

# Load monitoring at a short time step to set up actions: a feedback from the USER project on the Reunion Island

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## Abstract

The context of the French overseas territories is particular. Those territories are off the main grid. This implies relying on an expensive and CO<sub>2</sub> rich energy mix for electricity generation. Nevertheless, the tariff equalization mechanism keeps the price of the kWh exactly the same as the one in France mainland. The difference is covered by a tax paid by all the French consumers.

In such a context, the benefits of reducing the consumption of electricity are even more relevant. To do so and set up the appropriate actions and policies, a local knowledge is needed.

USER (Usages Spécifiques de l'Electricité à la Réunion) is a three-year project (2019–2022) funded by the French environmental Agency ADEME. USER aims at improving the knowledge about the households' use of electricity for their appliances on the Réunion Island. A deep understanding of the Island households is the path to success for relevant actions that will be accepted and preserve as much as possible the wellbeing and the local ways of life.

In this paper, we will present the project and discuss the main results of two of its parts. A quantitative survey focusing on the knowledge of the Reunion households' appliances and a monitoring campaign conducted on a sample of 45 Réunion Island households. Their cold appliances were targeted in the first place because they remain a major electricity consumption but not only. Up to five appliances were separately monitored for each participant. Active power was recorded every six

seconds during a whole month. In contrary to simple energy measurement, this short time step allowed us to see precisely what is really happening at the appliance scale: is there a malfunction? Is the use intensity too high?... Results from these analyses provide insights for local decision-makers (ADEME and EDF Réunion) to address households in a tailored manner. Main intervention included replacing the appliance or giving the right advice to optimize its use.

## Introduction

When setting up a campaign to reduce end-uses consumptions the first question that comes in mind is: how can we be sure not to miss our target? If we focus on the cold appliances, the tips are well-known but their real impact or their merit order can be discussed. Moreover, is the advice worth if the appliances are malfunctioning? In the special context of the Reunion Island, we tried to address those questions. Our goal was to objectify as much as possible what works, what can be expected in the "real life" and finally, what needs a special attention for future larger campaigns?

In this paper, we will present the ADEME funded project USER. The USER project is, to our knowledge, quite unique: mixing different types of approaches (a quantitative survey, a field and a sociological study). The results we obtained for two of the three parts of the project are described: a quantitative survey which aims at building the knowledge on the households' appliances and the first half of the monitoring campaign. After setting the background of the project and its goals, we will give some key figures about the local context of the Reunion Island. We will explain what is at stake regarding the specific electrical

end-uses and why the cold appliances were targeted. Then we will focus on the core of the project: the monitoring campaign. We will detail how it was set up, how we proceeded, the difficulties we encountered. This will lead us to the results and the indicators we defined and used to determine to which category a household belongs. We will also present how we communicated those results to the households to prepare the second phase of the campaign. To conclude, after a global feedback, we will question some key points such as energy efficiency in this context, scalability of this approach and extrapolation of the results.

### Context and goals of the USER project

In 2018, the French Agency for Ecological Transition (ADEME) launched its fourth call for research projects entitled “Vers des bâtiments responsables à l’horizon 2020”. EDF R&D, EDF Reunion and the local association SPL-Horizon Reunion decided to work together and to propose the USER project (Usages Spécifiques de l’Electricité à la Réunion). This proposal was selected by the ADEME as a three-year project (2019-2022).

USER focuses on the “specific electricity”. This term corresponds to all the residential electricity consumptions due to the households’ appliances (for example: fridges, freezers, TV, cookers...). Whereas in France mainland, those consumptions represent more than half of the residential electricity consumption (the rest is shared out among space heating, hot water and traditional cooking), in the overseas territories, the situation is very different. Indeed, electrical space heating is not significant due to the local climate, so are the electrical hot water and electrical traditional cooking. Air conditioning may be rising but it is not widespread. In this context, for most of the households, specific electricity represents their whole electricity consumption. This is particularly true on the Reunion Island (Figure 1).

Thus, the “specific electricity” counts for almost all the residential electricity consumption. Nevertheless, it remains widely unknown regarding the appliances stock (equipment rates, energy efficiency...).

Moreover, the context of the French overseas territories is special. They are off the main grid. This means they must be self-sufficient for their electricity generation. And even if renewables are developing, they widely rely on an expensive and CO<sub>2</sub> rich energy mix. Moreover, the tariff equalization mechanism keeps maintaining the price of the kWh exactly the same as the one in France mainland. The difference is covered by a tax paid by all the French consumers. The stake is clear: energy efficiency is the key.

But how to address the right messages to the right consumers if their appliances, their usage patterns are partially known? This is the purpose of the USER project: helping to understand the local context, the appliances stocks and consumptions as well as people’s behaviour towards their choices regarding their electricity consumption. The lessons learned would, in the end, contribute to improve energy efficiency from the households’ scale to the global scale.

The USER project is divided into three parts:

1. A quantitative survey to get overview on the appliances’ stocks on the Reunion Island and how people use their devices. This survey is completed by a report on the market of the main appliances (fridges, freezers, washing machines...)
2. A monitoring campaign conducted on more than fifty households. This field study is divided into two parts. The first part aims at drawing up an assessment of the initial situation regarding targeted appliances (especially cold appliances). That’s what we will present in this paper. The second part, after energy efficiency advice given to the households and even sometimes appliances replacements, will allow us to quantify what worked and what did not
3. A sociological study in the form of interviews conducted on a sample of 29 households to understand how they buy their appliances, how they make their choices, how they understand and apprehend their electricity consumptions.

