CHARGE guru

Why EV drivers choose to charge at home?

Key findings based on real life energy data analysis

Executive summary

In June 2022, the European Union reaffirmed its agreement to ban the sale of new cars and vans powered by petrol and diesel (also known as internal combustion engine or "ICE" vehicles) by 2035. Some nations - such as Norway, the Netherlands and the UK - are defining even closer end dates for the sale of new ICE vehicles. All mainstream car manufacturers are now offering 100% electric models and an ever-increasing volume of publically accessible chargers are being installed across Europe. It's therefore no surprise that EV sales have increased 10-fold across Europe in the last 5 years alone; with more than 2.2m electrified vehicles being sold in 2021, equating to over 15% of all new vehicles sold in Europe.

However, when switching to an EV, a whole new world opens regarding charging: will it truly be possible to plug and charge my electric car at home in the evening as easily as a smartphone? When all you have ever known is going to the gas station to fill up the tank, charging your EV at home is full of technical and financial question marks.

To answer with real life data all the questions one may have when choosing to go electric, we have analyzed the energy use of EV drivers charging at home on a charging station. This was made possible thanks to algorithms developed by the ChargeGuru R&D team. The full results of this study led in 2022 are detailed in the next pages of this document.

The 8 key learnings from this study are:

1. When charging at home, **dynamic load management** prevents any power outages. Without this smart feature on your charging station, there is a probability of power cuts happening **40% of the time** when charging.
2. It is possible to have fast charging at home: 85% of users have a 7 kW charging station at home, enabling them to **charge 40 km of range per hour.**
3. Home charging is used to travel **300km per week**, on average. Some home users charge enough to travel over **1000km** every week. It is thus completely possible to charge your EV at home, even when being used as your main family car or even a company vehicle.
4. Overall, a 21% increase of the total energy use for the home is observed for our respondents. On average, users charge **50kWh per week**, which represents a **30 to 40€ increase per month** on their energy bill.
5. When charging at home, charging sessions are short: once the car is plugged, it charges for an average of **3 hours** and rarely more than 5 hours.
6. You can choose to **plug your EV in every time you park at home** – as do 43% of users, **or only when the battery is low** – as do 57%.
7. Most users prefer to **charge in the nighttime:** two thirds of charging sessions happen between 7pm and 6 am.
8. We identified **3 charging profiles, zen, eco and comfort** using clustering algorithms. Each profile matches different driving needs and charging habits. There is not one lifestyle required to make home charging work. You are **free to charge at home as you wish:** home charging is not a constraint.

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Context & Methodology

1 Electric vehicle home charging solutions

In 2020, the global electric car stock reached 1% of total vehicle market share with over 10 million vehicles. This includes battery electric vehicles, also called BEV or 100% electric vehicles, and plug-in hybrid electric vehicles, also called PHEV. The former only use their electric motor and their battery for 100% of their range, whereas the latter also include an internal combustion engine and have a smaller electric range.

In France, the market share of electric new vehicles went from less than 2% in 2018 to 18.3%% in 2021[1], with battery electric vehicles reaching 9.8% of total sales. This growth means that many charging stations are being installed. Some stations are installed for public usage and others for private usage.

Contrary to the public ones, the **private stations are owned by individuals and information about how these stations are used is difficult to obtain.** Individual charging habits are however important to understand how the EV market is driven and its impact on the electricity network.

In France, following the current electricity norms, charging stations exist in 4 levels of nominal power: 3.7kW, 7.4kW, 11kW, and 22kW. The first two (3.7 and 7.4kW) are designed for single-phase electric installation. Such installations are largely widespread in French households.
The latter two (11 and 22kW) are designed for three-phase installation for rare households with very high electricity needs.

2 Study Objectives and Respondents Selection

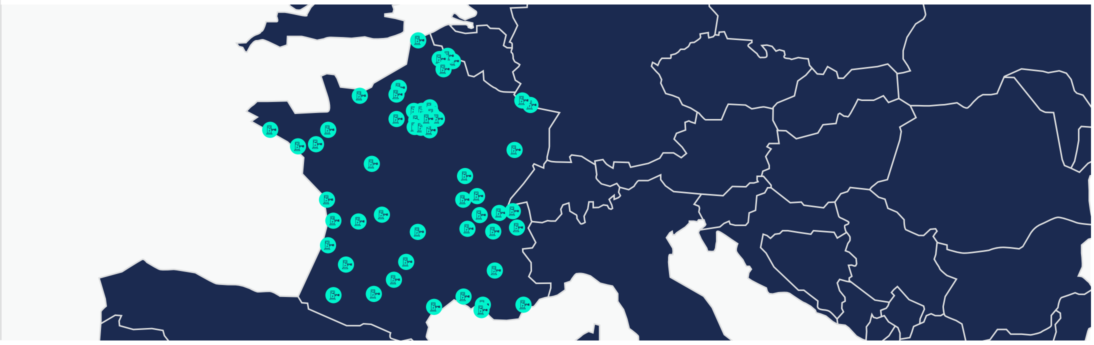
Goals of this study are twofold. Firstly, we measured **the impact of installing a charging solution at home.** Secondly, we used **a data-driven methodology to detect and classify home charging habits** based on smart-meter consumption data. The 8 key learnings are drawn from the observations made while achieving these goals.

To address these goals, we proposed to households who had installed a charging solution with us to participate in this study. Households needed to answer a few questions and to accept giving access to their electricity data before and after installation. Only customers that are in metropolitan France and have installed a single charging station between January 2020 and August 2021 were selected.

Furthermore, to retrieve the consumption data, only customers that own a smart meter and agreed for their electricity consumption to be recorded to be eligible. Finally, a set of 67 households met all the conditions and are analyzed in this study. Figure 1 represents where the households are located.
Since the households are spread throughout France, their charging habits are mostly comparable because households share a quite similar culture and weather. This cancels out some issues encountered when doing large-scale study of EV charging habits (disruptive weather, different time zones and work patterns). Additionally, all households use the same electricity network which is common to the whole country and is developed enough to support the extra load with the increase of EV charging.

Notes: 1. See the Global EV Outlook 2021 published by International Energy Agency: https://www.iea.org/reports/global-ev-outlook-2021, and Le marché automobile français Jan 2022 by CCFA
2. In France, smart meters are currently rolled out with about 80% of residential households covered as of the beginning of 2022.

FIGURE 1 **Households participating in the study are in metropolitan France**



3 Key definitions

Charging session

A charging session is defined as a continuous period where charging power is delivered to a vehicle.

As such, a charging session is not the period of time during which a charging cable is plugged in as a cable may be plugged without delivering any power. Consider a vehicle that is plugged in between 2:00 and 9:00. If power is delivered between 2:00 and 4:00 and then between 7:30 and 9:00 (no power between 4:00 and 7:30). In this case there are two charging sessions.

A charging session does not mean that the vehicle has been charged to its maximal capacity.

