



UE Smart Systems

Influence of outside temperature on consumption habits

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Table of contents

Table of contents	1
Abstract	1
Introduction	1
Context	1
Methodology	2
Influence of temperature on overall electricity consumption	2
Influence of temperature on several appliances	3
TV consumption	3
Hotplates consumption	3
Washing machine	4
Influence of temperature on use of heating (gas)	5
Limits and conclusion	6
Bibliography	7

Abstract

This study proposes an analysis on the impact of outside temperature on electricity and gas consumption. The aim of this study is to observe if temperature modifies the consumption habits of a household. Five measures were read from September 2020 to January 2022 : total daily electricity consumption, daily TV consumption, daily hotplates consumption, daily washing machine consumption and daily gas consumption. No clear correlations were found between outside temperature and the four former measurements, which are all electric appliances. On the contrary, there is an evident link between gas consumption, that is being used for space and water heating and outside temperature.

Introduction

a. Context

In France, it is well known that the weather influences power consumption because of electrical heating. [1] In this study, we wanted to check whether the electricity and gas consumption (which is used for heating) of a single household is thermosensitive. In other words, our goal is to expose potential modification in consumption habits due to variations in the outside temperature.

b. Methodology

Measures are taken from the ExpeSmartHouse project, whose goal is to “provide data from a 120m² household where a five-people family lives”. [2] Data was retrieved by sending queries to the Grafana platform using a Python script. [3] The raw datasets were then processed using Python’s module *pandas* and Excel.

1. Influence of temperature on overall electricity consumption

One could think that the global electricity consumption would be lower in the summer, since the days are longer (hence less need for electric lighting) and people tend to spend more time outside.

With the data, no unequivocal correlation is found. However, the trend line shows that this household consumes more when the temperature is low. This is probably due to lighting and an increased use of electrical appliances compared to summer.

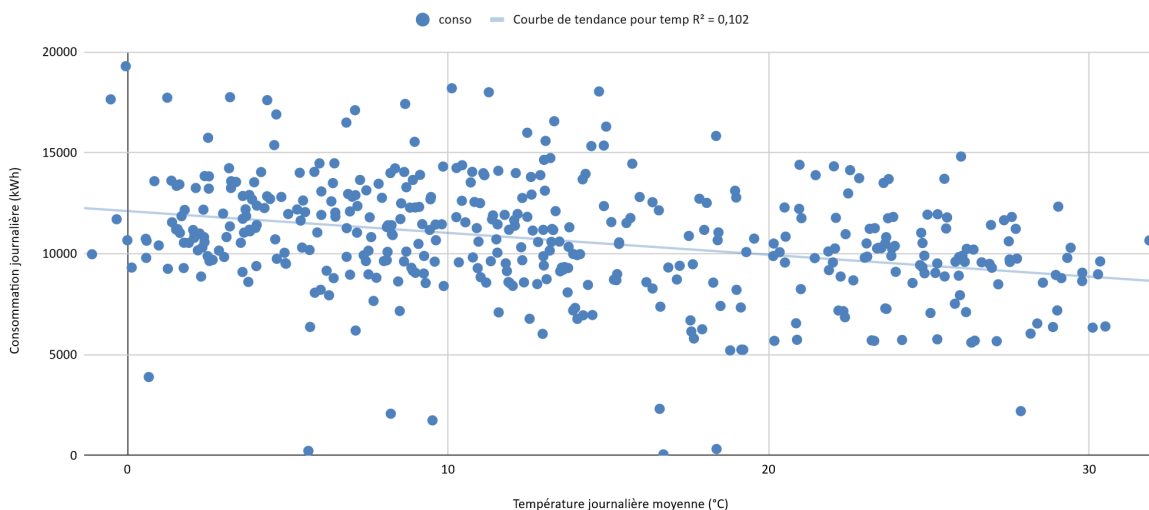


Figure 1: Daily power consumption according to the average daily temperature

2. Influence of temperature on several appliances

Since electrical consumption seems to decrease slightly with the outside temperature, we wanted to break down the power consumption between the different domestic appliances to see which were most influenced by the outside temperature.