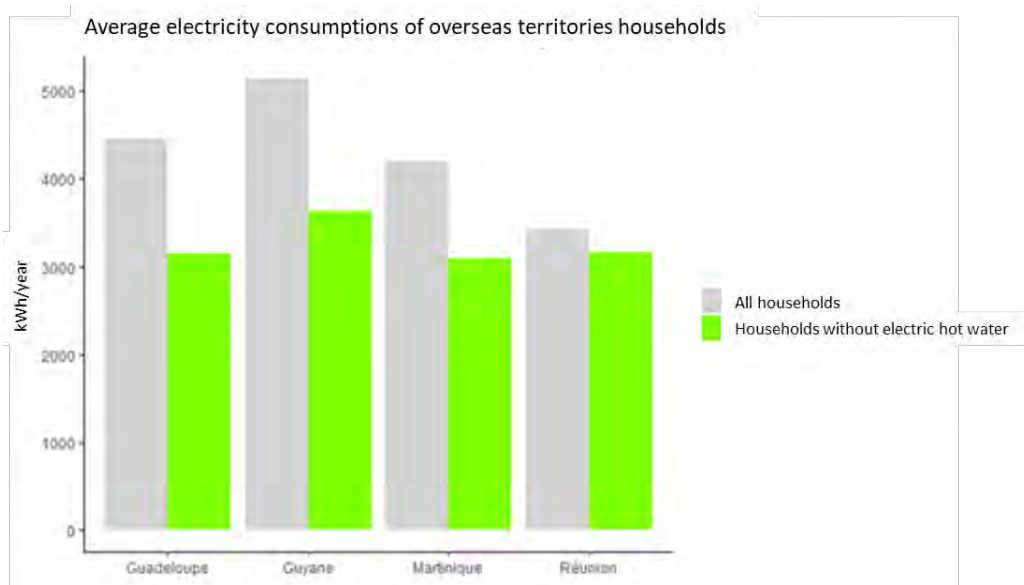


Figure 1. Average electricity consumptions for overseas households (EDF R&D 2012).

## The specific electrical end-uses on the Reunion Island

### THE SURVEY

The first part of the USER project was to improve the knowledge of the residential sector on the Reunion Island. In this context, this means gathering data on the ownership rates of a wide range of appliances but also on how households use their devices. The goal is to build a reliable picture of the situation.

The best way to answer those questions is to conduct a quantitative survey. The main difficulty for this kind of study is the length of the questionnaire. Choices have been made by EDF R&D and this task has been carried out by Etudes et Marketing Océan indien, a local polling institute. This led to a 30-minute questionnaire passed over the phone. The sample size was 1000 households selected according to nine quotas. Those quotas were: the location, the housing type, the occupancy status, the altitude (very important on the Reunion Island), the household's size, the number of children under 15, the sex, the age and the socio-professional category of the people questioned. The field study was conducted from March to August 2020.

### Introducing some key results

In this section, we will present some of the main results of the survey. This will help to better understand the local context and will put in perspective the monitoring campaign.

The end-uses can be divided into 7 main categories based on the purpose of the appliances used:

1. Cooling
2. Cold appliances
3. Cooking
4. Hygiene
5. Audio and video
6. ICT
7. Lighting, outdoor, mobility, and others

For each of these categories, we will present the ownership rates of the most iconic appliances. Then, when relevant, we will underline one or two facts about their features or their use.

The results show that when a comparison can be made, the figures on the Reunion Island regarding the ownership rates are not that far from the ones found for similar studies [1], [2] conducted on mainland France.

### Cooling

Due to the tropical and wet (overall) climate of the Reunion Island [3], cooling systems tend to be found in more and more households. Whereas about only 12 % of the households declare that they do not own any heating system, about one third say that they have at least one cooling system. Those cooling systems are for 95 % of them fixed air conditioners.

### Cold appliances

Refrigerators are among the most owned appliances. All the households questioned had at least one fridge. 10 % owned more than one leading the average number of 1.1 by household. This is a bit less than France Mainland (about 1.2). The aver-

age appliance age is 7.4 years old with more than a third being 3 years old or younger. Regarding the efficiency, one third of the machines are declared to be A+ or better. But more than 40 % of the households are unable to find the class of their devices. 88 % of the refrigerators found on the Reunion Island have independent freezers (two doors), the most widespread type being the two-door freezer above the fridge (in France mainland, it is the two-door freezer under the fridge). It must also be noticed that 12 % of the households own an American Refrigerator (freezer and fridge are vertical side by side) which is quite high (more than twice the figure for France mainland). The size of the refrigerators is coherent with their types: 7 households out of 10 have a "large" appliance (higher than 1.5 m).

Freezers are found in 59 % of the households (1.1 appliance by equipped household a little bit higher than France mainland for the ownership rate). They are quite older than the refrigerators (8 years old on average, between 4 and 10 years old for more than 50 % of the stock). The average energy efficiency is worse than what was found for the fridges which is coherent with an older stock. About 80 % of the freezers are horizontal and their volumes tend to be "small" according to the households (under 200l). For the vertical ones, half are described as more than 1.5 m high.

Those results indicate that the Reunion Island is not different from France mainland regarding the cold appliances ([1] [2]): Both ownership rates and electricity consumptions are high.

### Cooking

Cooking is important. It involves appliances that require power and they are often used daily. The energy consumption that follows can be significant.

On the Reunion Island the main specificity is the omnipresence of the rice cooker. It is the most widespread cooking appliance since 83 % of the household claim to own one. It is followed by the micro-wave oven (77 %), the ovens (67 %, both classical and mini) and the coffee makers (50 % for the machines with filters and 41 % of other types). The average number of cooking appliances owned by the households is shy 5 which is not much. The very low ownership rate for electrical cooktops must be underlined (17 %).

Regarding the intensity of use, 4 appliances are used at least once a day when they are present: the coffee makers (71 %), cooktops (70 %), micro-wave ovens (65 %), rice cookers (54 %).

### Hygiene

Two appliances stand out: the washing machines and the irons. They both top the ownership rates ranking with about 91 %.

It must be noticed that the other two large appliances of this category, the dishwashers, and the tumble dryers are not commonly found (24 % and 10 %).

When owned, washing machines and dishwashers are used a little less than 3 times a week, which is an average comparable to France mainland. With about 2 times a week, ironing, is quite frequent.

### Audio and video

On the Reunion Island, 97 % of the households own at least one TV and 75 % have a set top box. Those two appliances are clearly apart. Coming in third position is the game console with

31 %. The TVs are in most cases LCD LED or OLED. The average size is 95 cm.

Almost all the TVs and set top boxes are used daily for about 5h20 on average.

### ICT

Regarding the ICT, it must be noticed that the Reunion Island is very close to France mainland. 81 % of the households have an Internet wireless modem, 63 % own at least one laptop (21 % a desktop), 54 % a printer and 34 % at least one tablet. The multi-equipment exists but is less frequent than in France mainland.

82 % of the households own at least one smartphone (for an average of two when the households are equipped).

### Lighting, others, outdoor, and mobility

For the other appliances, we can notice that the LED technology for lighting is already widely used (83 % of the households own at least one bulb and in more than 50 % of the households, there is only one type of bulb). The hair dryers can be found in 47 % of the households. Pools and aquariums are owned by 8 % of the households but both are very rarely heated. Electric mobility is still shy. Electric bikes top the ranking with 2 % of the households equipped.