Energy and Peaks

Summarizing household consumption data is an important step to quickly grasp trends. This is a challenging task due to the voluminous data at hand. A classical way is to analyze the peak power drawn by the energy consumed:

- The **energy consumed** over a period of time is both easy to measure and to understand. In a consumption context, this energy represents the most important part of what is billed. Energy is often expressed in **kilowatt-hour (kWh).**

- The **peak power** is the maximal electricity drawn over a period of time and, due to its instantaneous nature, is more difficult to measure. Peak power still must be monitored to avoid breaking various electricity equipment.
  In a consumption context, peak power is not directly billed. Peak power is often expressed in **kilowatt (kW)** or in **kilovolt-ampere (kVA).**

For households, relevant periods of time are the week and the day to adapt to people's schedule. Taking a coarser period of time smooths out important specificities such as the weekday-weekend discrepancy. In this study, the two values are compared before and after charging station installation to see how electricity consumption has evolved.

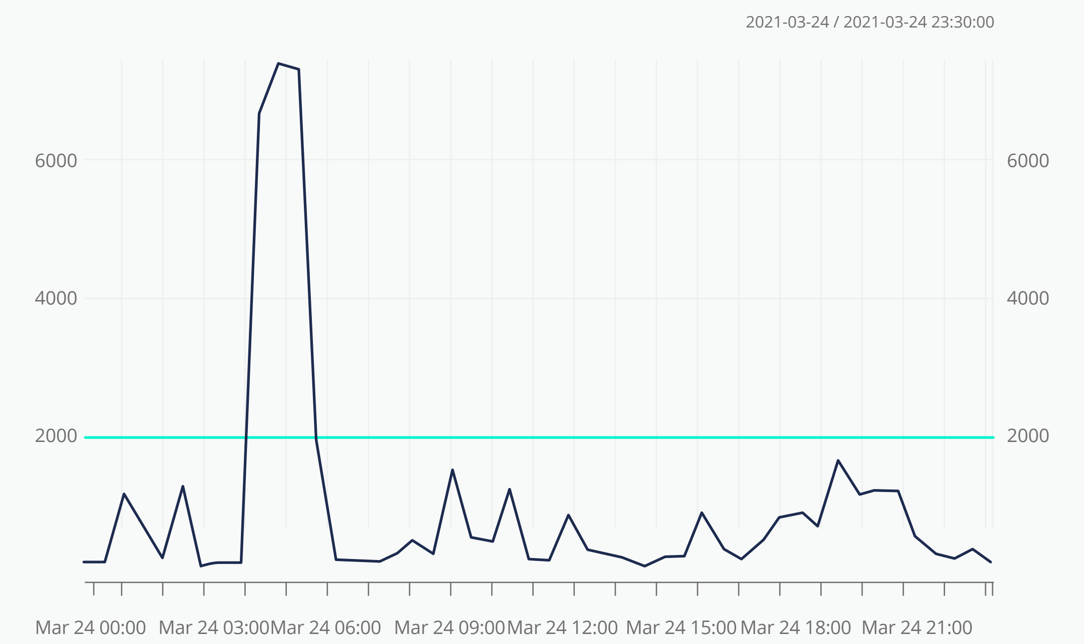
4 Detecting charging sessions from consumption data

In this study, we detect charging sessions from the total power delivered by the meter. Since the meter does not deliver power only for the charging stations, an algorithm has been developed to separate power delivered to stations from the power delivered to other devices. The method proposed relies on a threshold value that depends on the nominal power of the stations installed.

The methodology described is adapted from a 2019 paper analyzing electric vehicle consumption profiles with US data[3]. For each household studied, h=1,...,67, the total power used by the household is measured at specific timestamps. For most households, one value each 30 minutes is known. Figure 2 represents the series of total power consumed for a single household.

Notes: 3. See Gerossier, A., Girard, R., & Kariniotakis, G. (2019). Modeling and forecasting electric vehicle consumption profiles. Energies, 12(7), 1341.

FIGURE 2 **Total Power (W) used throughout a specific day by one household. When the total power exceeds the green line threshold, a charging session is detected.**



Intuitively, when a power bump is observed in the series, it means that a charging session occurred. For instance, from Figure 2, a charging session was started around 4 o'clock until 6 o'clock on the 24 March 2021.
The following algorithm was used to collect all the charging stations for each household:

1. From the complete time series (x_t), outliers and missing values were detected. These values were replaced by the existing values of the previous day when available, otherwise, two days before, three days before, and so on. This replacement method is favored due to the well-known **daily seasonality** of electricity consumption.

2. A threshold value τ_h was automatically defined for this household. The exact value of the threshold is determined by the type of station installed and the subscribed power.

3. The series was fully scanned. When the series goes over τ_h, a charging session is registered along with the starting hour. The charging session continues as long as the series keeps being above the threshold.

4. A random normal noise for starting and ending timestamp was added to account for the discreteness of the series.

Is the electrical infrastructure of my home powerful enough to charge at home?

The #1 question about home charging is the capacity of the home to power both standard appliances and the charging station. As we all know, overloading the electrical infrastructure of the home results in a power cut. Is there a risk of going over the home's power limit when charging? What can be done to avoid this?

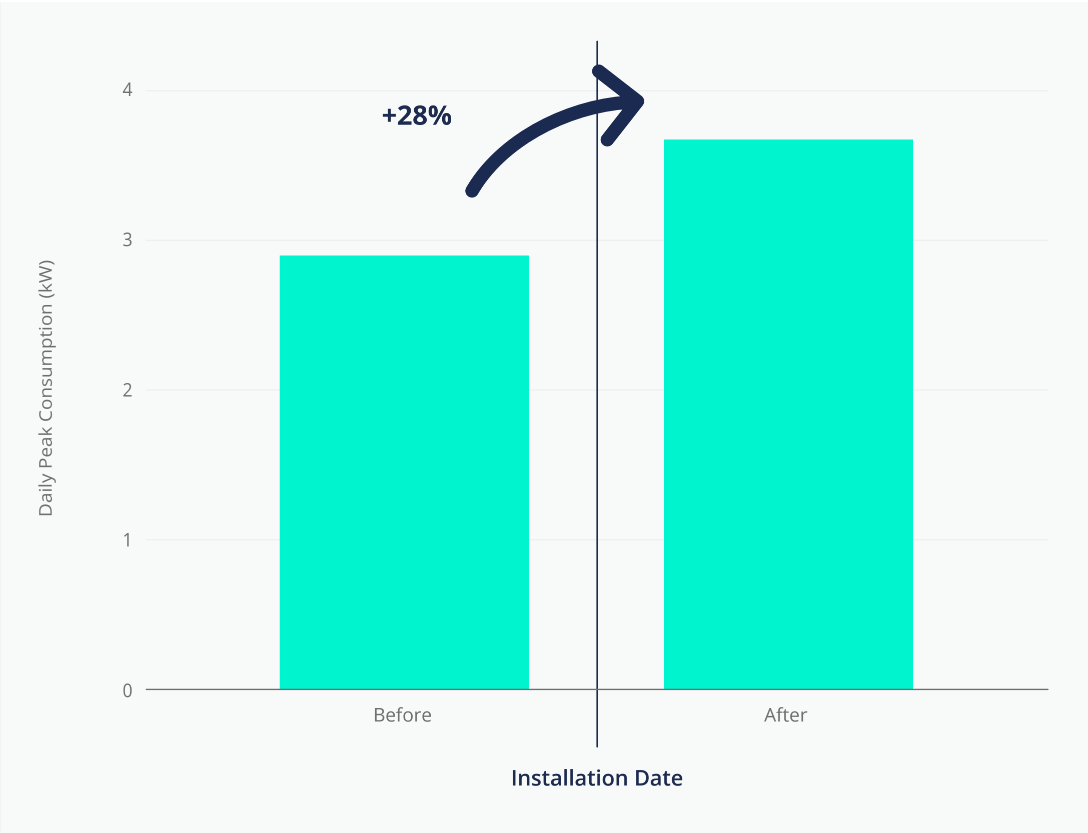
1 A significant increase in the maximum power used by the home with a charging station

