology ([2]) to identify concrete use cases and produce relevant statistical indicators.

This methodological report aims to describe the steps followed and the project results, of one of those use cases which measures the distribution and density of recharging stations.

Given the growing significance of electro-mobility and the increasing share of electric vehicles, this analysis focuses on the distributions of recharging stations – both in terms of their overall spread as well as by specific category (i.e. maximum power output). The aim is to assess the level of development for the network of recharging stations by NUTS 2 and NUTS 3 regions and identify possible "recharging deserts".

In the context of the 9th Cohesion Report, similar analysis has been carried out regarding the distribution of recharging stations such as the availability of nearby electric vehicle recharging points (within 10km) by DG REGIO and the Joint Research Centre (JRC) based on data from EAFO, Eurostat and TomTom.

The statistical indicators to be produced are the following:

- **Indicator 1:** Measure the **recharging infrastructure density** through the number of recharging stations by NUTS 2 and NUTS 3 region.
- **Indicator 2:** Quantify the re**charging infrastructure network capacity** through the number of recharging stations per capacity category by NUTS 2 and NUTS 3 region.
- **Indicator 3:** Determine the re**charging infrastructure distribution** by calculating the maximum and average road distance between the nearest recharging stations within a NUTS 2 and NUTS 3 region.

While recharging stations primarily refer to electric plug-in and hybrid vehicles, the current work concerns only electric vehicles.

The work was piloted only on a small sample of EU countries, namely Belgium (BE), Netherlands (NL) and Slovakia (SK).

2 DESCRIPTION OF THE DATA SOURCES

Three datasets were used for the analysis: EAFO/Eco-Movement, OSM, , and NUTS raw data.

2.1 European Alternative Fuels Observatory (EAFO) / Eco-Movement

The EAFO is a proprietary data source and was used in the European Commission's TENtec ([3]) Interactive Map Viewer for the visualisation of recharging stations. The data was provided by Eco-Movement and was limited to the year 2021.

([1]) Supported by a contract with GOPA.

([2]) Supported by a contract with PwC.

([3]) TENtec is the European Commission's information system to coordinate and support the Trans-European Transport Network (TEN-T) policy and to monitor the compliance of the transport infrastructure TEN-T standards.

2.2 OpenStreetMap (OSM)

The OSM database refers to the geospatial data collected and maintained, which is contributed by volunteers around the world. It allows identification of regions and key points, like recharging stations. The OSM data was used to complement the EAFO data to enable routing calculations.

2.3 NUTS raw data

NUTS ([4]) raw data is available via direct download from a Eurostat repository in the format of a geojson or .shp file. The data consists of various identifiers such as the name of the NUTS region, the region ID, the region level, and the actual geometry data (polygon or multipolygon).

NUTS data is required to attribute recharging stations by their coordinates to their corresponding NUTS region.

3 RECHARGING POINTS CATEGORIES

A specific element that needs to be considered for the recharging stations study, is the key classification of the recharging points defined by the Regulation (EU) 2023/1804 on the deployment of alternative fuels infrastructure and displayed in the table below.

Table 1: Recharging points classification according to the Alternative Fuels Infrastructure (AFIR) Regulation

Category	Sub-category	Maximum power output	Definition pursuant to Article 2 of this Regulation
Category 1 (AC)	Slow AC recharging point, single-phase	P < 7.4 kW	Normal power recharging point
	Medium-speed AC recharging point, triple-phase	7.4 kW ≤ P ≤ 22 kW	
	Fast AC recharging point, triple-phase	P > 22 kW	High power recharging point
Category 2 (DC)	Slow DC recharging point	P < 50 kW	
	Fast DC recharging point	50 kW ≤ P < 150 kW	
	Level 1 – Ultra-fast DC recharging point	150 kW ≤ P < 350 kW	
	Level 2 – Ultra-fast DC recharging point	P ≥ 350 kW	

4 METHODOLOGY AND DATA TREATMENT

4.1 Indicator 1: Recharging Infrastructure Density

This indicator relates to the overall density of recharging stations within a designated NUTS region and is calculated through the total number of recharging stations within the NUTS region area.

([4]) The Nomenclature of Territorial Units for Statistics (NUTS classification) is a hierarchical system for dividing up the economic territory of the EU. NUTS 1 classification refers to major socio-economic regions, NUTS2 to basic regions and NUTS 3 to smaller regions.

4.2 Indicator 2: Recharging Infrastructure Network Capacity

For quantifying the recharging infrastructure network capacity within a designated NUTS region, the categorical distribution of the recharging stations will be considered, i.e. the total number of stations per class as per AFIR.

