Analysis and Optimization of Energy Consumption

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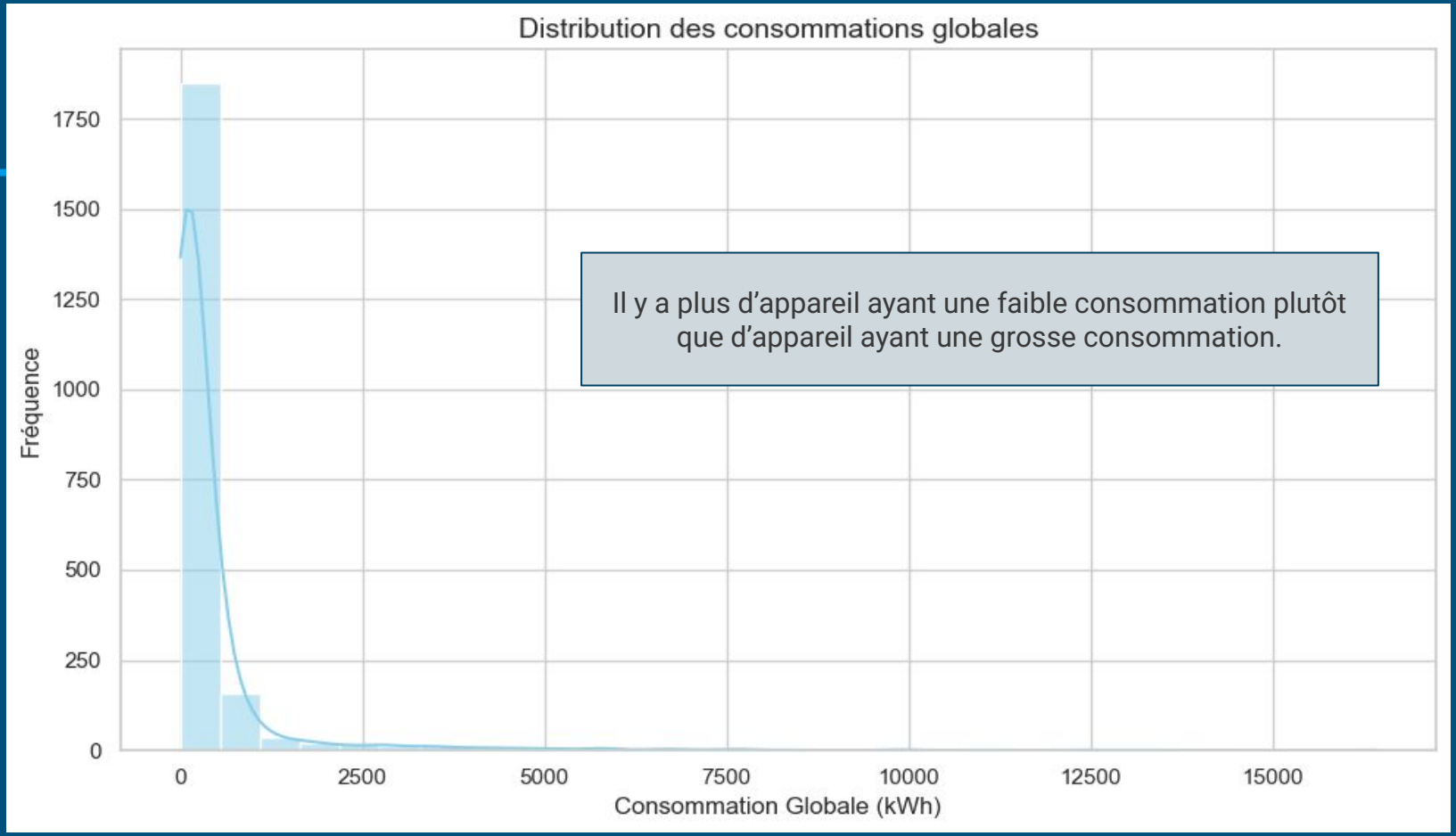
Topic presentation

- Climate emergency and energy transition worldwide
- Optimizing energy in business and society
- Project objective: Predictive analysis to reduce consumption

First dataset: individual yearly consumption data

Appareil suivi	Audio_TV	Bouilloires	Box Internet	Box TV	Cafetière_expresso	Cafetière_filtre	Cave à vin	Chambre froide	Chaudières	Chauffage électrique	...	Repassage	Réfricongélateur	Réfrigérateur	Santé	Sèche linge	Sécurité
ID logement																	
101	0.0	5.3	264.4	123.2	31.5	0.0	0.0	0.0	0.0	565.9	...	0.0	242.8	0.0	0.0	0.0	0.0
102	0.0	0.0	162.2	106.4	44.8	0.0	0.0	0.0	392.0	0.0	...	0.0	481.3	0.0	0.0	0.0	0.0
103	0.0	0.0	157.6	107.8	0.0	0.0	0.0	0.0	0.0	1898.0	...	0.0	524.9	0.0	0.0	0.0	0.0
104	0.0	0.0	96.4	0.0	16.2	0.0	0.0	0.0	119.1	0.0	...	0.0	172.9	0.0	0.0	53.9	0.0
105	0.0	173.5	102.1	166.7	26.6	0.0	0.0	0.0	0.0	16.2	...	0.0	493.1	0.0	0.0	504.2	0.0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1007	0.0	133.7	416.3	40.1	9.4	0.0	0.0	0.0	0.0	123.4	...	0.0	585.0	0.0	0.0	0.0	143.6
1008	0.0	0.0	154.0	120.4	0.0	0.0	0.0	0.0	190.2	0.0	...	0.0	303.2	0.0	0.0	562.2	0.0
1009	0.0	0.0	193.4	0.0	0.0	0.0	0.0	0.0	203.9	2207.3	...	0.0	729.2	0.0	0.0	831.6	0.0
1010	174.9	0.0	360.5	198.7	19.0	0.0	703.4	0.0	0.0	5617.1	...	0.0	0.0	281.5	0.0	257.2	0.0
1011	0.0	114.0	150.6	235.3	0.0	0.0	0.0	0.0	0.0	1090.2	...	0.0	783.1	0.0	0.0	851.2	0.0