The peak power is the maximal power drawn over a period of time. Peak power is often expressed in kilowatt (kW) or in kilovolt-ampere (kVA). Peak power in the home still must be monitored to avoid breaking various electricity equipment or causing a disjunction. Indeed, if the peak power goes above the maximum capacity of the home energy meter, the power will go out for the entire building.

The power levels of charging stations are very important compared to the power drawn by other appliances in a home. In most households, common appliances almost never reach such power: ovens can go up to 4kW, washing machines up to 2kW. Home electricity installations are therefore not designed for the power levels reached by charging stations, ranging from 3,7 to 22kW.

Installing a charging station means higher peaks will thus be reached, as a charging station represents a very high power compared to the other appliances in the home. Our data shows a **28% increase in the daily peak** after the charging station installation.

FIGURE 3 **Average daily peaks (kW) for a household before and after installing a charging solution**



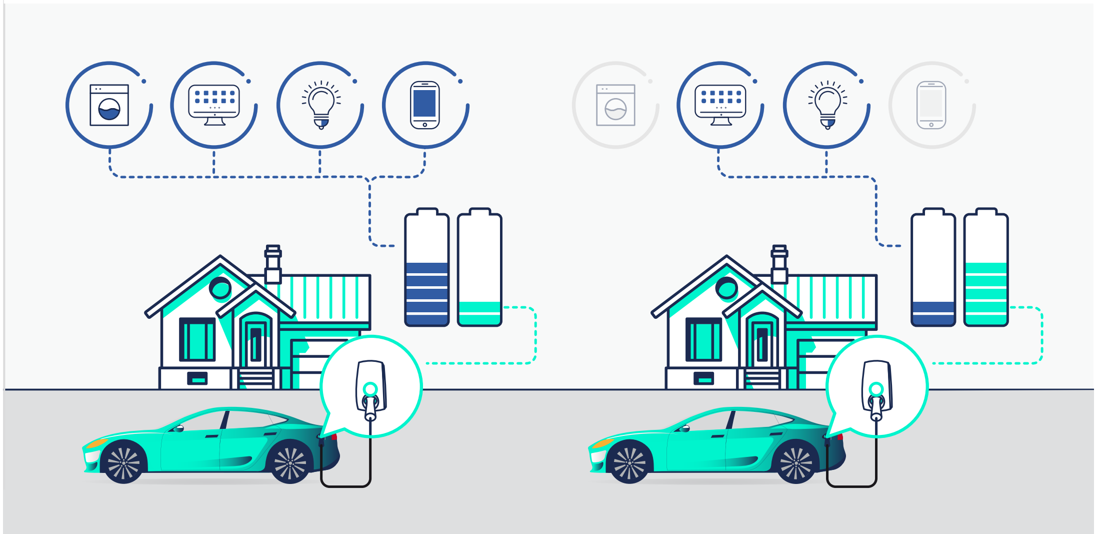
The average daily peak goes from 2,9kW to 3,7kW: it does not represent the absolute peak reached in a day, but the average of all daily peaks over the considered period.

This increase means there is a higher risk of going over the maximum power of the home and of the power going out. This is all the more true when you consider that the car will be charged at the same time as others are being used. The sum of your standard energy consumption added to the charging station can easily go over the maximum power of the home. Going over this limit causes a disjunction of the electrical system of the home.

One solution to avoid a disjunction when charging is to increase the maximum capacity offered by the energy meter of the home. This is not possible for all houses, as some are already at the absolute maximum enabled by the electrical grid. When it is possible, it requires an action from the electricity provider and also represents a monthly cost for the higher meter capacity.

Another solution is to limit the maximum power drawn by the chagrin station so that the total never goes above the maximum capacity of the home electricity meter.

2 Avoiding disjunctions when charging at home thanks to dynamic load management



Dynamic load management systems have been designed to solve this problem.

This system adapts the power drawn by the station to the power used by the rest of the household: the charging power decreases when other appliances are on, and the power increases when no other appliances are running. Adding a dynamic load management system when installing a charging station requires selecting the right hardware and represents a cost between 100€ and 400€.

3 Measuring the risk of disjunction when charging at home

To confirm the need of installing a dynamic load management system, we estimated how often charging would cause a disjunction if the management system had not been installed for all the households which have installed a dynamic load management system alongside their charging solution.

In the consumption data available, we identified the times when the daily peak power reached the maximum power of the home. When this happens, it means that the management system activated and reduced the power drawn by the charging station down to the maximum power of the home.

We calculated the **risk of disjunction** by dividing the number of days where the dynamic load management system activated by the total number of days. Results show that the real risk can go up to **90%**, which means the system is useful almost every day, and the average is **40%.** Our calculations show that, **without a dynamic load management system, the electrical installation in a typical household can disjunct 2 out of 5 days.**

4 Nearly all users choose peace of mind and convenience

Given all the benefits it offers, **nearly all households (93%) choose to add a dynamic load management system** to their charging solution. The exact distribution among the studied households is available below.

