French wind turbines study

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Introduction

This study is dedicated to the quantification of the the distribution of wind turbines in France. Consequently it consists of the description of the data sets and tools used. The objective is to get quantifiable data on the number and power of installed wind turbines in each territorial entity in France: commune, department or region.

I   Resources

I.1   Wind turbines

Wind turbine data is extracted from the Open Street Map (OSM) database [3] using Overpass [4, 5]. It contains the data from mainland France as well as overseas departments and regions of France. This dataset can be obtained by using Overpass with the following query:

```
[out:json];
area["name"="France"]->.boundaryarea;
(node(area.boundaryarea)["power"="generator"]["generator:source"="wind"];);
out;
```

I.2   Locality

The next step is to match the coordinates of the wind turbine to a territorial geographical entity. In our first attempt we used the longitude and latitude of the wind turbine to perform a reverse search of the address. However, this approach did not yield good results, mainly because wind turbines are far from known addresses and the closest known address is not necessary in the same geographical entity as the wind turbine.

To solve this issue, the geo API from the French government [2] was used. For a given longitude and latitude, the commune, department and region enclosing this coordinate are obtained.

The API can be tested here by providing the longitude and latitude of the wind turbine [1] in the commune section. The process was automated in python and the result extracted from: https://geo.api.gouv.fr/communes?lat=turbine_latitude&lon=turbine_longitude&fields=nom,code,codesPostaux,departement,region&format=json with the corresponding values for "turbine_latitude" and "turbine_longitude".

Finally, the borders of the departments that appear in the heat map are derived from the commune boundaries. The commune boundaries are extracted from the same API using the department request and then treated to remove any duplicates.

II   Results

II.1   Comments

If a geographical entity was not found using the geo api (mainly for offshore wind turbines), it was grouped using "Other" as the locality name. For now, almost all of them (80 out of 82) are located in the wind farm in front of Saint-Nazaire.

As mentioned previously, the installed power of the turbine is not always available in the OSM database, hence some rows of the installed power are unknown.

Finally, the OSM data contains both wind farms and private wind turbines.
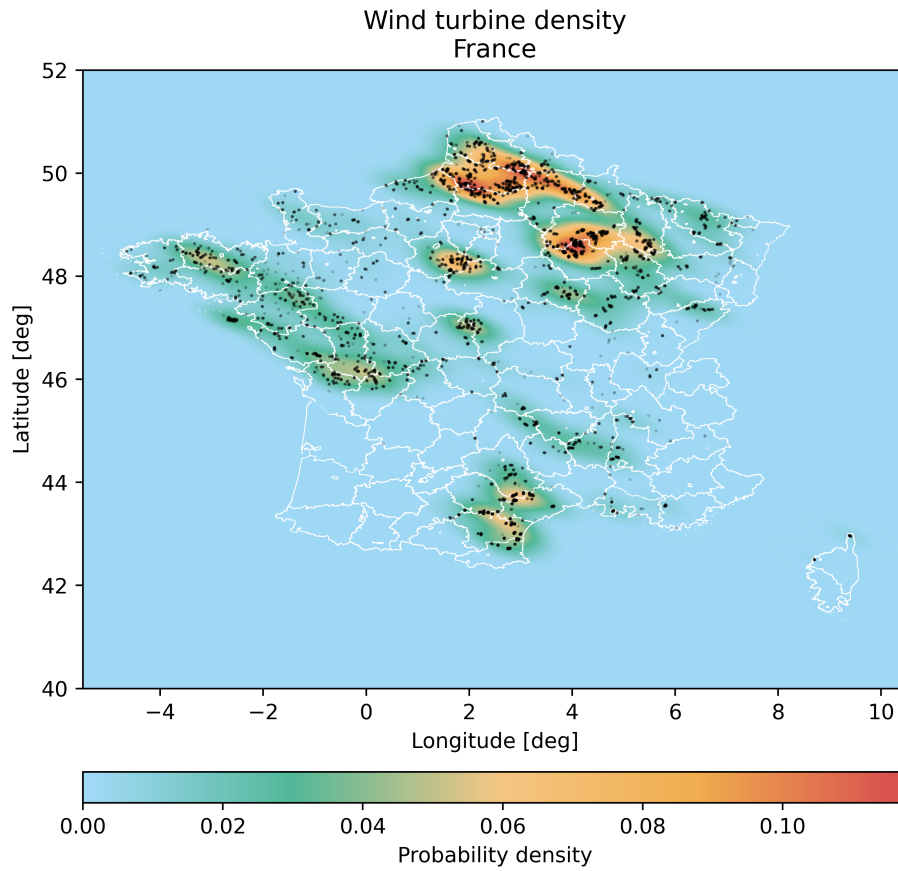
II.2   Heat map

Figure 1: Mainland France, wind turbine distribution.
● : wind turbine, — : department borders

II.3   Ranking by communes

Insee code	Commune	Known installed power [MW]	Wind turbines [#]
98817	Le Mont-Dore	Unknown	102
Other	Other	482.0	82
34121	Joncels	64.2	41
97110	La Désirade	3.8	41
97119	Petit-Canal	7.0	39
97420	Sainte-Suzanne	10.2	37
34046	Cambon-et-Salvergues	59.8	36
97108	Capesterre-de-Marie-Galante	3.9	32
51268	Germinon	75.0	30
12253	Salles-Curan	87.0	29

Table 1: Top 10 communes ranked by number of wind turbines.

II.4 Ranking by departments

Department code	Department name	Known installed power [MW]	Wind turbines [#]
80	Somme	1651	747
51	Marne	1001	469
10	Aube	940	404
2	Aisne	859	386
62	Pas-de-Calais	906	380
11	Aude	436	298
28	Eure-et-Loir	635	282
60	Oise	572	260
55	Meuse	471	244
22	Côtes-d'Armor	337	233

Table 2: Top 10 best departments ranked by number of wind turbines.

II.5 Ranking by regions

Region code	Region name	Known installed power [MW]	Wind turbines [#]
32	Hauts-de-France	4245	1863
44	Grand Est	3967	1846
76	Occitanie	1566	872
75	Nouvelle-Aquitaine	1162	631
24	Centre-Val de Loire	1263	570
53	Bretagne	856	541
52	Pays de la Loire	935	512
27	Bourgogne-Franche-Comté	925	452
28	Normandie	854	392
84	Auvergne-Rhône-Alpes	674	382
1	Guadeloupe	40	163
988	Nouvelle-Calédonie	Unknown	153
Other	Other	482	82
93	Provence-Alpes-Côte d'Azur	98	77
4	La Réunion	17	60
11	Île-de-France	67	50
94	Corse	18	30
2	Martinique	1.1	15
975	Saint-Pierre-et-Miquelon	Unknown	10

Table 3: All regions with at least one wind turbine, ranked by number of wind turbines.

II.6 Availability

Wind turbine data and the aggregations by commune, department and region are available to the public by sending an email to: ds@hellowatt.fr.

References

[1]   *Geo API documentation*. URL: https://api.gouv.fr/documentation/api-geo.

[2]   *Geo API main page*. URL: https://geo.api.gouv.fr/.

[3]   *Open Street Map*. URL: https://www.openstreetmap.org/#map=5/46.271/3.955.

[4]   *Overpass*. URL: https://overpass-turbo.eu/.

[5]   *Overpass documentation*. URL: https://wiki.openstreetmap.org/wiki/Overpass_turbo.