https://www.data.gouv.fr/fr/datasets/elecdom-donnees-de-consommation-annuelle/

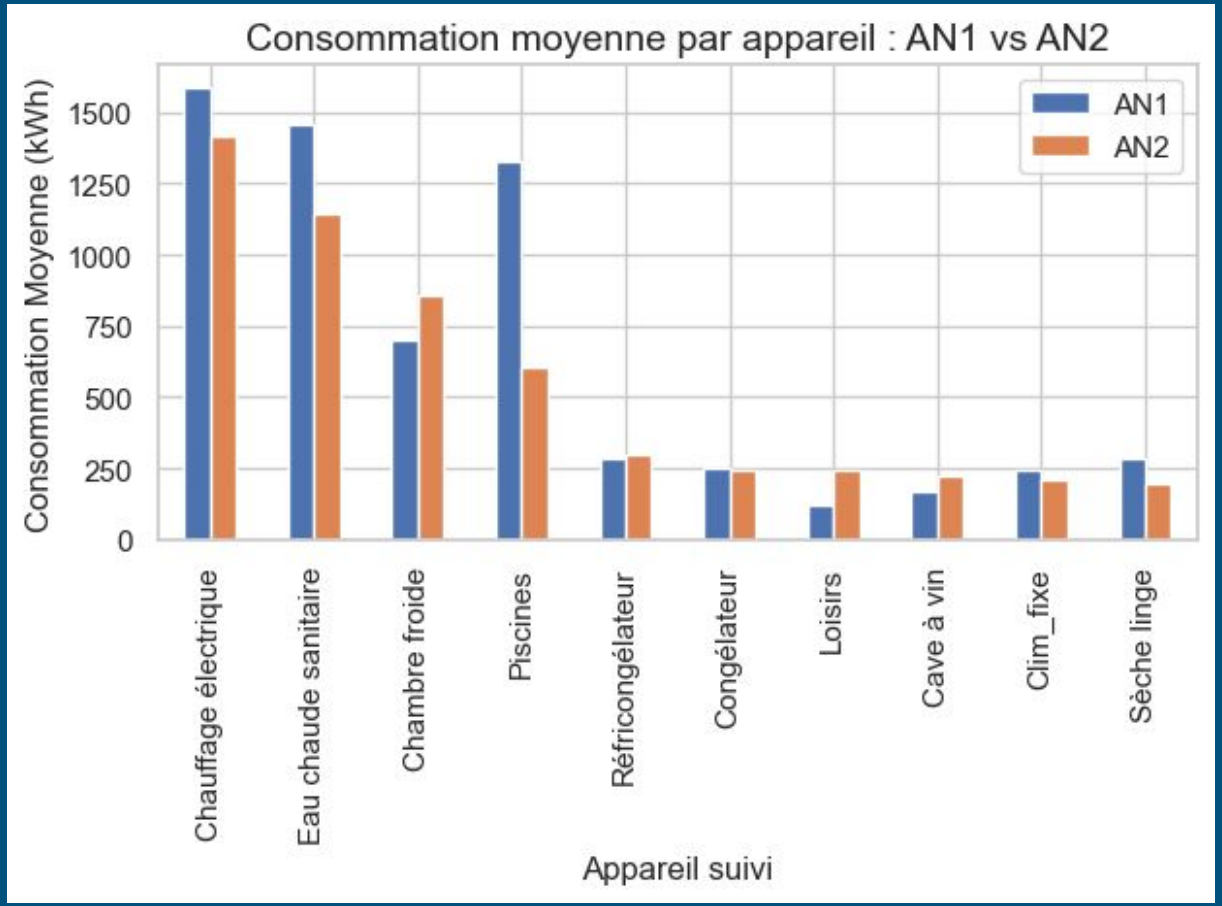

Distribution des consommations globales
Fréquence
1750
1500
1250
1000
750
500
250
0
0
2500
5000
7500
10000
12500
15000
Consommation Globale (kWh)
Il y a plus d'appareil ayant une faible consommation plutôt que d'appareil ayant une grosse consommation.

```
=== Statistiques descriptives ===
       Consommation annuelle  AN1  Consommation annuelle AN2
count                2142.000000                2142.000000
mean                  207.652754                 187.133660
std                   625.672558                 555.032274
min                     0.000000                   0.000000
25%                     5.150000                   3.725000
50%                    56.700000                  49.700000
75%                   164.075000                 157.375000
max                 12159.700000                7861.900000
```

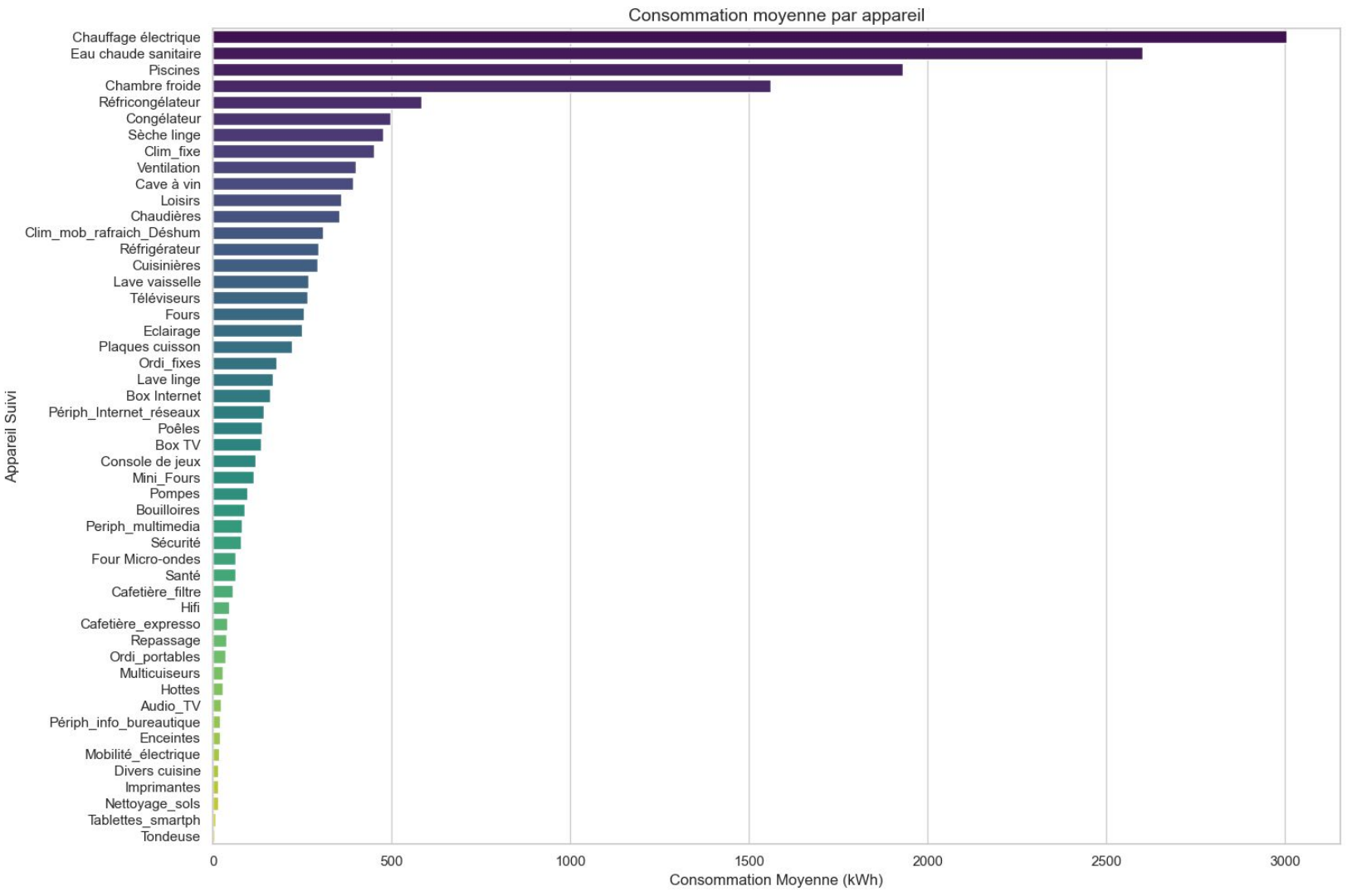
```
=== Répartition des appareils (hors 'Général') ===
Appareil suivi
Téléviseurs              135
Eclairage                120
Lave linge               119
Box Internet             118
Ordi_portables           108
Four Micro-ondes         106
Réfricongélateur         105
Box TV                    92
Lave vaisselle            90
Chauffage électrique      84
```