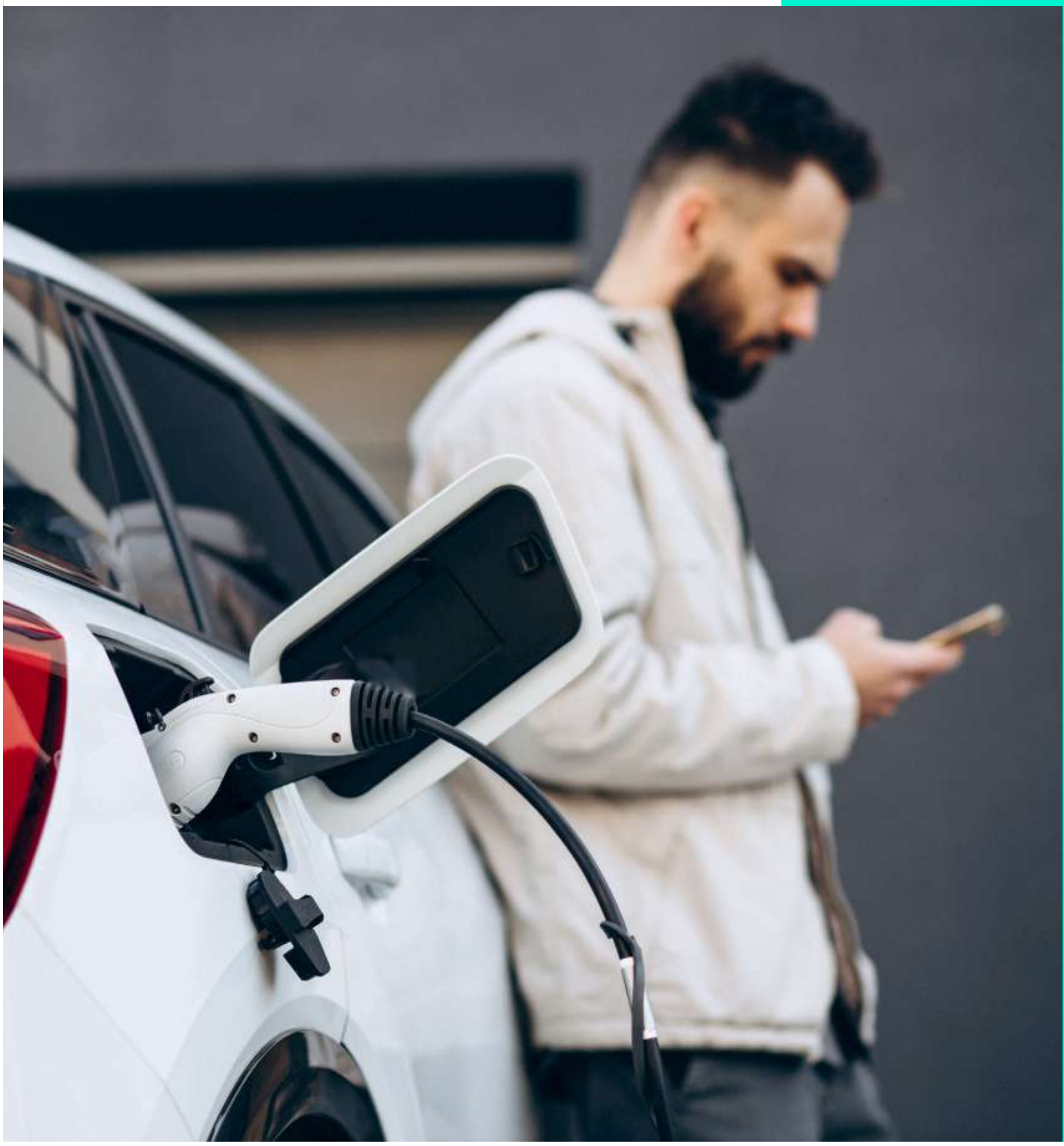
TABLE 1 **Analysis of charging solutions: number of households for each charging solution**

Charging power	3.7kW	7.4kW	11kW	22kW
No dynamic load management	3	1	1	0
With dynamic load management	5	56	0	1
Total	**8**	**57**	**1**	**1**

With French smart electricity meters, such a system is inexpensive and easy to install. Therefore, most studied households opt to install such a system along with the charging station.

Thanks to the dynamic load management systems installed for ChargeGuru customers, **only 3% of households** had to increase the meter's capacity.

How fast and how much can I charge at home?



1 Choosing the charging power of your home charging station

Different charging powers are available to charge at home ranging from 3,7 kW to 22 kW. With charging stations, the higher the charging power, the faster the vehicle will be able to charge, regaining more range per minute spent plugged.

TABLE 2 **Power of charging solution installed by respondents in their homes**

Charging power	3.7kW	7.4kW	11kW	22kW
Average range charged per hour	20 km	40 km	60 km	120 km
Number of households	8	57	1	1
Household share	12%	85%	1,5%	1,5%

85% of households choose to install a charging station with a power of 7,4kW. The average distance driven per day in France is 29 km[4] : this means that an hour of charge time per day would be enough for the average user with this charging solution.
A few households (12%) choose a lower power: 3,7 kW. This is chosen either when the user has a low charging need or when there is already an important electricity consumption in the home, making it impossible to install a more powerful charging solution.

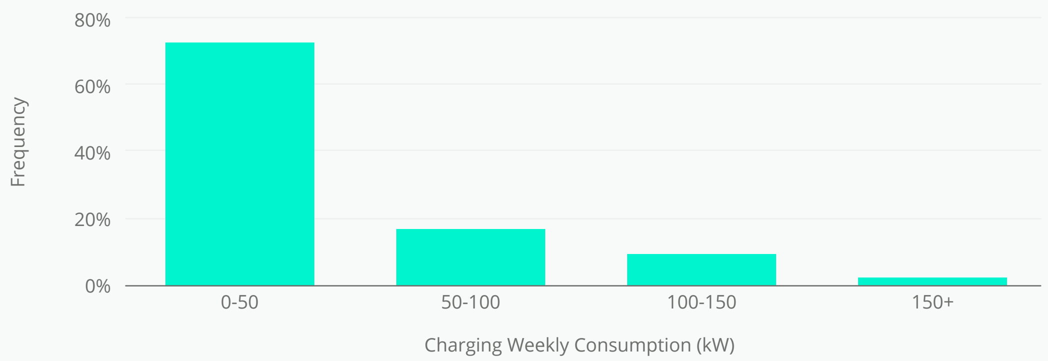
Rare individuals (3%) opt for three-phase stations with higher charging power, to tailor their specific needs.

Notes: 4. Enquête IPSOS Avere-France/Mobivia https://www.avere-france.org/publication/enquete-ipsos-avere-france-mobivia-les-francais-motives-a-passer-au-vehicule-electrique-sils-sont-bien-informes-et-accompagnes/

2 How far can I drive every day if I charge at home?

Based on the energy data collected, our team measured how much electricity was used for EV charging on a weekly basis. The Figure 4 below shows how much energy households use per week to charge their vehicles. In the figure, we exclude all weeks where there are no charging sessions at all.

FIGURE 4 **Frequency of people depending on the weekly energy they use to charge their vehicles**



On average, people use around **50 kWh per week** to charge their vehicles. Depending on the driving style, the weather conditions and the efficiency of the car, this amount of energy translates **to 300 km of range.** Some people charge up to 200 kWh every week, which is enough energy to drive for 1000 km.