a. TV consumption

At first glance, one could think that people would spend less time watching TV in the summer than in the winter, because they would be more inclined to go outside. This has

been corroborated by studies led by the *Groupe M6*, which showed that temperature was the primary factor influencing the time spent watching TV. [4]

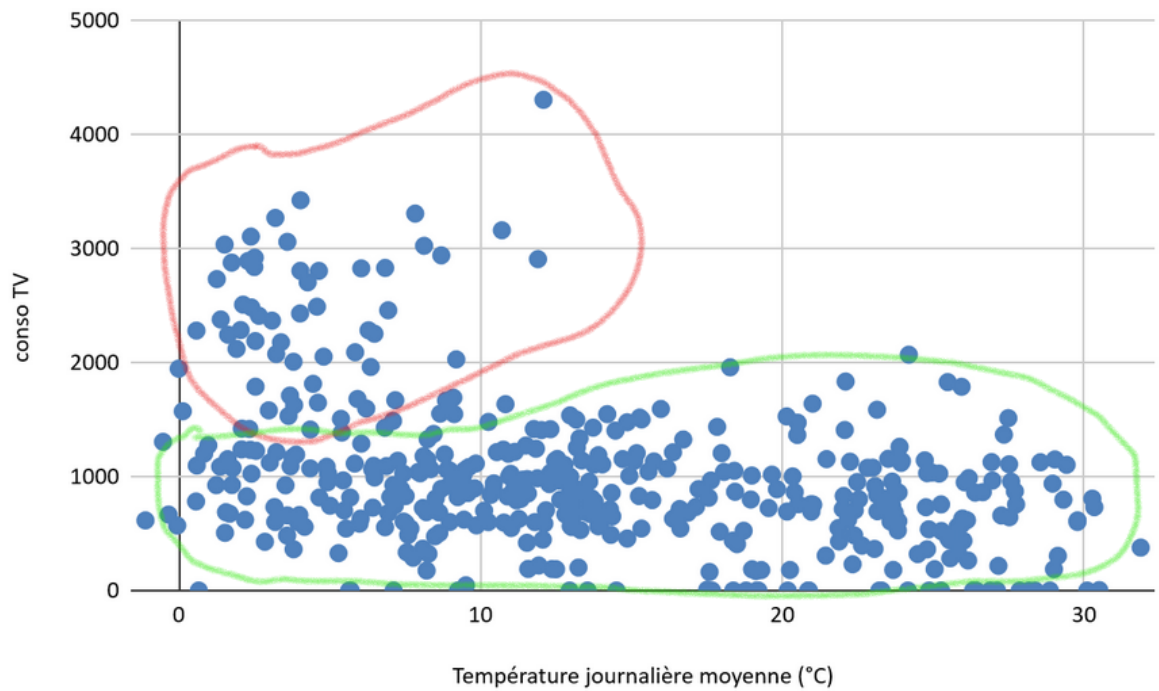


Figure 2 : TV consumption according to the average daily temperature

We also found similar results in our household. The days for which most time was spent watching TV were when the outside temperature was below 10°C (red circle). However, if we put these few days aside, the daily time spent watching TV is roughly constant (green circle).

b. Hotplates consumption

One could also think that meals in the winter are more substantial, whereas meals consumed in the summer tend to be lighter and often cold. If this is true, there would be a correlation between the outside temperature and the daily consumption of the hotplates. No such correlation was found (fig. 3), even on a monthly basis (fig. 4).