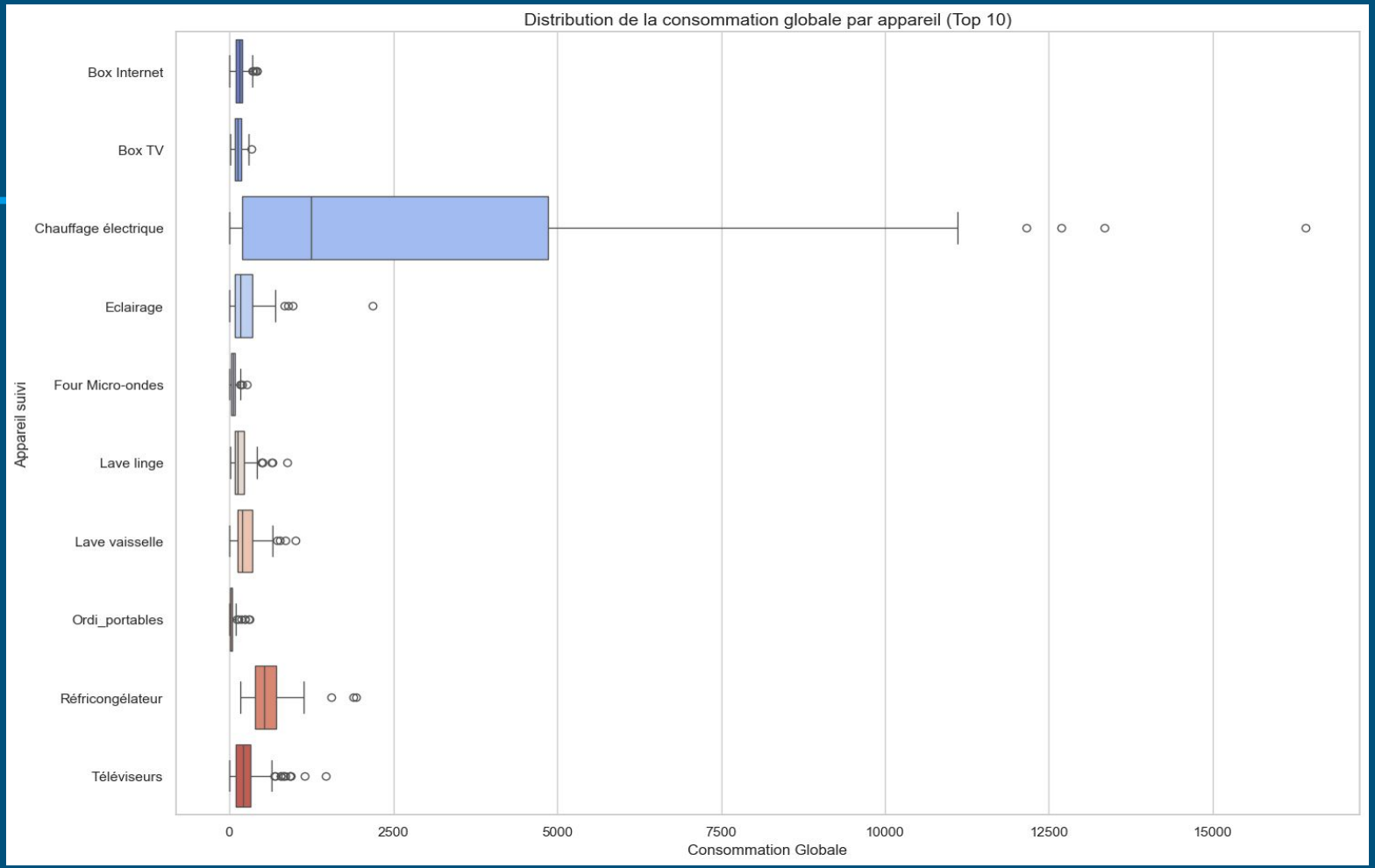
```
       Consommation Globale
count           2142.000000
mean             394.786415
std             1084.382880
min                0.000000
25%               36.650000
50%              123.700000
75%              311.075000
max            16420.500000

Nombre total de logements : 120
```

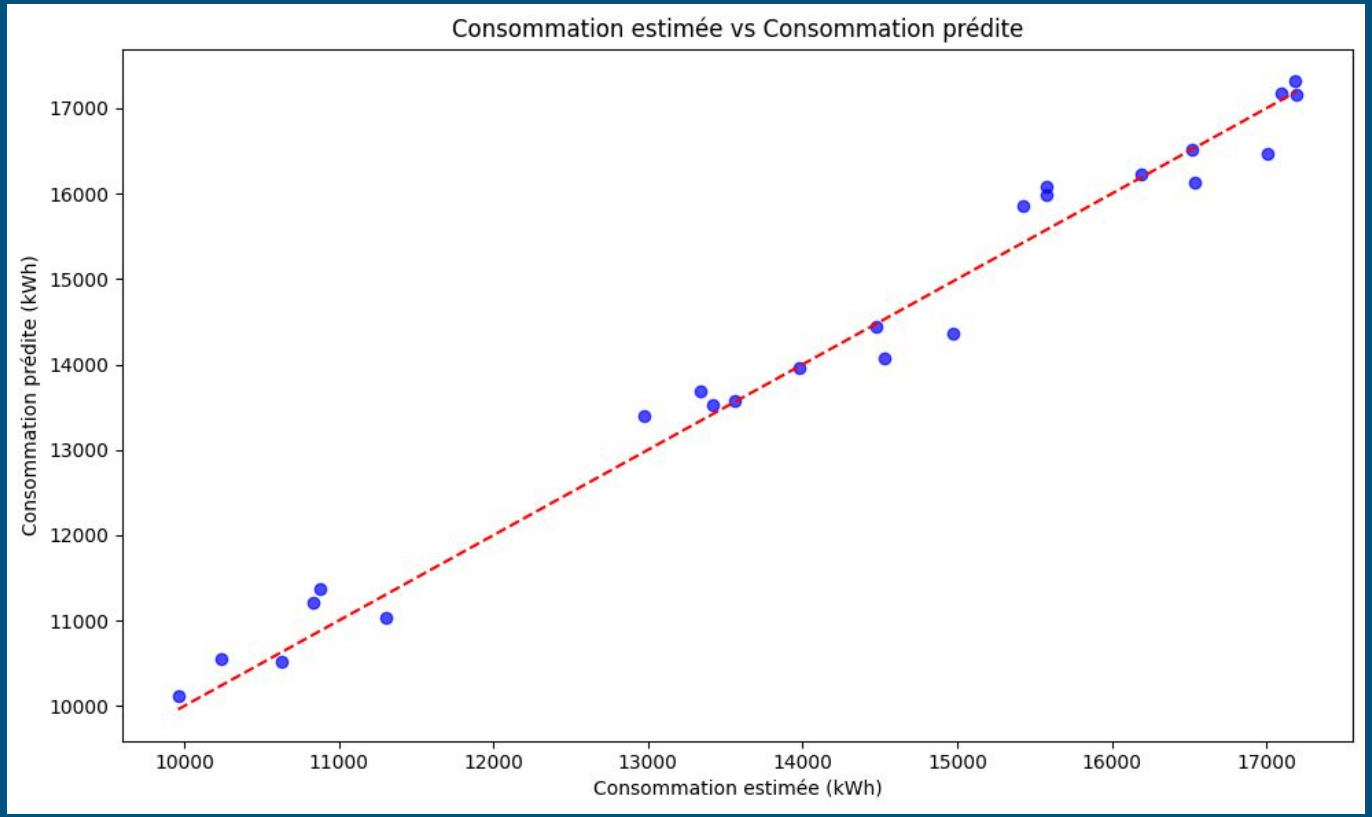



```
=== Top 5 appareils les plus énergivores (en moyenne)
Appareil suivi
Chauffage électrique     3004.863095
Eau chaude sanitaire     2602.003125
Piscines                 1929.807143
Chambre froide           1559.950000
Réfricongélateur          582.833333
Name: Consommation Globale, dtype: float64
```