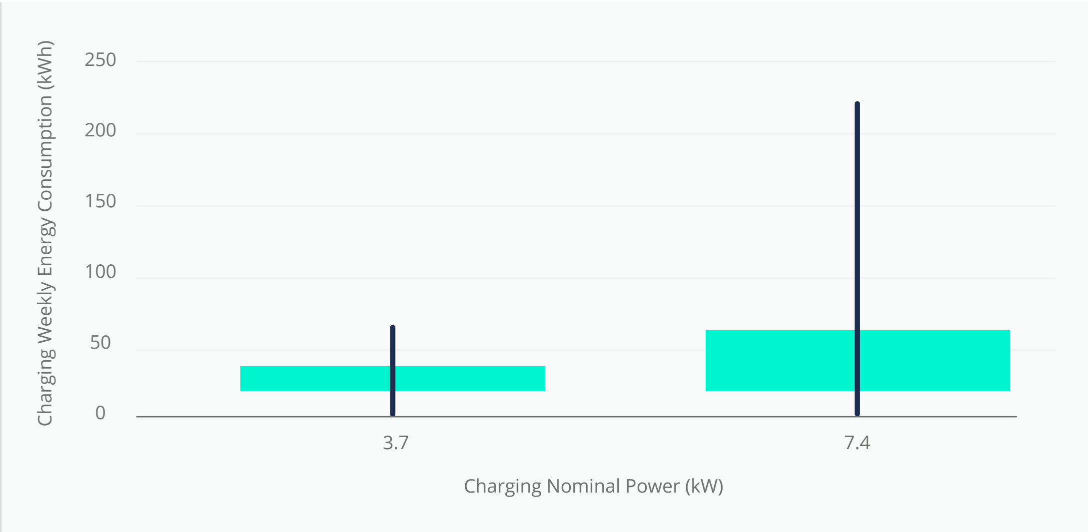
We also conclude from the data that **the weekly energy consumed by a household is quite similar whether it is equipped with a 3.7 kW or a 7.4 kW station**[5], as illustrated in the Figure 5 below.

This means that it is possible to charge enough energy to meet your driving needs even if you choose a lower charging power. A higher charging power offers more comfort by making your car ready to go in a shorter amount of time.

The figure below illustrates the weekly energy consumption for charging (in kWh) observed with the respondents.
The box shows the 25th and the 75th percentiles of the data set and the lines show the minimum and the maximum.
We can notice that for the 3,7 kW charging station, 75% of respondents use less than 40 kWh per week, and the maximum is slightly above 50 kWh. For the 7,4 kW charging station, 75% of respondents use less than 60 kWh per week and the maximum reaches over 200 kWh per week.

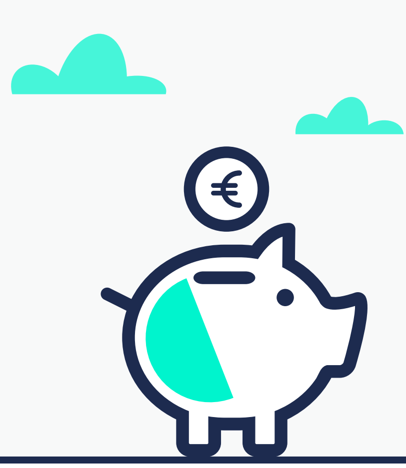
Notes: 5. Stations with other nominal powers are excluded from this analysis since too few households opted for such nominal powers.

FIGURE 5 **Charging Weekly Energy Consumption per Nominal Power of the charging solution installed**



How much does home charging cost per month?

1



30 to 40€

spent per month for charging on average

Notes: 6. Price in France according to the regulated electricity tariff as of August 2022 - Source.

7. Price of a liter of Super SP95 - E10 in France as observed by the Ministry of the Energy Transition - Source.

8. Average fuel car consumption of 5,6L/100km - Source.

When comparing total electricity consumption before and after the charging solution installation, we observe that **the average daily energy grows by 21%**, from 16kWh to 19,4kWh.

This evolution directly impacts the electricity bills of households that increase in approximately the same amount. In France, a kWh of electricity costs 0,1740€. As our data shows, households use 50kWh to charge 300km of range per week on average.

This represents a cost of charging at home of **37,40€ per month** over a full year[6].

With a liter of gasoline costing 1,73€ in France on average , this would represent **72,30€ a month with a combustion engine car[8].** Charging at home roughly **divides by two** the cost of fueling your car every month.

Over a full year, charging at home represents **savings of 418,80€** on average compared to fueling a traditional car in France.

2

Optimizing the cost of charging at home

To go further, the cost of charging calculated above can be optimized by choosing in different ways.

Installing solar panels at home

We observe that some households opt to use solar panels: this concerns **5%** of the studied set. This figure is high compared to the average for France, knowing that 435 000 homes have been equipped with solar panels in France as of 2021 vs 36,2 million single homes in the country[9]. The energy produced by the solar panels can either be used for the home or can be sold back to the electrical grid. Either way, the energy bill of the home will be reduced.

Choosing an optimized energy tariff and charging during off-peak hours

Notes: 9. Source and Source INSEE.

10. Price in France according to the regulated electricity tariff as of August 2022 - Source.

11. Engie Elec Car , Vert Electrique Auto.

Another solution to reduce the cost of charging at home is to charge when the electricity is cheaper. If we take the example of France, it is possible to opt for a **peak / off-peak tariff**. With this tariff, a kWh costs 0,147€ during off-peak hours and 0,184€ during peak hours[10].

By choosing to charge only during off-peak hours, the cost of charging would be reduced to 31,60€ every month. This represents savings of 70€ over a full year.

Energy tariffs dedicated to electric car owners are also available, with a price of the kWh of 0,1126€. With this tariff, charging at home would cost only 24,21€ per month. In this case, it is possible to save 160€ over a full year on the charging cost[11].

Different options are available to charge only during off-peak hours:

- **Installing an energy management system with the charging station:** this system enables charging only during off-peak hours. It is the easiest and most durable solution as it requires no management on a daily basis and works without requiring any internet connection. This system can be combined with a **dynamic load management system**, necessary in most homes to charge at maximum power. The return on investment is reached within less **than 3 years** given the savings of charging during off-peak hours.

- **Scheduling charging sessions using the charging station's app:** this requires a smart charging station with an integrated app, often connected to the internet. An unstable internet connection can render the setting useless and cause the car to charge during peak hours. There can be a conflict between the schedule set in the app and the dynamic load management system and the car might not be charged at all the next morning.

- **Scheduling charging sessions using the car's information system or app:** depending on the operating system of the car, this can be more or less complicated to set up. It offers the advantage of being integrated with the vehicle at no extra cost. As with the last solution, here can be a conflict with the dynamic load management system installed.

Last observation regarding tariff optimization: the global picture of the household energy use must be considered, as the cost of electricity with optimized tariff is higher during peak hours than with standard tariffs. If there is a monthly fix fee, it is often more expensive. It is often estimated that switching to a peak / off-peak tariff makes financial sense when **at least half of the total daily energy use happens during off-peak hours.**

Home charging habits: when to charge at home and for how long?