### CONCLUSIONS ON THE SURVEY

This quick overview of the main appliances stock in the Reunion Island shows us interesting facts. Firstly, the ownership rates for a significant number of appliances are close to the ones found in France mainland (fridges, freezers, washing machines, TVs, modems, PCs, smartphones...). Secondly, for some other devices, the ownership rate is below (dishwashers, tumble dryers for example) or above (air conditioners, rice cookers). This can easily be explained by the climate or the culinary background. Thirdly, the number of appliances owned by a household seems to be, according to our survey, lower than in France mainland and so is the multi-equipment.

The survey helped us to set a good picture of the appliances stock in the Reunion Island, but it also confirmed some key points for the monitoring campaign. Cold appliances, especially fridges, are the most important targets: they are widely spread, and their types and sizes are quite large. This, combined with the tropical wet climate, which increase the energy consumption, leads us to what is a major share of electricity (if not energy) consumption for the households. Then, TVs, washing machines and rice cookers will be the other appliances looked after.

## The monitoring campaign

### THE SET-UP

#### Principles

The monitoring campaign is central in the USER project. It is also the riskiest part. This campaign is divided in 2 phases. A first phase quantifies the initial situation. A second phase, after several months, assesses the effects of the communication made towards the households and in some cases the effect of the appliances' replacement.

In this paper, we will present the first phase since the second phase is still running.

The goal is then to select about 50 households with enough diversity. This means as close as possible to some of the quotas used for the survey (cf. The survey part above). The idea for this monitoring campaign is to record the load curves of up to 5 appliances per household during at least a month. Then the data are processed and analysed. This leads us to assess the annual energy consumptions and to identify the possible malfunctions thanks to the short time step power loads (6 seconds). For each household a report is generated. The electricity consumptions of the five appliances monitored are ranked for each appliance within each household and those consumptions are compared to those of the closest participants regarding some key criteria.

Since we are focusing on the cold appliances and especially on the fridges, we classified them into 3 categories:

1. those with the expected energy consumptions and load curves (i.e., regular cycles)
2. those with a high energy consumptions and normal load curves
3. those with anormal load curves (irregular or without cycles, i.e., the compressor works continuously).

For the third category, the appliance was replaced.

### Households' selection and local constraints

Selecting a relevant sample of households is a key point. Especially when the sample size is limited. The two main concerns are:

- Households' reliability: this means the ability of the households to follow the rules required to ensure that the monitoring campaign will unfold as expected
- Having enough diversity in our sample to cover a consistent range of households. This will be guided by 3 of the quotas used for the survey.

Such a selection requires a very good knowledge of the field and can only be addressed by a local partner. In the case of USER, this task was completed by the local association SPL-Horizon Reunion<sup>1</sup>. Thanks to their portfolio of costumers and their contacts, they manage to recruit 63 households as shown in Table 1.

A pitfall to avoid when monitoring cold appliances is the climate, i.e., the ambient temperature<sup>2</sup>. A month is too short to capture the seasonal variations. So, the assessment of the annual consumption for those appliances is biased but not totally wrong. Moreover, and most important for the project, we need to be able to make a relative comparison. This implies considering the date of the monitoring in our analyses<sup>3</sup>.

1. <https://energies-reunion.com/la-spl-energies-reunion/>

2. On the Renuion Island, the seasons are reversed.

3. We tried as much as possible to match the timeframes for the two campaigns, but we had to compose with the COVID constraints.

Table 1. Distribution of the sample

Housing type	Household size (people over 15)	Financial status	Target	Number recruited	Percentage
House	$\leq 2$	Financial insecurity	11%	11	17%
House	$\leq 2$	No financial insecurity	26%	21	33%
House	$> 2$	Financial insecurity	9%	8	13%
House	$> 2$	No financial insecurity	21%	10	16%
Flat	$\leq 2$	Financial insecurity	6%	5	8%
Flat	$\leq 2$	No financial insecurity	12%	1	2%
Flat	$> 2$	Financial insecurity	5%	4	6%
Flat	$> 2$	No financial insecurity	10%	3	5%

### THE MONITORING SYSTEM

The monitoring system used for USER was designed by EDF R&D. Every 6 seconds, it measures the instantaneous active power of up to 9 appliances. To do so, 9 plug-in sockets are used: one per device. They transmit their data to a hub where they are timestamped thanks to a real time clock. The protocol used is EnOcean. All the values are locally stored in the hub on a SD card (Figure 2). This choice has pros and cons. It simplifies the set up: the system is made to be plug and play and to be very simple to use. The local storage frees us from any network configuration or blind zone. But the drawback is that once the system is supposed to be running, we have no possibility to check remotely if it works properly.

This system is proven and has been used for thousands of days of monitoring by EDF R&D both for the needs of EDF and Enedis [4].

The time step is 6 seconds: every 6 seconds, each socket sends the value of the active instantaneous power it measures. Six seconds can be considered as a short time step for a load curve. Indeed, it is too long to record the transients, but it suits very well with most appliances' time constants. In other words, a 6 second time step reflects very well the actual functioning of a device in terms of power demand (Figure 3).

### IMPLEMENTATION FOR THE USER PROJECT

For the USER project, 5 sockets out of 9 were set up for each household. Even if the system is designed to be plug and play, to minimize the risk of mistakes and since the monitoring would only last one month, SPL-Horizon Reunion oversaw the

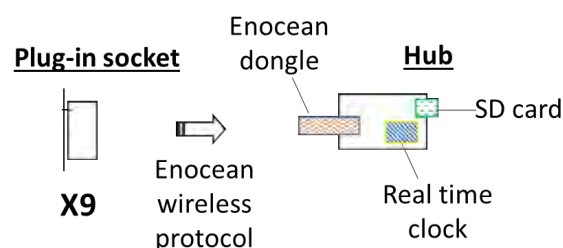


Figure 2. Diagram of the monitoring system.

installations. This support also helped the households to better understand what the purpose of the monitoring was and to answer their questions if any.

### The results

#### WHAT DID WE OBSERVE?

After all, 45 households out of 63 had good enough data to be processed. This means enough days (not less than a week) and enough measurements for each day (at least 11 000 points for each appliance). 216 appliances were monitored among which 28 different types. Regarding the cold, we recorded a bunch of 50 refrigerators and 34 freezers (Figure 4).

With more than one refrigerator per household monitored and a significant number of freezers, our focus on the cold appliances would be relevant.