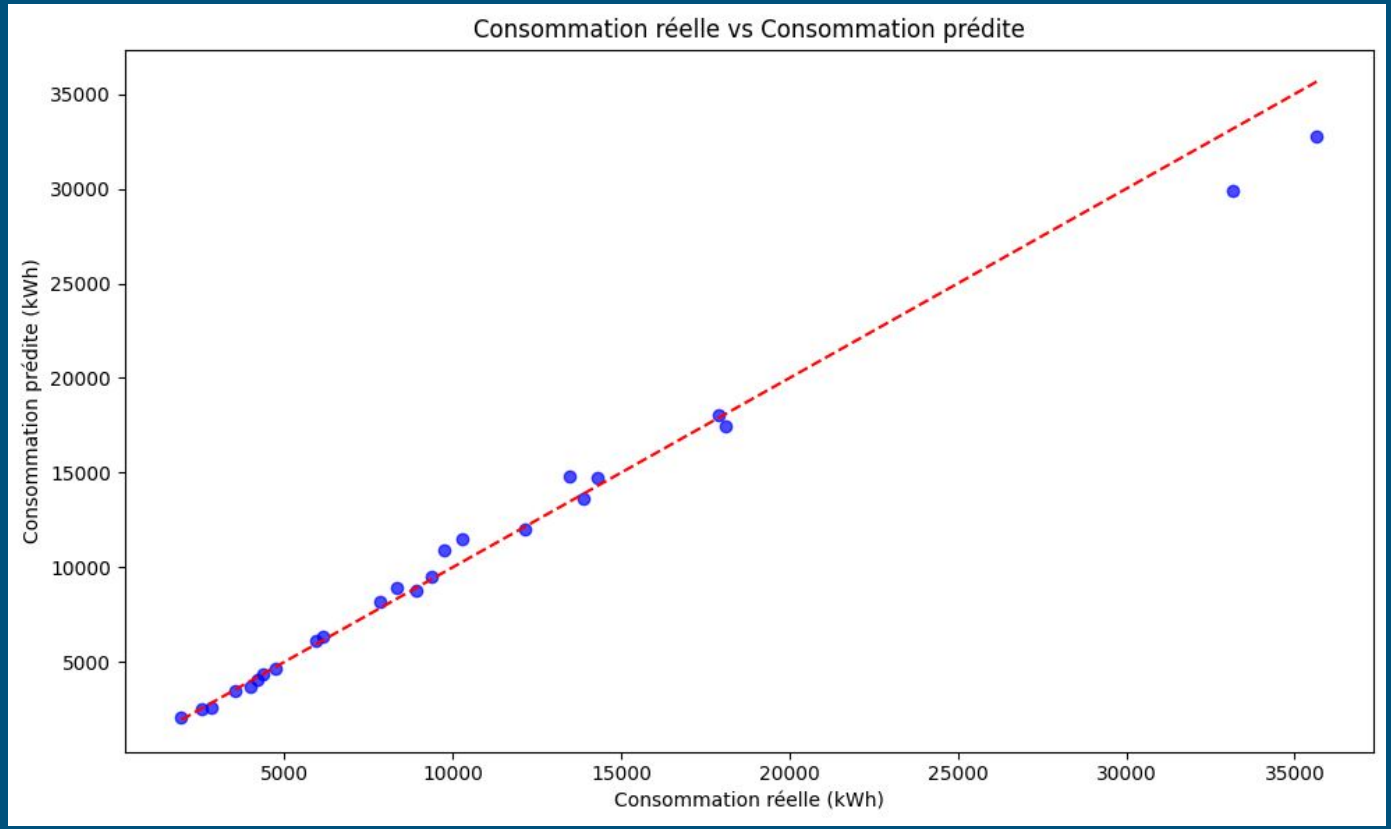

Consommation moyenne par appareil
Chauffage électrique
Eau chaude sanitaire
Piscines
Chambre froide
Réfricongélateur
Congélateur
Sèche linge
Clim_fixe
Ventilation
Cave à vin
Loisirs
Chaudières
Clim_mob_rafraich_Déshum
Réfrigérateur
Cuisinières
Lave vaisselle
Téléviseurs
Fours
Eclairage
Plaques cuisson
Ordi_fixes
Lave linge
Box Internet
Périph_Internet_réseaux
Poêles
Box TV
Console de jeux
Mini_Fours
Pompes
Bouilloires
Periph_multimedia
Sécurité
Four Micro-ondes
Santé
Cafetière_filtre
Hifi
Cafetière_expresso
Repassage
Ordi_portables
Multicuiseurs
Hottes
Audio_TV
Périph_info_bureautique
Enceintes
Mobilité_électrique
Divers cuisine
Imprimantes
Nettoyage_sols
Tablettes_smartph
Tondeuse
Appareil Suivi
0
500
1000
1500
2000
2500
3000
Consommation Moyenne (kWh)


Distribution de la consommation globale par appareil (Top 10)
Box Internet
Box TV
Chauffage électrique
Eclairage
Four Micro-ondes
Lave linge
Lave vaisselle
Ordi_portables
Réfricongélateur
Téléviseurs
Appareil suivi
0
2500
5000
7500
10000
12500
15000
Consommation Globale

Machine learning predictions of home consumption based on average appliance consumption