4.3 Indicator 3: Recharging Infrastructure Distribution

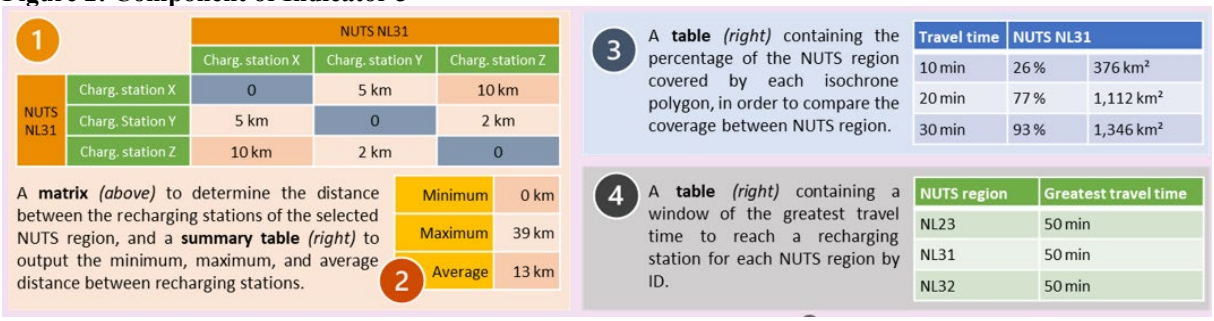
To assess the recharging infrastructure distribution of the recharging stations, the road distance will be considered in such a manner as to allow comparability between NUTS regions.

As a starting point, the Origin – Destination pairs between recharging stations need to be identified and based on this the minimum, maximum and average distances between recharging stations are calculated. The travel time is computed using R5R library from Conveyal.

The next step is to compute isochrone polygons from each recharging station to calculate what percentage of a NUTS region can be covered within a certain timeframe (i.e. 10 minutes) from any recharging station. This is done by combining the individual polygons into a single polygon that is used for the area calculation.

Furthermore, by having the greatest travel time to reach a recharging station provides an answer on whether any 'recharging deserts' can be identified within a NUTS region, i.e. the single furthest point from a recharging station inside of a given NUTS region.

Figure 2: Component of Indicator 3



5 LIMITATIONS AND FUTURE IMPROVEMENTS

5.1 Limitations

The methodological approach, although promising, had a few limitations.

A major concern in the current implementation is the computation time needed for the calculation of Indicator 3 (for BE 3 days). The needed precision for a NUTS delimitation, required to scale up the isochrone polygons, - given the number of recharging stations – it negatively affects the calculation time. Furthermore, a second data ingestion process is required to retrieve road distance/travel time between recharging stations.

In addition, working with the r5r package, has the following implications:

- A sub-setting of the OSM dataset is required. The chosen method to perform this retains complete multipolygons and complete ways, resulting in cases where the road network can extent outside of the NUTS polygon in consideration.

- Lack of matrix symmetry: When assessing the output from the Time Travel Matrix, it should be noted that quite often the from-to and to-from pairs for a given set of stops are not equal. This is due to the routing engine and the fact that often, the same route is not taken for both directions.

- The polygon outputs from r5r display snapping inconsistencies over large areas. Specifically, they tend to snap to the points in such a way that large areas are covered despite them not having a legitimate coverage, except from the points themselves. Also, to mitigate this a limit was set at 60 min. This maximum Travel Time output implies that if the 100% threshold is not reached within 60 minutes, the output will still be 60 minutes.

- The r5r package has a hard coded limitation of its network analysis. An OSM file containing more than 975,000 km of road networks will in this case lead to an error. For this project, as a sub-setting of the OSM data is carried out, it was not an issue but could possibly pose a problem if larger regions are to be examined in the future.

5.2 Future Improvements

To enhance the output of the statistical indicators for the recharging stations, the total amount of roadways within a NUTS region could be incorporated. This would allow the calculation of a metric in the sense of "x number of recharging stations per y kilometres of roadway".

To lessen the influence of polygon snapping further enhancements could be made to the methodology as follows:

- ✓ Enhance the methodology for isochrone generation by iterating them based on minimising the overall travel time over large distances. This would mean that smaller travel time isochrones would be repeatedly calculated.

- ✓ If each origin point were to be given a buffer, it could slightly shift the general isochrone generation and potentially mitigate the polygon snapping, however it would increase the computation time greatly.

- ✓ Initiate a random grid-based selection of origin points to ensure coverage of the NUTS region is retained and get a range of isochrones from which confidence intervals could be calculated. In this way, coverage would remain the same, but the computation time would be decreased at the expense of fewer isochrones being created.

6 RESULTS AND CONCLUSIONS

The study on identifying statistical indicators relating to the density and distribution of recharging stations using innovative data has evidently shown that commercial data sets tend to have better and richer content that crowd-sourced ones, but they also entail financial costs.