1 Do I need to charge my EV as soon as I get home?

Notes: 12. Please note that, contrary to the rest of the study, additional respondents are included in this section: 89 here against 67 for the rest of the study.

We asked participating households how they use their charging station[12]. **Most people claim that they charge their EVs only when the battery is empty (57%), while the rest charge their vehicle each time they park home (43%).**

Regarding the frequency, about one third claims that they charge every day, while the others charge between 1 and 3 times per week. Full results can be found in Table 2.

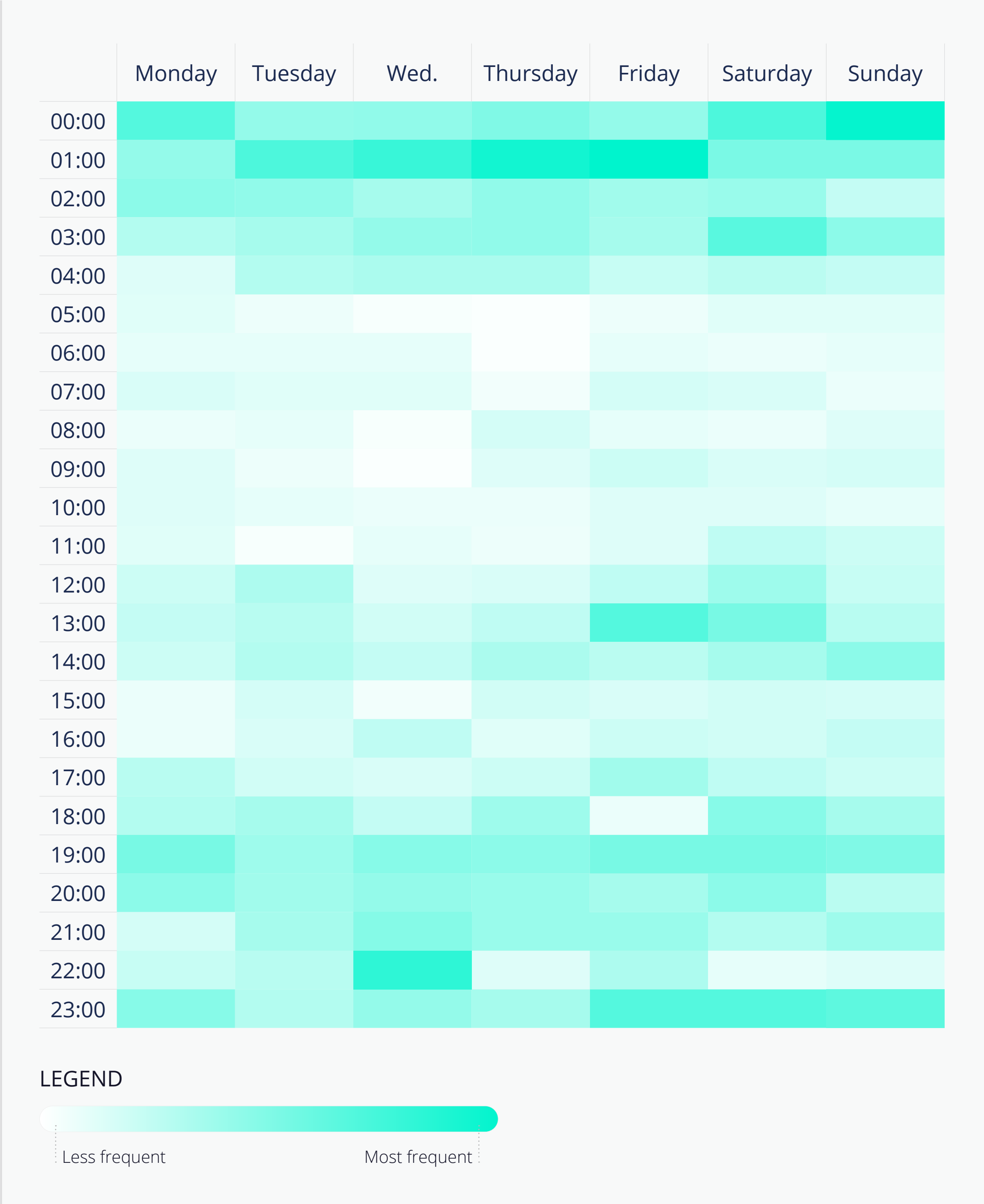
TABLE 3 **Charging habits claimed by 89 respondents**

	Every day	4-5 times / week	2-3 times / week	Once / week	Total
Charge when parking	22 (25%)	5 (6%)	5 (6%)	6 (7%)	**38 (43%)**
Charge when empty	2 (2%)	3 (3%)	23 (26%)	23 (26%)	**51 (57%)**
Total	**2 (27%)**	**8 (9%)**	**28 (31%)**	**29 (33%)**	**89 (100%)**

2 When can I charge at home?

Our algorithm identifies the start time of each charging session and its end. We are thus able to identify when most people charge, as illustrated with the figure below.

FIGURE 6 **Heatmap of charging sessions according to time of the day and day of the week (on a 0-100 scale)**



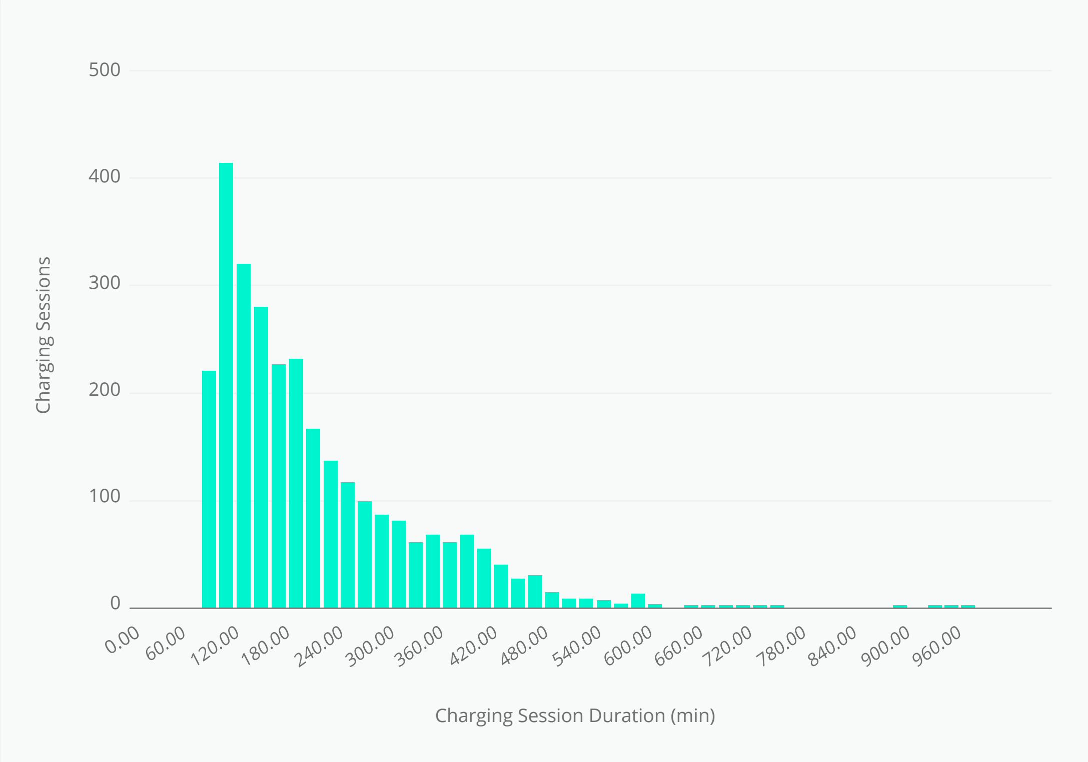
We can conclude that **charging at night** is preferred by most users: about **one third of chagrin sessions occur between 19:00 and midnight**, and **another third between midnight and 06:00.** However, it is completely possible to charge during the day, as a third of charging sessions happen between 06:00 and 19:00.