Machine learning predicts a home's consumption based on its appliances



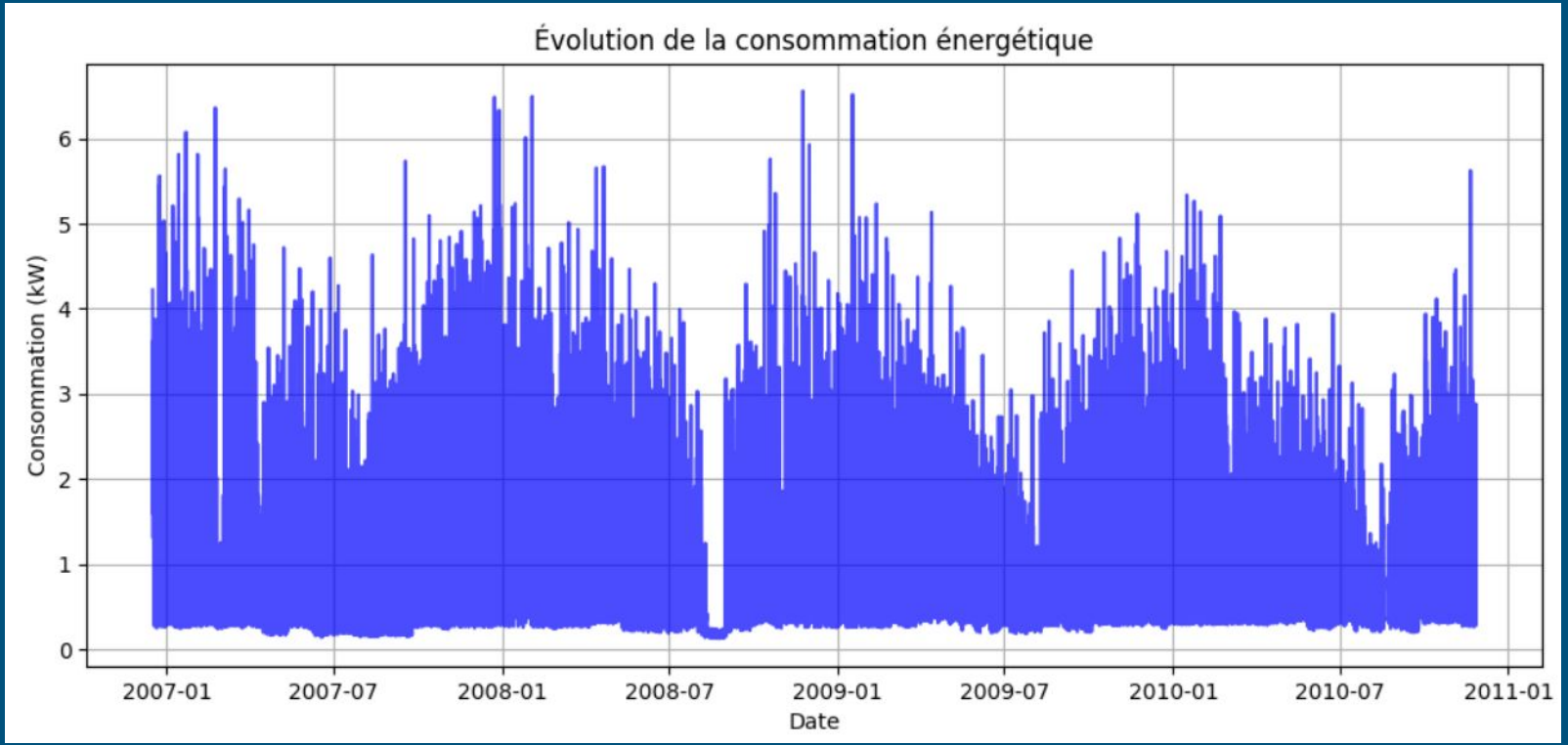
2nd dataset

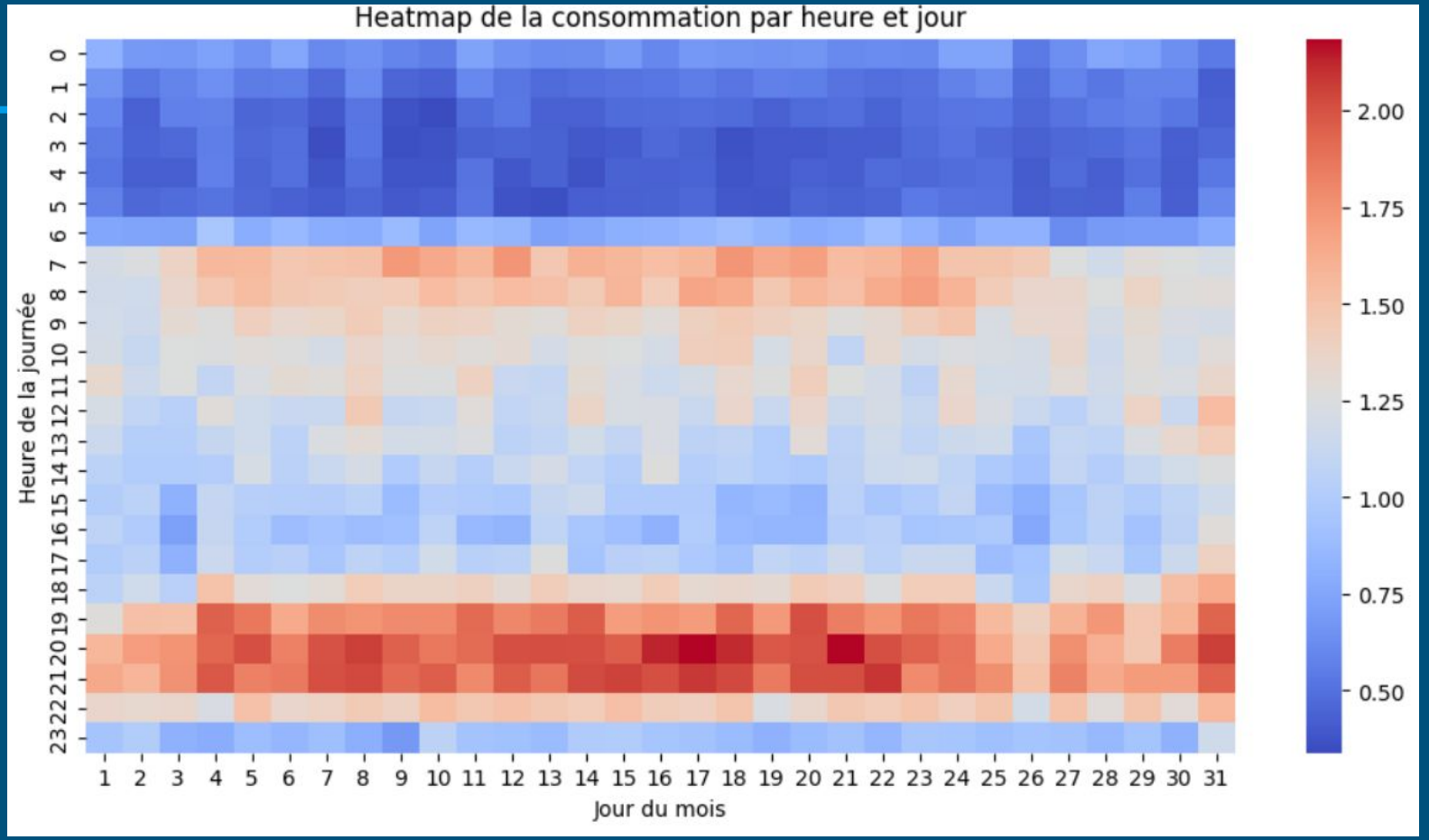
	DateTime	Global_active_power	Global_reactive_power	Voltage	\
0	2006-12-16 17:00:00	4.222889	0.229000	234.643889	
1	2006-12-16 18:00:00	3.632200	0.080033	234.580167	
2	2006-12-16 19:00:00	3.400233	0.085233	233.232500	
3	2006-12-16 20:00:00	3.268567	0.075100	234.071500	
4	2006-12-16 21:00:00	3.056467	0.076667	237.158667	