In detail, the following Eurobase tables are envisioned:

a. Number of recharging stations per NUTS 2 and NUTS 3 region

b. Number of recharging stations by class per NUTS 2 and NUTS 3 region

c. Minimum, average and maximum travel time between recharging stations per NUTS 2 and NUTS 3 region

Examples of these tables are presented in the ANNEX section.

Going forward, the methodology will be further developed and refined to strengthen the analytical framework, as well as adjustments will be made to the set-up in the data lab to enable the scale-up of the indicators to more MS.

Annex A Examples of tables on the statistical indicators

TABLE A: Number of recharging stations per NUTS region

	TIME	2021
GEO		
BE	Belgium	12 470
BE1	Région de Bruxelles-Capitale/Brussels Hoofdstedelijk …	1 251
BE10	Région de Bruxelles-Capitale/Brussels Hoofdstedelijk …	1 251
BE100	Arr. de Bruxelles-Capitale/Arr. Brussel-Hoofdstad	1 251
BE2	Vlaams Gewest	9 653
BE21	Prov. Antwerpen	2 547
BE211	Arr. Antwerpen	1 395
BE212	Arr. Mechelen	505
BE213	Arr. Turnhout	647

TABLE B: Number of recharging stations per power category by NUTS region

			TIME	2021
	GEO	POWER		
BE	Belgium	Alternating current - < 7,4 kW (slow, single-phase)		423
BE	Belgium	Alternating current - ≤ 7,4 kW but ≤ 22 kW (medium-sp…		10 543
BE	Belgium	Alternating current - > 22 kW (fast, triple-phase)		65
BE	Belgium	Direct current - < 50 kW (slow)		48
BE	Belgium	Direct current - ≤ 50 kW but < 150 kW (fast)		392
BE	Belgium	Direct current - ≤ 150 kW but < 350 kW (ultra-fast, leve…		270
BE	Belgium	Direct current - ≥ 350 kW (ultra-fast, level 2)		3
BE	Belgium	Unknown		726
BE1	Région de Bruxelles-Capitale/Brussels Hoofdstedelijk …	Alternating current - < 7,4 kW (slow, single-phase)		284
BE1	Région de Bruxelles-Capitale/Brussels Hoofdstedelijk …	Alternating current - ≤ 7,4 kW but ≤ 22 kW (medium-sp…		442
BE1	Région de Bruxelles-Capitale/Brussels Hoofdstedelijk …	Alternating current - > 22 kW (fast, triple-phase)		4
BE1	Région de Bruxelles-Capitale/Brussels Hoofdstedelijk …	Direct current - < 50 kW (slow)		:
BE1	Région de Bruxelles-Capitale/Brussels Hoofdstedelijk …	Direct current - ≤ 50 kW but < 150 kW (fast)		6
BE1	Région de Bruxelles-Capitale/Brussels Hoofdstedelijk …	Direct current - ≤ 150 kW but < 350 kW (ultra-fast, leve…		8
BE1	Région de Bruxelles-Capitale/Brussels Hoofdstedelijk …	Direct current - ≥ 350 kW (ultra-fast, level 2)		:
BE1	Région de Bruxelles-Capitale/Brussels Hoofdstedelijk …	Unknown		507
BE10	Région de Bruxelles-Capitale/Brussels Hoofdstedelijk …	Alternating current - < 7,4 kW (slow, single-phase)		284
BE10	Région de Bruxelles-Capitale/Brussels Hoofdstedelijk …	Alternating current - ≤ 7,4 kW but ≤ 22 kW (medium-sp…		442
BE10	Région de Bruxelles-Capitale/Brussels Hoofdstedelijk …	Alternating current - > 22 kW (fast, triple-phase)		4
BE10	Région de Bruxelles-Capitale/Brussels Hoofdstedelijk …	Direct current - < 50 kW (slow)		:

TABLE C: Average and Maximum Travel Time between recharging stations per NUTS class

	TIME	2021	2021
	DURATION	Maximum	Average
GEO			
BE10	Région de Bruxelles-Capitale/Brussels Hoofdstedelijk …	120	12.3
BE100	Arr. de Bruxelles-Capitale/Arr. Brussel-Hoofdstad	120	12.3
BE21	Prov. Antwerpen	84	20.2
BE211	Arr. Antwerpen	57	12.7
BE212	Arr. Mechelen	65	17.4
BE213	Arr. Turnhout	76	19.7
BE22	Prov. Limburg (BE)	75	21.2
BE223	Arr. Tongeren	75	17.7
BE224	Arr. Hasselt	58	15.7
BE225	Arr. Maaseik	64	22.8
BE23	Prov. Oost-Vlaanderen	89	21.2