There is a **13% increase** of charging sessions on **weekend** days compared to the rest of the week. This could be linked to a higher usage of the car during the weekend compared to the rest of the week.

3 How long will my electric charge every day?

With our data, we are able to measure the length of charging sessions. The Figure 7 below shows the duration (in minutes) of all charging sessions detected from the set of studied households.

FIGURE 7 **Histogram of charging session duration (in minutes)**



On average, a charging session lasts around **3 hours** and most of all sessions last between 1 and 5 hours.

Many users refrain from switching to an electric car fearing charge times of 24 hours and more. We see from real user data that this does not happen when charging at home, thanks to a convenient and accessible charging solution.
To go further with our data, we measured the duration of charging sessions depending on the start time of the session. We see in the figure below that **charging sessions started in the evening are up to twice longer** than charging sessions started during the day.

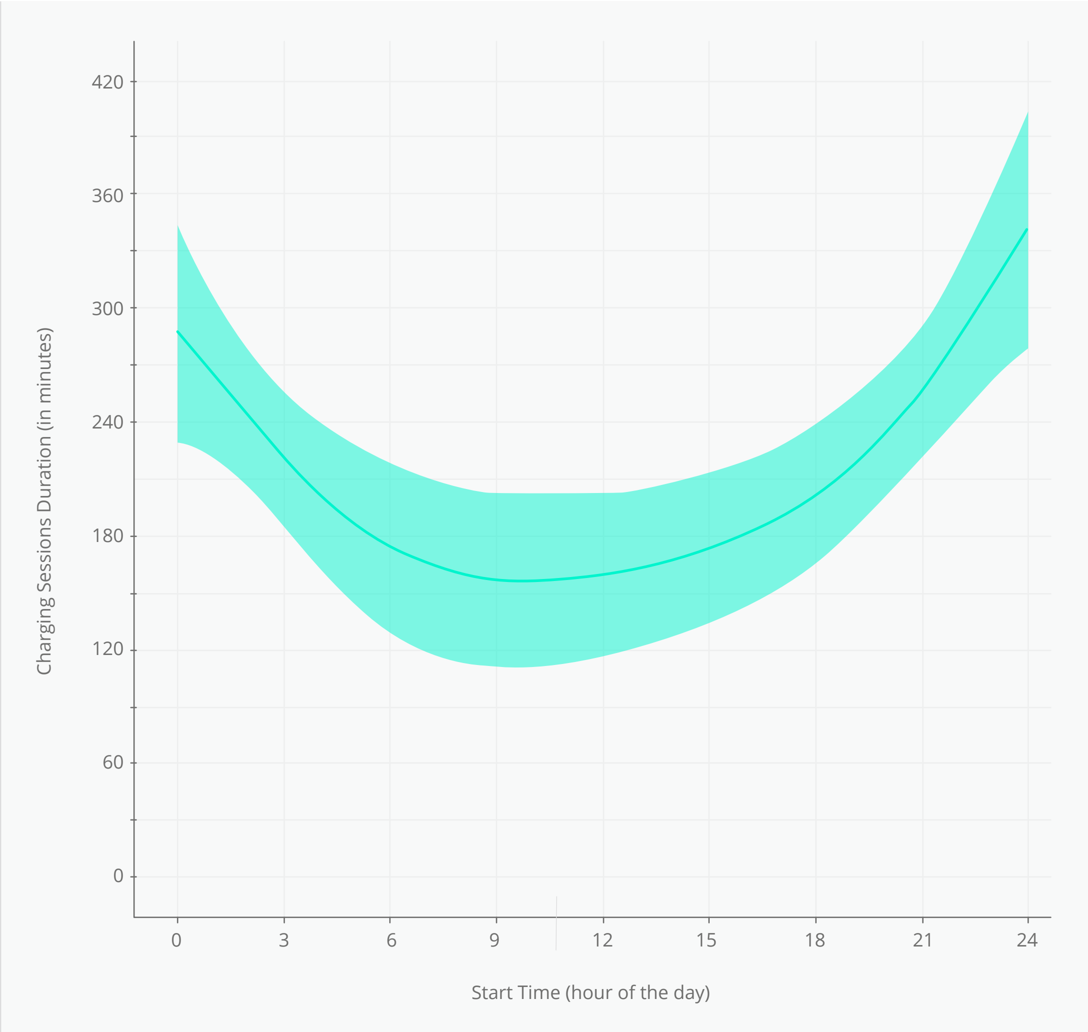
This difference can be explained by two main factors:

1. Households who need long charging sessions usually optimize their charging sessions to have the off-peak hours tariffs. Since off-peak hours are usually at night, sessions in the evening tend to last longer.

2. Charging sessions that start in the middle of day are often interrupted by users before the vehicle is fully charged, leading to shorter sessions.

FIGURE 8 **The average charging session duration (in minutes) against the time of the day when the charging session starts.**

The solid line represents the average duration; the transparent area represents the average fluctuation around the average.



Home charging profiles

1

Building clusters of charging profiles

Using the algorithm developed by our team to detect charging sessions from the total power use measured by the household meter, we defined clusters of charging profiles. The following parameters were used to determine the clusters:

Weekly charging session frequency

The number and duration of charging sessions indicates how often the EV is charged, and thus how often the EV is used. The frequency highly changes between households due to different usage: some households have a single session per week, while others charge every single day.