Daily consumption

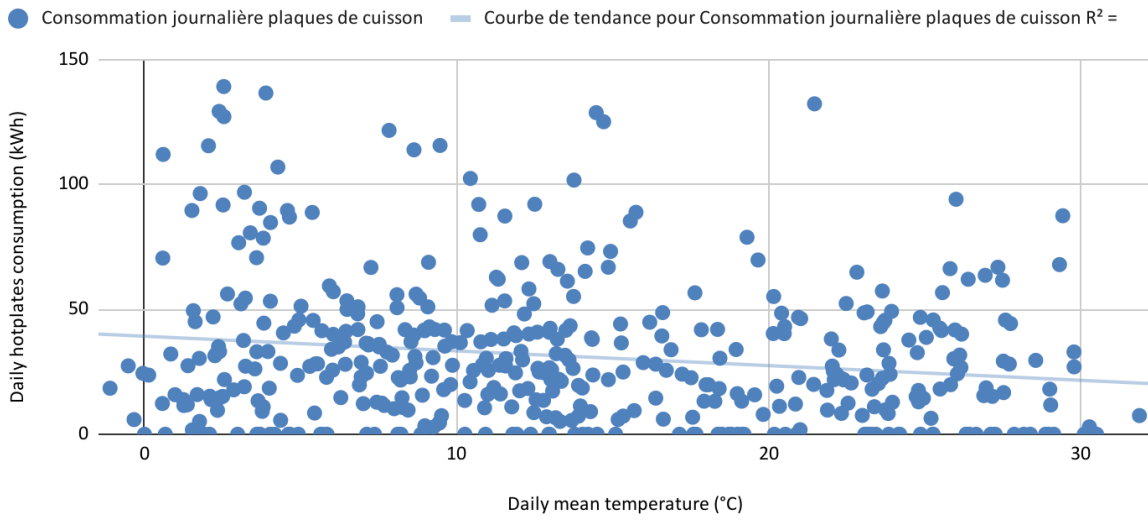


Figure 3: Daily power consumption of hotplates according to average daily temperature