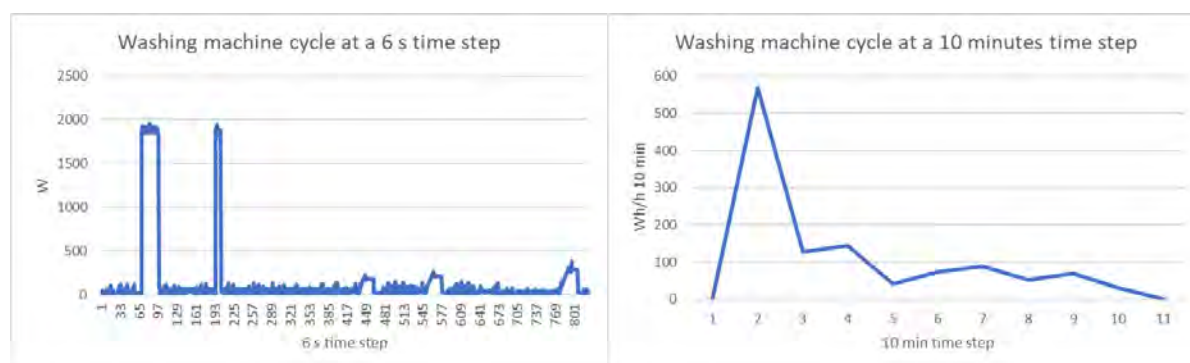


Figure 3. The same washing machine cycle at a 6 second time step (left) and at a 10-minute time step (right - energy consumption over 10 minutes).

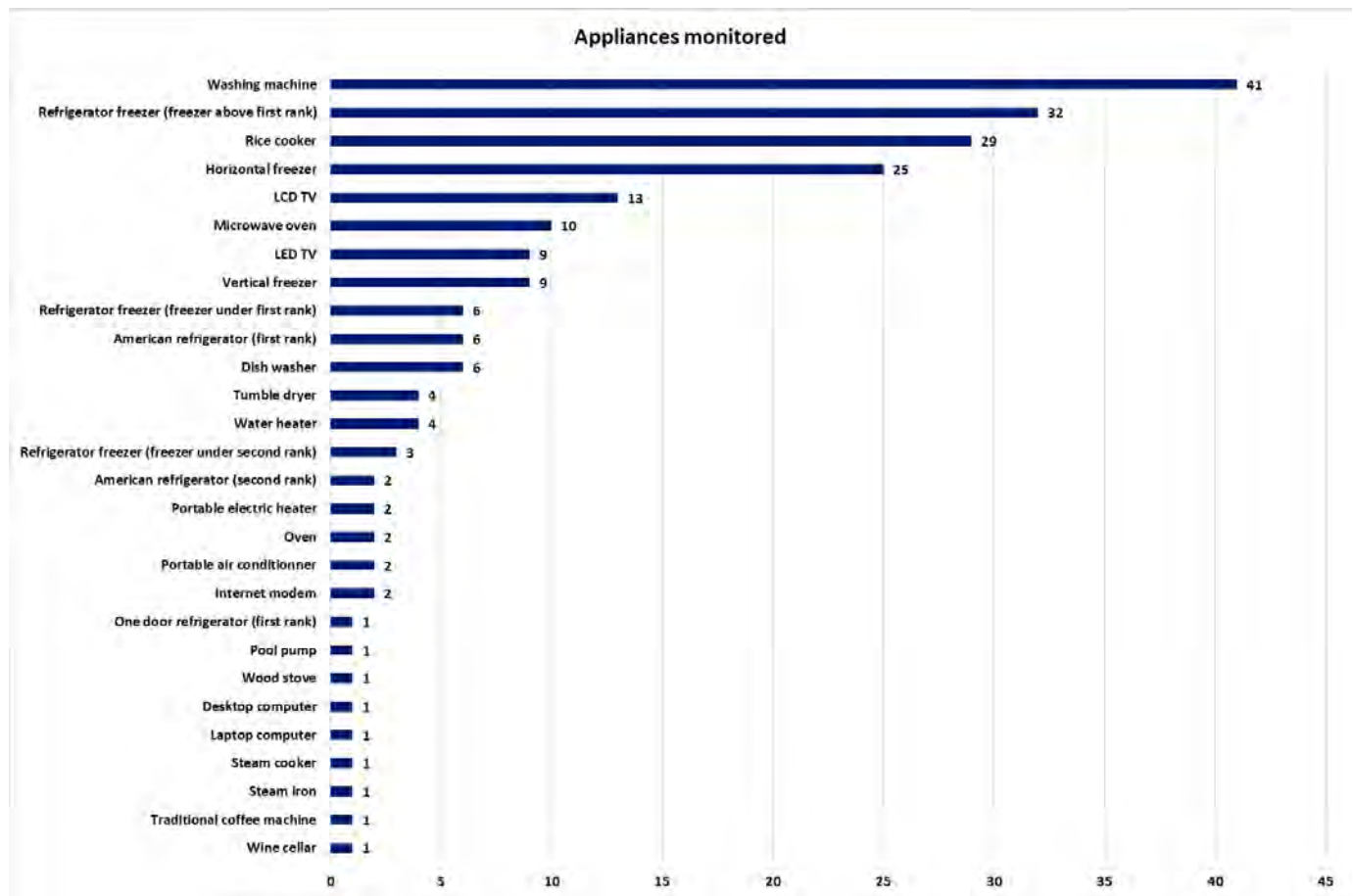


Figure 4. Appliances monitored during the first campaign of the USER project.

## MAKING THE DATA SPEAK

### Algorithms and indicators

As described above (cf. The monitoring system), for each appliance monitored, we recorded the instantaneous active power at a 6 second time step. Before processing the data, the raw values must be vetted and cleaned up to confirm that the right appliance is declared and to eliminate erratic pikes that can occur with any wireless system.

After this first step, we proceeded to the data analysis. This analysis consists in common graphic representations and, for the cold appliances, to the computation of ad hoc indicators.

### Common graphic representations

For each appliance, we drew a bunch of graphics designed to better understand the intensity of use and the patterns.

Below, we present for the refrigerator and the LCD TV of one household the most relevant graphics and what can be learned from them.

The most basic graphics are the load curves for the days with the minimum and the maximum electricity consumption (Figure 5). This controls that for the extreme values, the appliance's operation is normal or not.