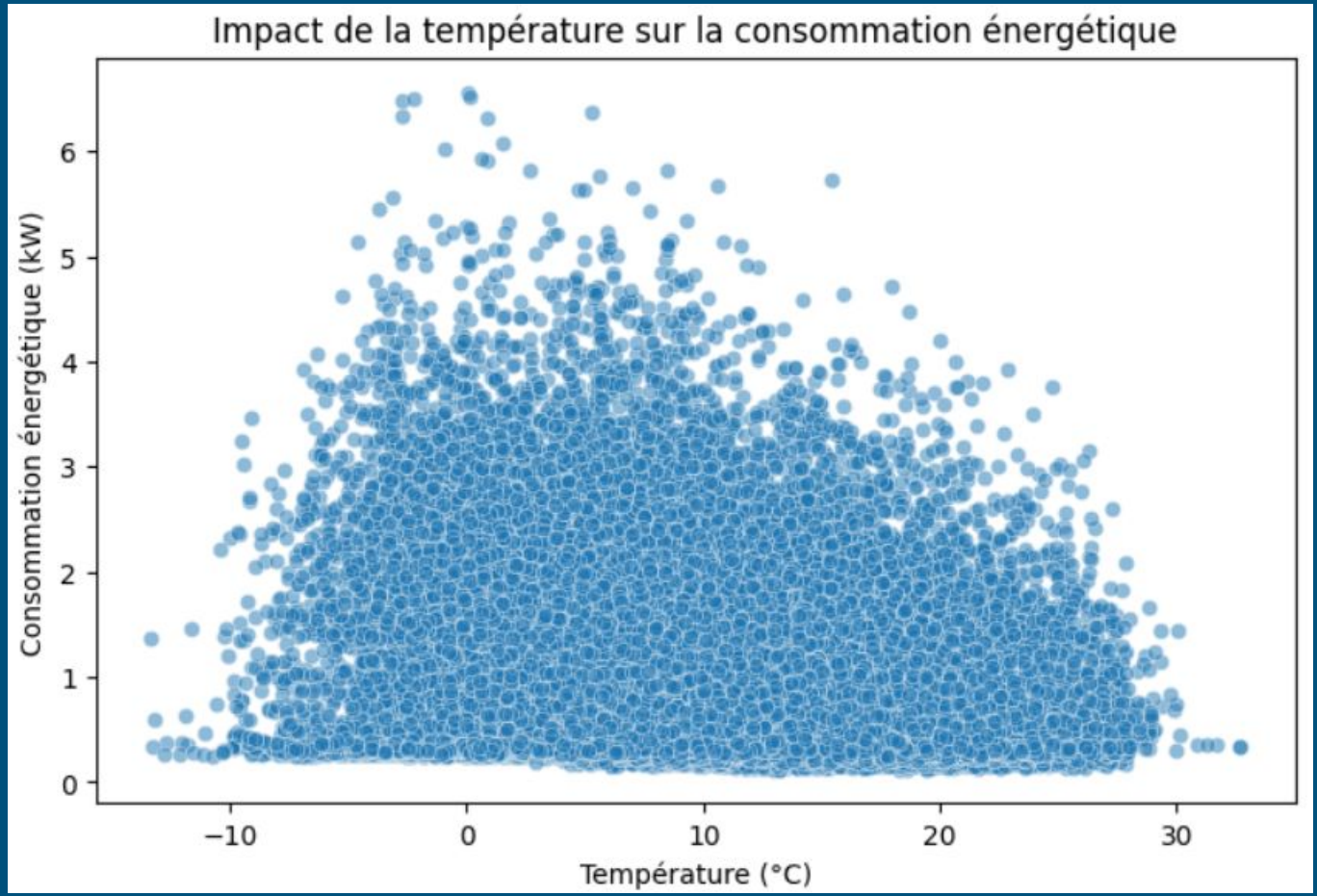
	Global_intensity	Sub_metering_1	Sub_metering_2	Sub_metering_3	YEAR	MO	\
0	18.100000	0.0	0.527778	16.861111	2006	12	
1	15.600000	0.0	6.716667	16.866667	2006	12	
2	14.503333	0.0	1.433333	16.683333	2006	12	
3	13.916667	0.0	0.000000	16.783333	2006	12	
4	13.046667	0.0	0.416667	17.216667	2006	12	

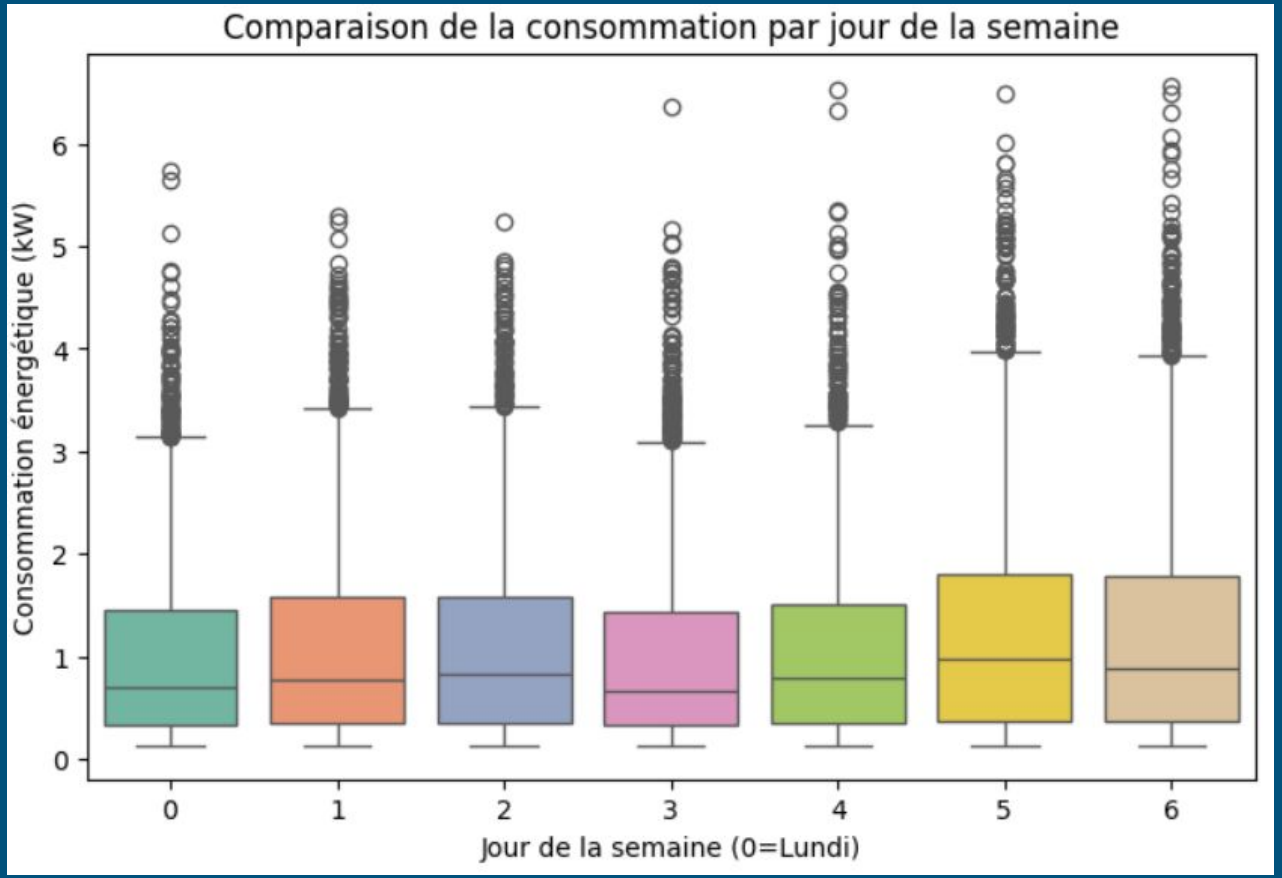
	DY	HR	T2M	QV2M	WS10M	PRECTOTCORR	ALLSKY_SFC_UV_INDEX
0	16	17	5.69	6.10	3.24	0.03	0.0
1	16	18	5.65	6.10	3.33	0.01	0.0
2	16	19	5.74	6.04	3.29	0.02	0.0
3	16	20	5.65	5.92	3.00	0.02	0.0
4	16	21	5.60	5.80	2.64	0.04	0.0