Monthly consumption

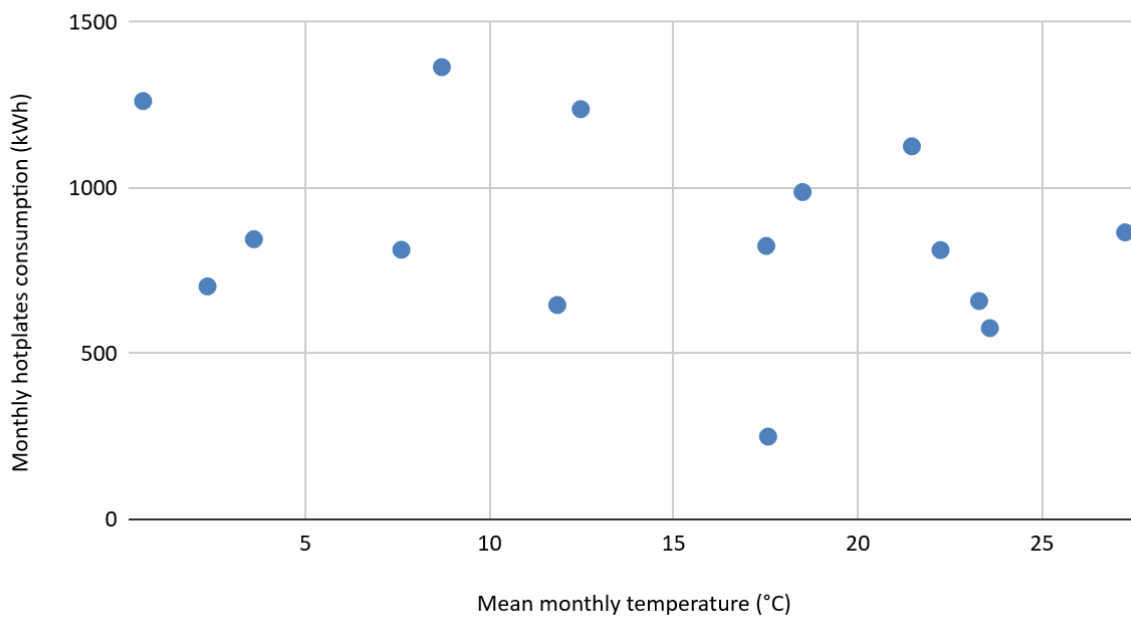


Figure 4: Monthly hotplates consumption according to average monthly temperature

c. Washing machine

Likewise, common sense inclines us to think that the load of laundry would be sparser in the summer, since people wear less clothes when the temperatures are hotter, which would decrease the use of the washing machine.

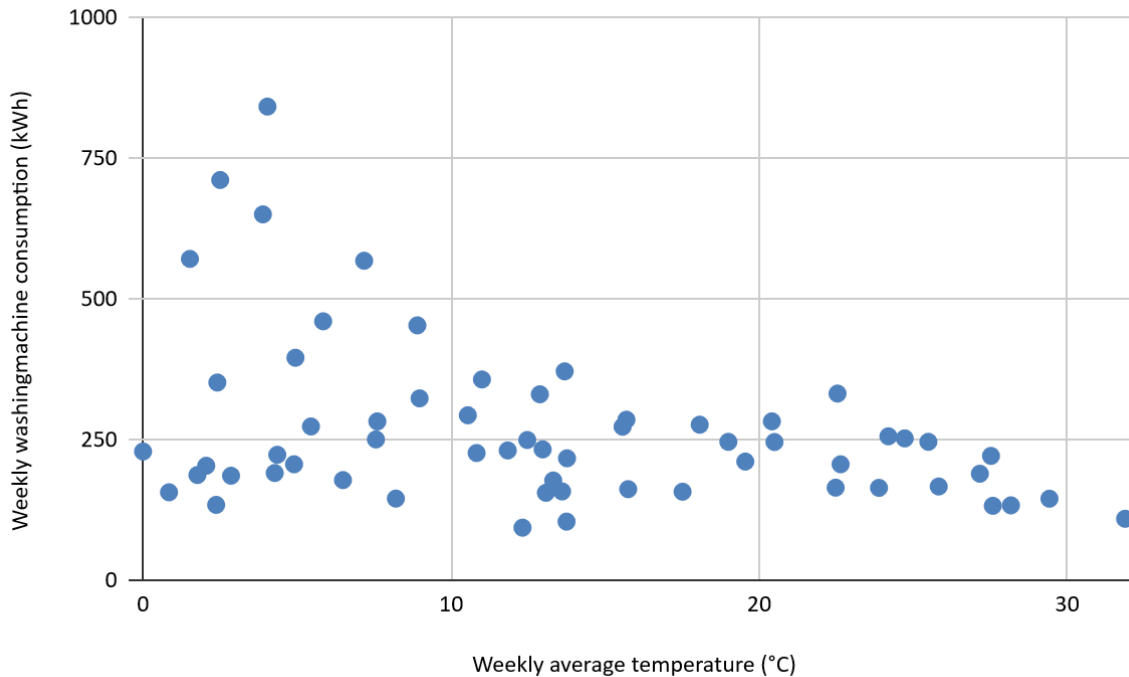


Figure 5: Weekly washing machine consumption according to average temperature

Since a household does not use its washing machine on a daily basis, we used the weekly average for temperature and consumption. Similarly to TV consumption, the weeks for which the washing machine was the most used are indeed among the coldest, but apart from these weeks the consumption seems to be roughly constant.

3. Influence of temperature on use of heating (gas)

So far, we only analyzed data related to electric consumption. The household is also consuming gas for its space heating and domestic hot water. It seems obvious that the consumption for space heating would increase when the temperatures decrease. This is indeed what we notice : consumption linearly decreases until a certain temperature threshold (around 15-16°C), at which point gas is only used for domestic hot water, hence the gas consumption remaining constant (fig. 6).