The hourly power demand heatmap is the second very useful tool to describe the appliance's behaviour. This shows when the devices are used and with which level of intensity. In our example, we clearly see that the TV is off at night, that it is of-

ten turned ON at 10 a.m. for the rest of the day and that when it is ON, the power demand is quite stable. On the contrary, the refrigerator is working 24/7 with a lower power demand at night (cooler temperatures, no openings) and that from the morning to the evening, the power demand rises gently. The heatmap allows us to see things that the solely load curves do not (Figure 6).

The daily cumulative electricity consumptions are also very precious. they allow us to compare each day through different angles. With these graphics, for each day we can see when and with what intensity the appliance is working (slope break, slope value) and at the end of the day, we have the information regarding the level of consumption. The comparison between days tells us about the regularity of use and the singularities. For the LCD TV, for example, we can visually identify some "clusters" (days with similar profiles and with close ending levels). But in this case, globally, it is quite scattered. On the contrary, a refrigerator that works as expected (i.e., with regularity) will have days alike (Figure 7). In the case shown, one day is apart. It corresponds to the day with the maximum energy consumption (Figure 5). We can see that the deviation happened between 5 a.m. and 7 a.m.: the cycles are larger. This day can also be retrieved on the heatmap.

The last relevant graphic useful for the whole appliances is the three-hour average power demand. The three-hour average power demand reflects the global behaviour of the appliance over three hours and for the whole campaign. The day is divid-

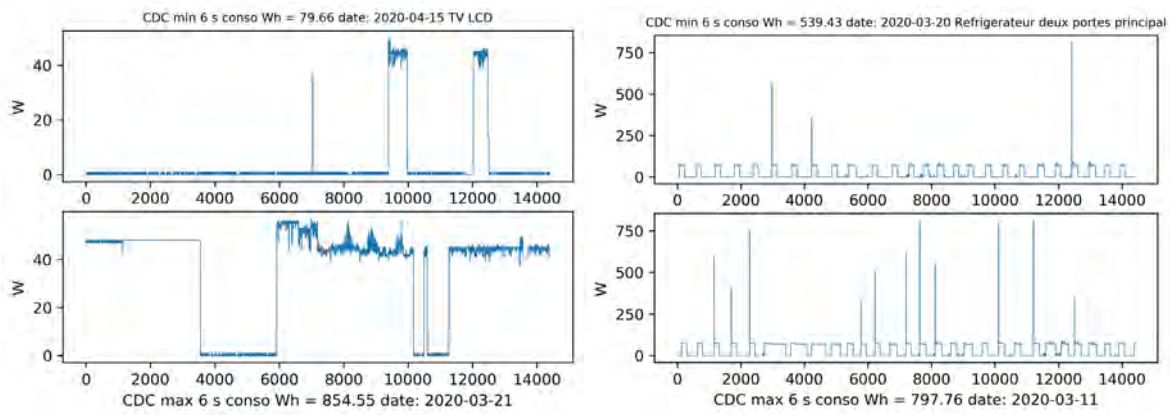


Figure 5. Days with the minimum and maximum electricity consumption for the LCD TV (left) and the two-door refrigerator (right) – household 4.

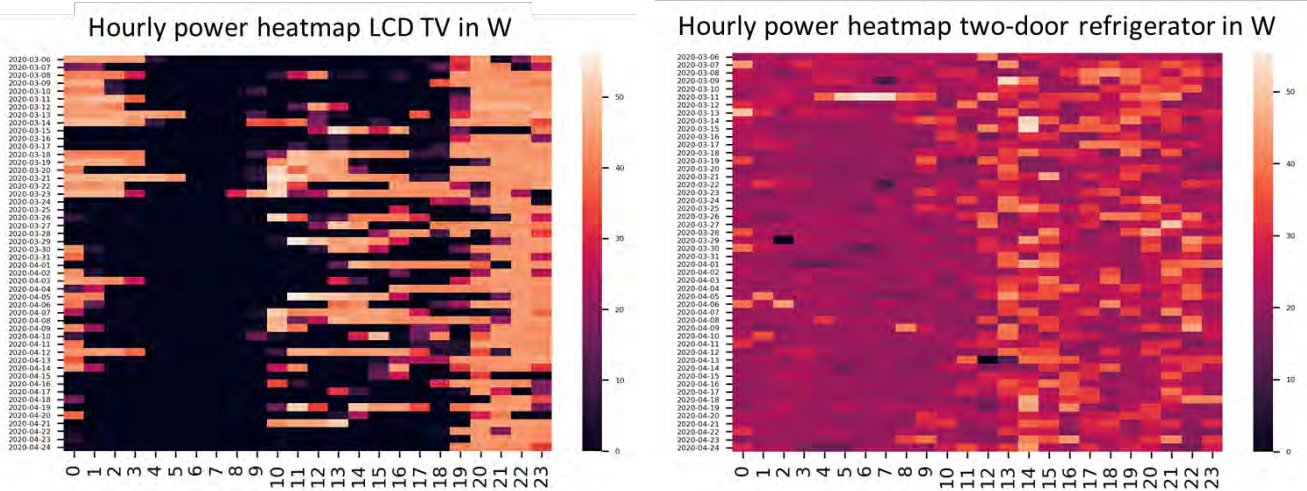


Figure 6. Hourly power demand heatmaps for the LCD TV (left) and the two-door refrigerator (right) – household 4. The Y axis are the dates.

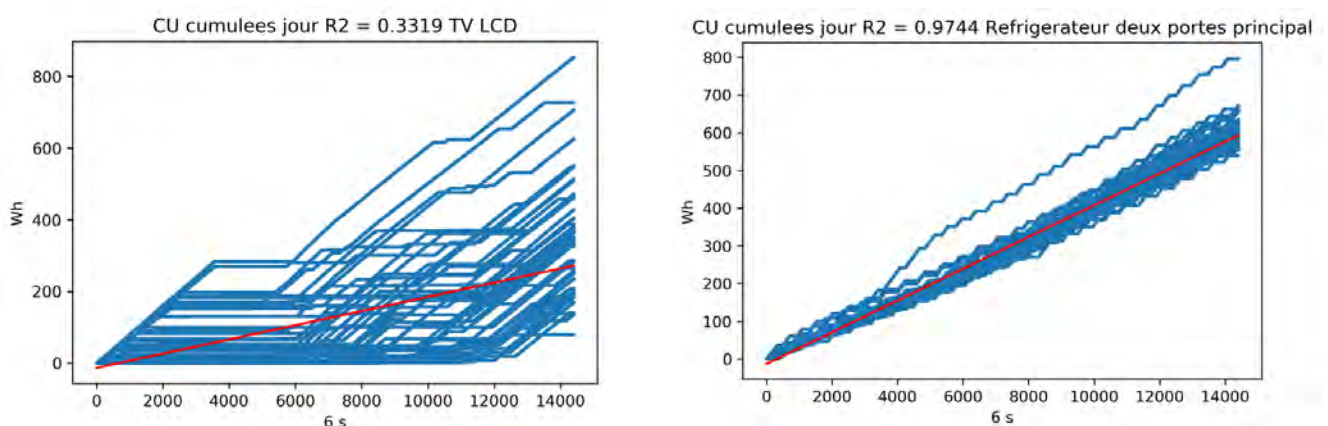


Figure 7. Daily cumulative electricity consumptions for the LCD TV (left) and the two-door refrigerator (right) – household 4.