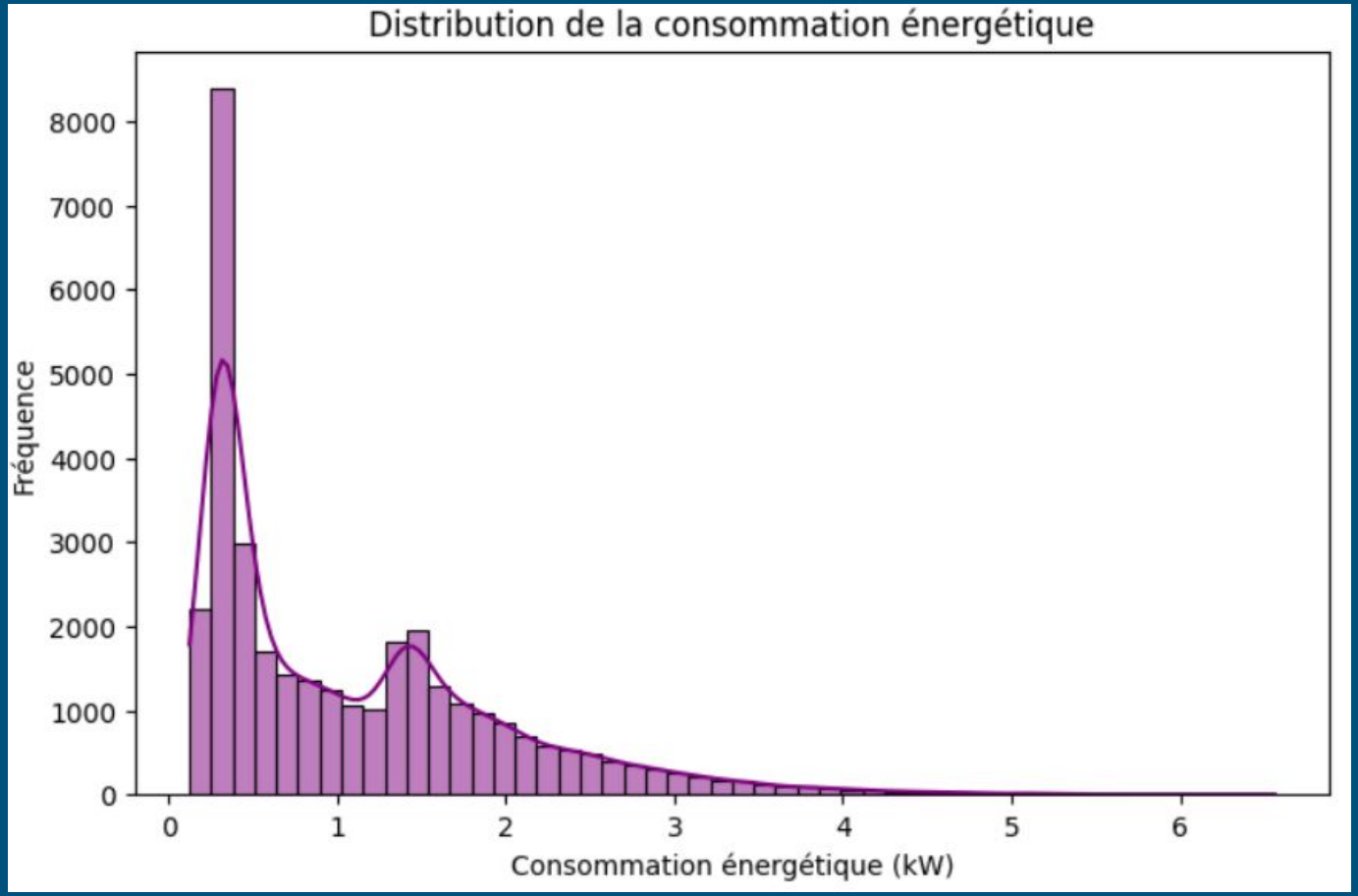
2nd dataset

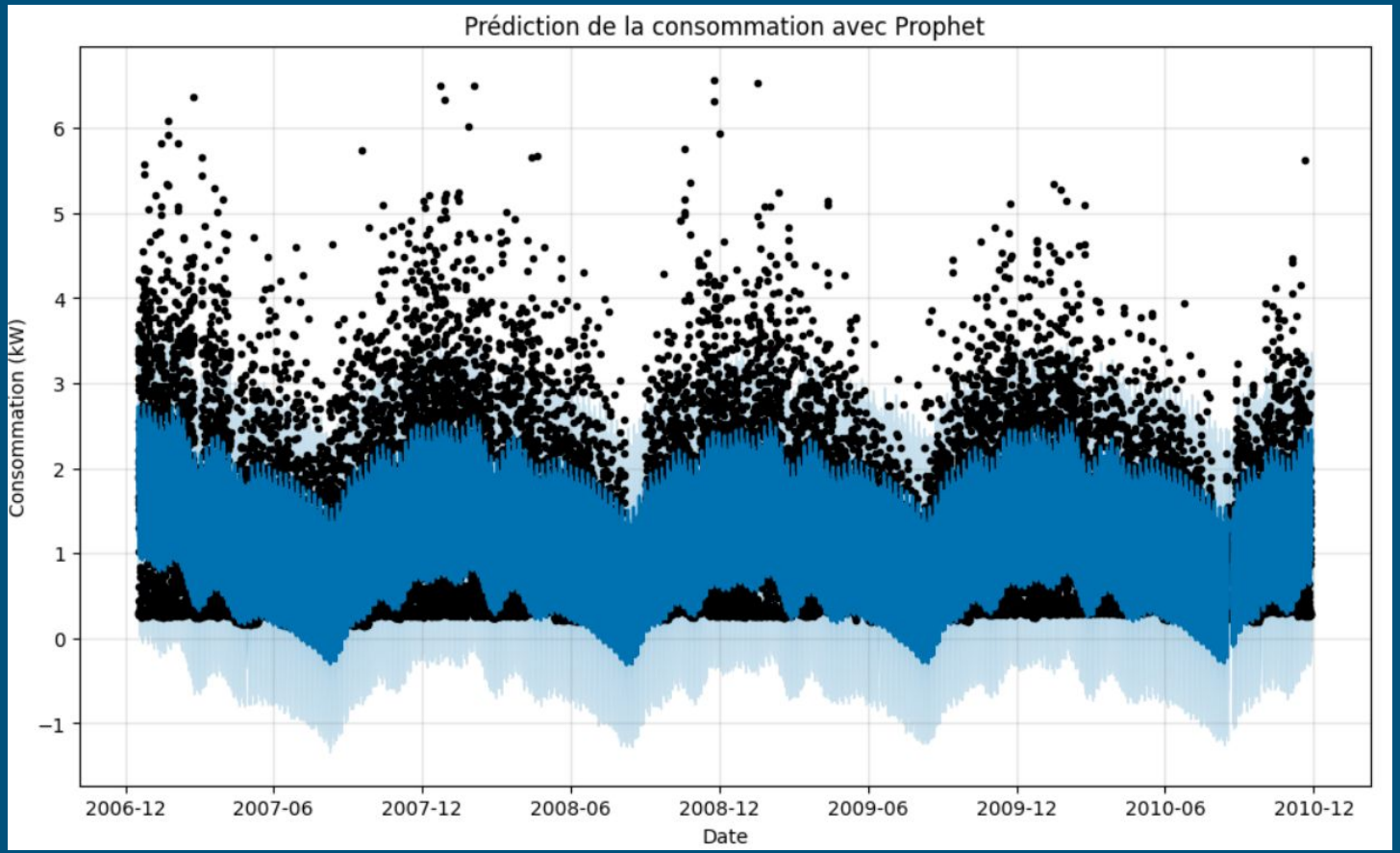

Évolution de la consommation énergétique
Consommation (kW)
0
1
2
3
4
5
6
2007-01
2007-07
2008-01
2008-07
2009-01
2009-07
2010-01
2010-07
2011-01
Date


Heatmap de la consommation par heure et jour
Heure de la journée
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Jour du mois
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
2.00
1.75
1.50
1.25
1.00
0.75
0.50


Impact de la température sur la consommation énergétique
Consommation énergétique (kW)
0
1
2
3
4
5
6
−10
0
10
20
30
Température (°C)

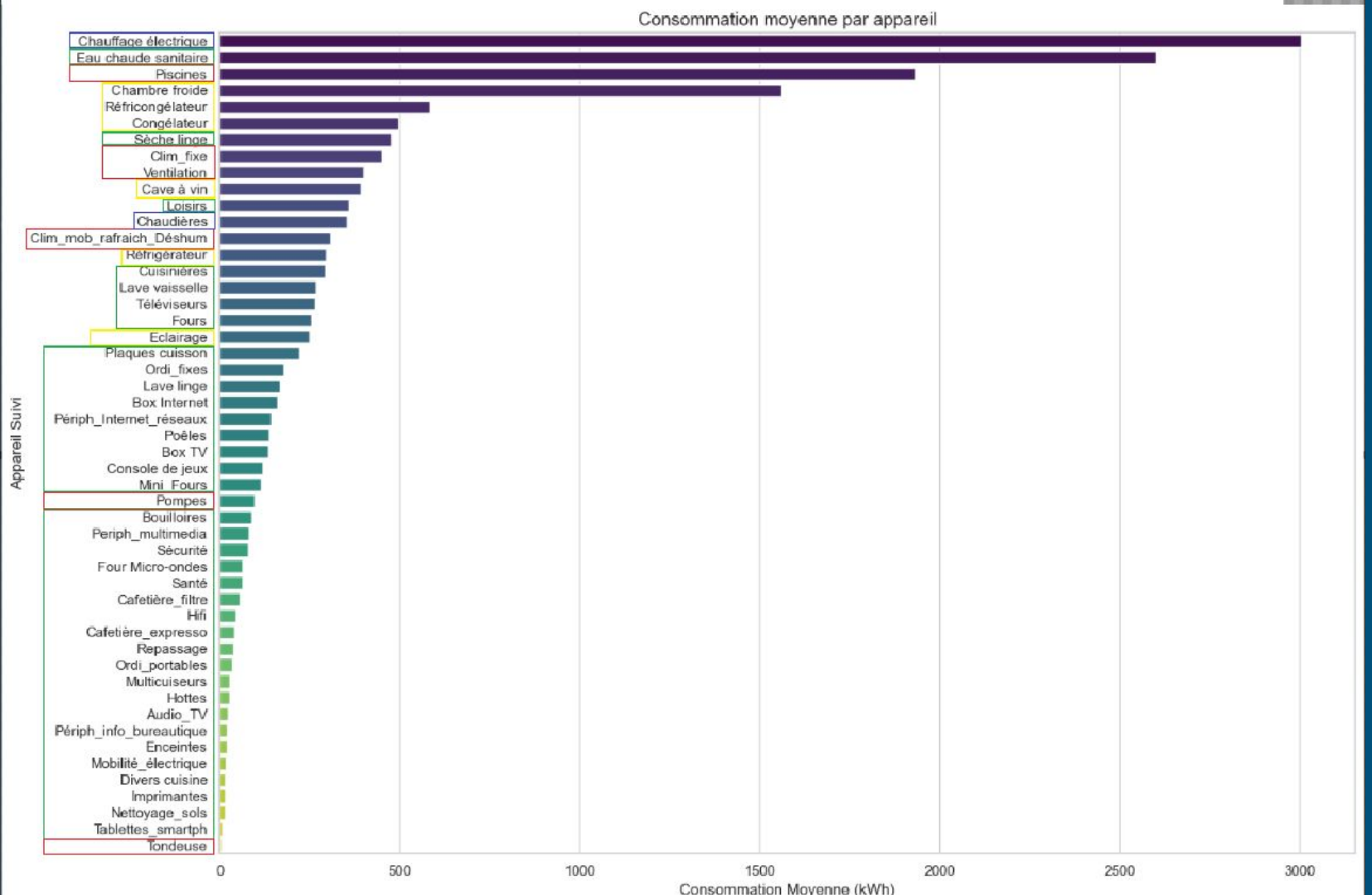

Comparaison de la consommation par jour de la semaine
Consommation énergétique (kW)
0
1
2
3
4
5
6
Jour de la semaine (0=Lundi)


Distribution de la consommation énergétique
Fréquence
8000
7000
6000
5000
4000
3000
2000
1000
0
0
1
2
3
4
5
6
Consommation énergétique (kW)


Prédiction de la consommation avec Prophet
Consommation (kW)
6
5
4
3
2
1
0
−1
2006-12
2007-06
2007-12
2008-06
2008-12
2009-06
2009-12
2010-06
2010-12
Date

Linking two datasets

- Correlation between peak consumption and the use of specific appliances (heating, lighting, household appliances).
- Optimization by programming appliances at off-peak times and raising employee awareness.
- Improving thermal insulation to reduce consumption linked to climatic variations.



Red : Summer

Blue : Winter

Green : independent of season

Yellow : Higher usage in winter

Conclusion

- Clear identification of trends and causes of energy peaks
- Effective predictive models to anticipate future consumption
- Concrete recommendations to address environmental and economic issues

Thank you for listening !