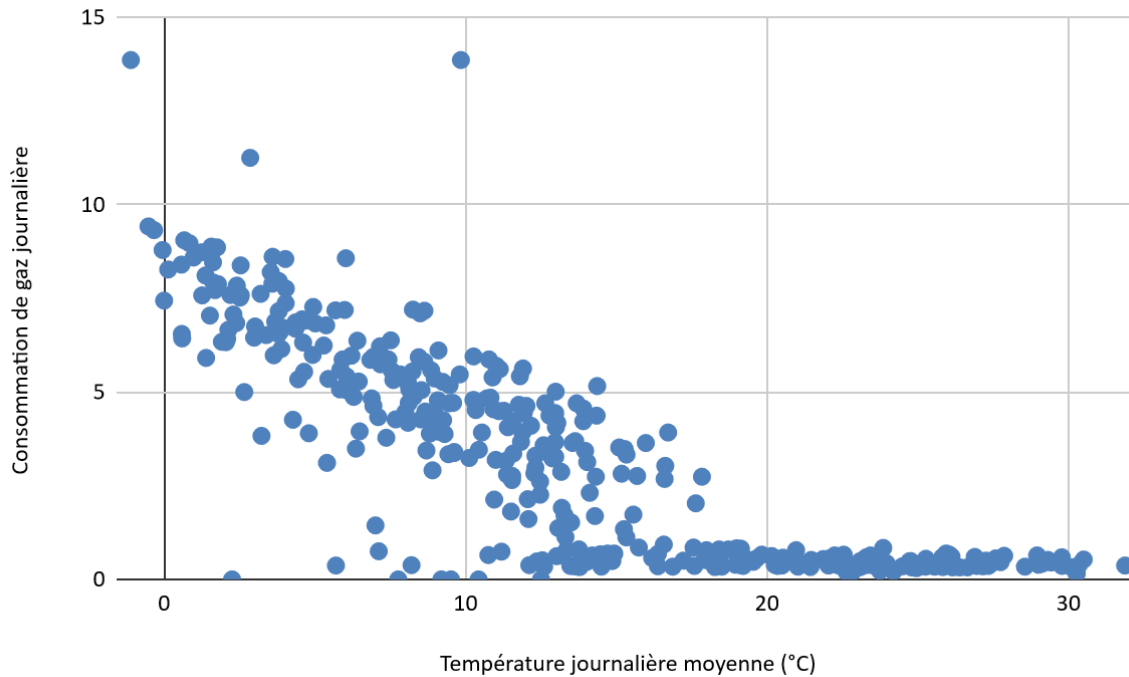


Figure 6: Gas daily consumption according to average daily temperature

Limits and conclusion

We managed to uncover a small correlation between electric consumption and temperature, but there is no clear linear trend linking the two measures. When breaking down the consumption between different appliances, we notice that some (washing machine and TV) are indeed used more when temperatures are low. But again, this is not a rule set in stone and there are cold days where the consumption of these appliances is equal to the consumption during hotter days.

There are obviously many limits to this short study. First, we focused our analysis on a single household only. It would be interesting to aggregate the data for electric consumption of the different appliances on tens of households, with the hope that it would bring to light more evident links. [5] We also performed only a basic statistical analysis and it could be interesting to use some more advanced statistical tool to interpret the data. In particular, it could be relevant to plot not only the daily consumption/daily average temperature graphs, but also the weekly, biweekly, monthly, quarterly, etc. graphs. The consumption patterns might indeed not vary as fast as the temperature and might only be observable over a longer time period. Furthermore, days when one or several members of the household are away (on vacations or on a business trip for instance) should also be accounted for in order to correct the consumption. Lastly, other weather-related measures should be included in our study. For instance, TV consumption might well be also correlated not only to temperature, but also to the amount of sunshine during the day.

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