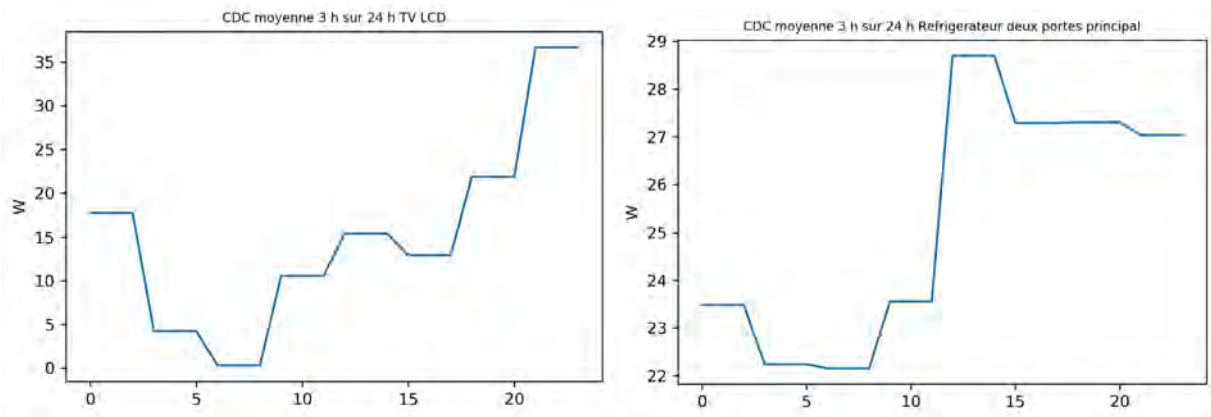


Figure 8. Three-hour average power demand for the LCD TV (left) and the two-door refrigerator (right) – household 4.

Table 2. Values and indicators for the cold appliances.

Indicator / Value name	Definition
Theoretical annual consumption	Computed thanks to equations tuned by EDF R&D. Input data are appliance type, efficiency, and total volume
Extrapolated annual consumption	Computed from the month recorded
Consumption ratio	Ratio between Extrapolated and theoretical consumption
Minimal theoretical annual consumption	Minimal annual consumption computed from the minimal three-hour power demand over the whole days
Maximal gain	Gain between the extrapolated annual consumption and the minimal theoretical annual consumption
Daily average number of cycles	Total number of cycles divided by the total number of days
Average cycle duration	In minutes, computed on all the days
Average ON ratio	Mean of the ratio between cycle duration and length of the day
Three-hour average power demand ratio	Computed from the curve presented above (Figure 8). It is the ratio between the maximal and the minimal values

ed into three-hour timeframes. For each of these timeframes, the average power demand for all the days is computed. This graphic gives a quick overview of the average power demand of the appliances through the day and erases some singularities. For the cold appliances, it gives a very good hint of the difference between night and day (Figure 8).

#### Indicators for cold appliances

For the cold appliances, we needed to go further. The correct functioning of this family of devices is all about regularity. They are ON 24/7 but they cycle several times a day. The rest of the time, they drain no power. One cycle looks like a rectangle. The ideal case is when all cycles are alike, the reference being during the night when no one disturbs the appliance by opening its door and when the ambient temperature is the coolest. This night timeframe can be used as a reference for what can be considered as the “optimal” functioning.

This led us to define some indicators especially designed for the cold appliances and to compute other values which are presented in the Table 2.

Those indicators and values have also been completed with some graphics to display the distributions (Figure 9).

#### CONVERTING THE NUMBERS INTO DECISIONS

##### What is a normal consumption?

In our case, on the Reunion Island, this question is a bit tricky. Indeed, due to the wet and tropical climate, the fact that some appliances may not be tropicalised<sup>4</sup>, the electricity consumption could be much higher than expected. So, the absolute consumption could not be the sole criterion to determine whether there is a problem. Thanks to the other indicators (Table 2) we could better sort out the malfunctioning appliances (for example no cycling, total duration of cycling, difference of power between night and day above a certain threshold<sup>5</sup>). Nevertheless, we added an optimised relative comparison between each appliance of each household with similar peers to help us establish a ranking that makes sense (Figure 10).

4. Tropicalised for a cold appliances means that the machine is designed to work at best under a tropical weather.

5. The values of the thresholds are mainly empirical and rely on experience.

### The benefits of a short timestep for the final cut

As presented in the previous sections, the results of the household 4 led us to classify it as a “normal” (Figure 10) and even “sober” household regarding its refrigerator electricity consumption. The annual consumption is among the lowest, the functioning is steady and so is the daily behaviour.

Nonetheless, to decide the final status of some households regarding their cold appliances, the 6s load curves remain precious. Since it delivers an accurate image of what is really going on at the appliance's level, it helped in many cases. For example, left on Figure 11: the refrigerator does not work or does not cycle, and right on Figure 11: the refrigerator cycles unevenly.

After this first round of monitoring, it was planned to replace the cold appliances (both refrigerators and freezers) that were identified as malfunctioning. To do so we computed and analysed the data as described (see previous sections and Figure 11) and we ended with 5 replacements for the refrigerators and 7 replacements for the freezers. This means that 10 % of the refrigerators and 20 % of the freezers were in a state that justified a renewal.

### What was delivered to the households?

The philosophy of the USER project regarding the field study is to establish a diagnostic with a first round of monitoring. This diagnostic led in some cases to an appliance replacement for the cold appliances. For each household, a report was established and delivered. This report was designed to make the households become aware of their electricity consumptions and of the ranking of their monitored appliances (Figure 12). This report was completed with some relevant graphics (presented in the previous sections) for each appliance.

This report, edited by EDF Reunion, was then brought, and explained to the households. It was completed with some advice about energy efficiency related to their appliances.

The ongoing second monitoring campaign will tell us if those actions resulted in a decrease in electricity consumption.

## What did we learn? Conclusions and perspectives

### FEEDBACK FROM THE FIELD

Halfway through the two-part monitoring campaign of the USER project, what have we learned so far?

It is no surprise that the complexity of a field study should never be underestimated. Things that look simple in theory can be much more complex when facing the reality. For example, following basic rules can be a challenge for some households, their knowledge of their appliances is also sometimes very weak (taking a photo of the monitored appliances is always useful). Even if a system is designed to be plug and play, going on site with each household is a very good point. Having enough diversity in the sample of households is essential so is the knowledge of the households. For this, conducting a survey prior to the field study is a must do whenever possible.

We found that nearly 15 % of the cold appliances monitored were malfunctioning (i.e., ratio between number of malfunctioning appliances and total number of cold appliances). Given the importance of the electricity consumption dedicated to this end-use, this raises a key question: can this be extended to the whole cold appliances stock of the Reunion Island?

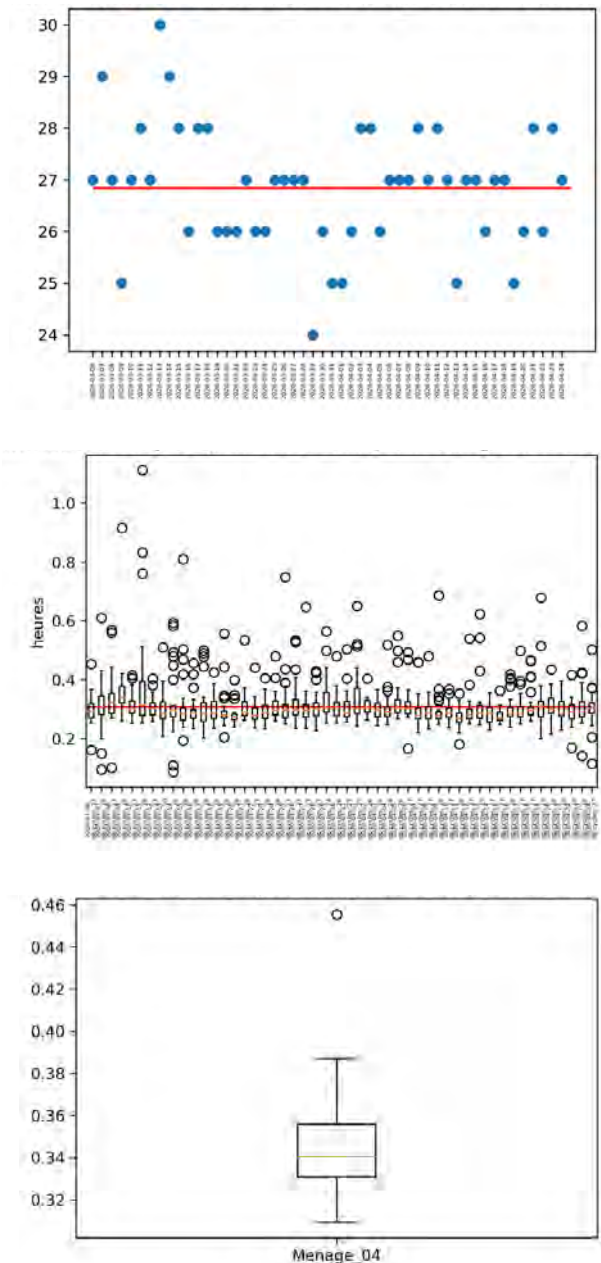


Figure 9. Two-door refrigerator: number of working cycles per day (1), daily boxplots of cycles durations (2), average ON ratio (3) – household 4.

### SCALABILITY

Drawing definitive conclusions on the cold appliances stock on the Reunion Island is hard regarding our sample size. Nevertheless, it indicates that the fraction of the stock that is malfunctioning is significant. Of course, monitoring more households would be interesting but setting up a much larger campaign would be money and time consuming.

Regarding the other end-uses, the reports given to the households with some efficiency tips (e.g. minimize openings, avoid heat sources close to the appliance or direct sunlight, food should be cooled down before being stored, cleaning and defrosting on a regular basis) and the ranking of their consump-

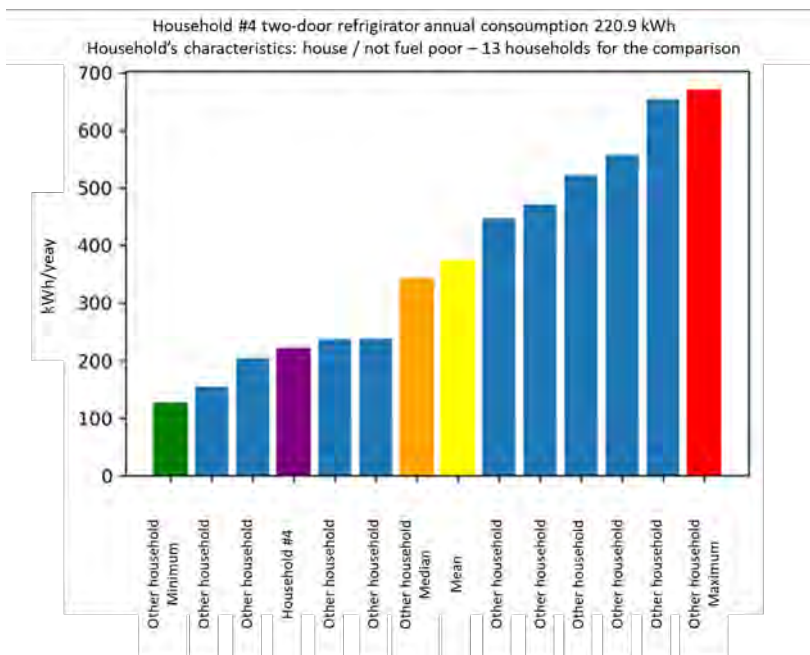


Figure 10. Two-door refrigerator annual electricity consumptions ranking according to similar criteria and values (min, max, mean, median) – household 4.

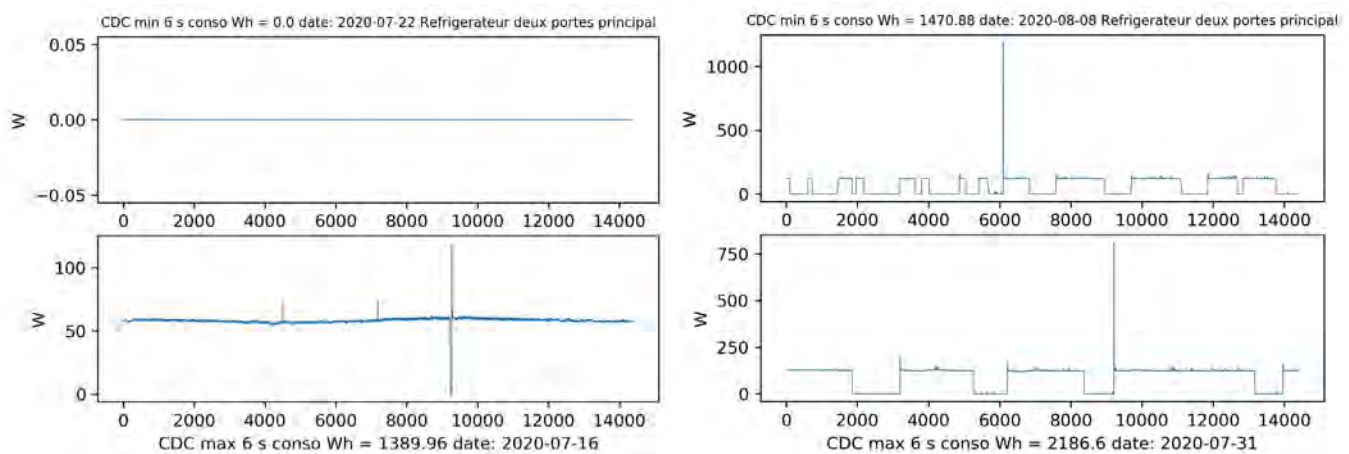


Figure 11. Load curves of two different malfunctioning two-door refrigerators (days with min max electricity consumptions).

tions (Figure 10 and Figure 12) should raise households' awareness and we hope that the second monitoring campaign will show this impact in the results.

At the very end, it might be interesting to extrapolate the consumptions to the whole stocks based on the survey results.

#### WHAT CAN BE EXPECTED NOW?

After the second monitoring campaign, we will try to estimate the impacts of advice and of the appliances' replacements. As of now, we can already assert that targeting the malfunctioning machines would be a first relevant step towards energy efficiency.

The other major lesson we expect to learn is which advice is followed and had a significant impact on the electricity consumptions. This will certainly help to design upcoming campaigns.

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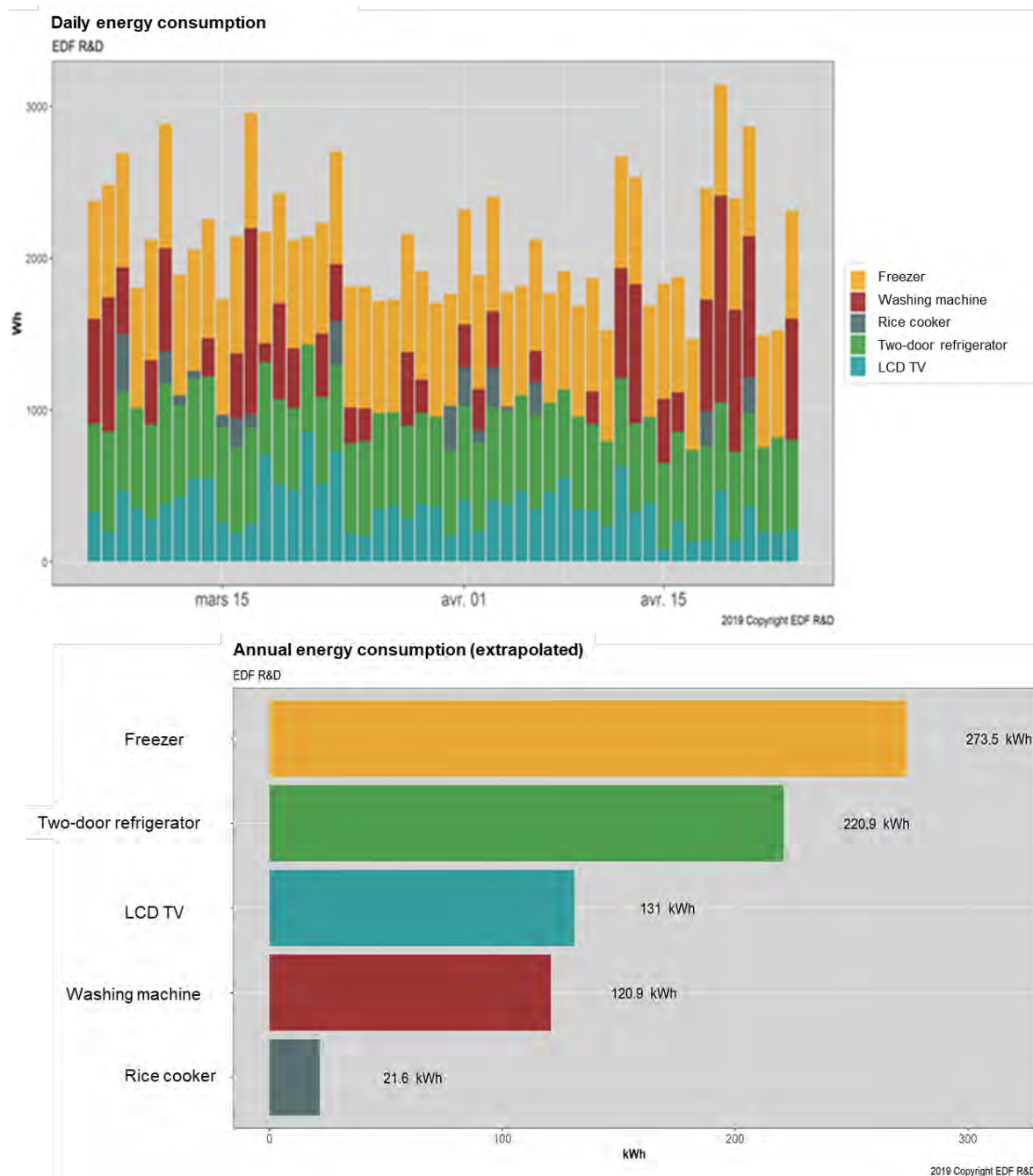


Figure 12. Daily electricity consumption for each appliance (above) and extrapolated annual electricity consumptions per appliance (below) – household 4.

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