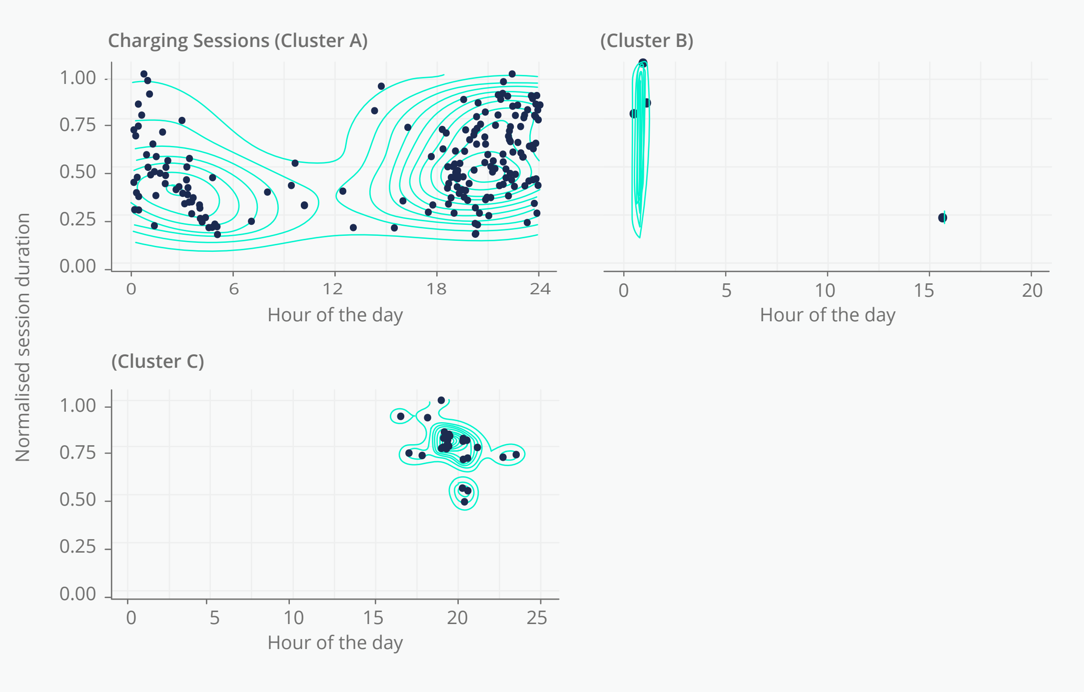
Time of the day of the charging session

Another interesting factor is when the sessions occur in the day. A quick and efficient way to analyze the charging sessions is with a scatterplot of all charging sessions by hour of the day and normalized session duration.

The normalization is chosen to enable comparison of households between one another no matter the EV battery size.

Based on those two criteria, we built clusters for all of our data points, as illustrated in the figure below. Each point represents a charging session, x-axis shows the hour of the day when the session started, and y-axis shows a normalized session duration, values close to 1 mean that the sessions are the longest. The red lines represent the contours of the 2D density of the scatter points.

FIGURE 9 **Scatterplot of charging sessions for representative users of the three clusters**



For each household, the frequency and period of the day of charging sessions are registered in tables. The tables are then clustered with the well-known k-means clustering algorithm. No objective criterion was used to determine the best number of clusters.

The number of clusters was instead fixed to 3 after comparing results: cluster sizes were quite balanced, and clusters were most explainable. The clustering results lead to the three user profiles described in the following sections.

2 Three profiles of home charger habits

Using the data-driven methodology described above, the habits are detected from the overall electricity consumption and clustered into three profiles:

TABLE 4 **Three charging habits profiles detected from total electricity consumption analysis**

Zen	Eco	Comfort
Once a week	**3 times a week**	**Every day**
When they arrive home	At night	Any time of the day, mostly at night
Old habits die hard! This profile charges when the battery is close to empty, as they would do when fueling their petrol car.	This profile uses all available tools to charge when it is cheapest and with the least impact on their home energy use.	This profile makes sure to charge whenever they get home, making the most of their electric car's capacity.

Each profile is detailed in the three following subsections, including an illustration of the charging sessions of a typical household belonging to the profile.

Zen

The key characteristics of the zen profile are:

Frequency

One charging session per week.

Time of the day

No particular time of the day.

Full analysis

Thanks to the dynamic load management, the user does not need to worry about a potential disjunction and can plug the car to charge when they get home in the evening.

The low charging frequency means the user charges when they notice the battery is running low. This is similar to going to the gas station when the fuel tank is almost empty. Old habits die hard!

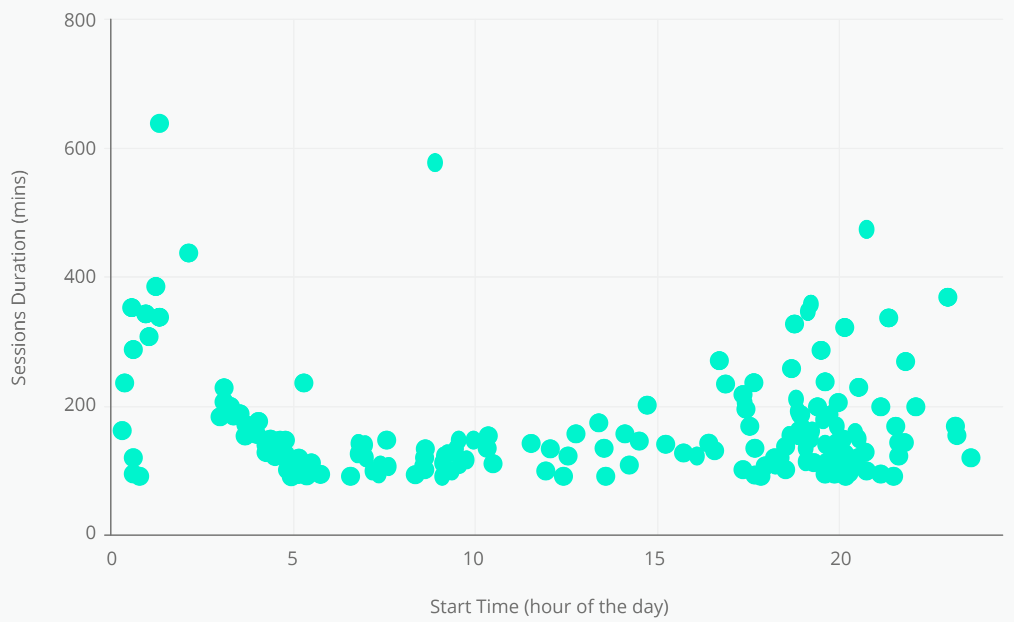
Households are not focused on charging at the best tariff but on filling up the battery back to 100%. This could be explained by a lack of knowledge on energy tariffs, or the relatively low cost of charging compared to the cost of gasoline, not motivating the user to optimize charging sessions.

The figure below shows an example of all the charging sessions and their duration of a typical household with the zen profile. All available charging sessions in the energy data are shown.

FIGURE 10

All the charging session durations (in minutes) against the time of the day when the charging session starts for a given household in the profile "Zen".

All charging sessions in the available data are shown.



Eco

The key characteristics of the eco profile are:

Frequency

About one charging session every 2 days.

Time of the day

Off-peak hours during the night.

Full analysis

The optimizer profile schedules the start of the charging session, either with a device installed with the charging station or with an app, to charge during off-peak hours only.

This profile makes the most of home charging by maximizing their savings.

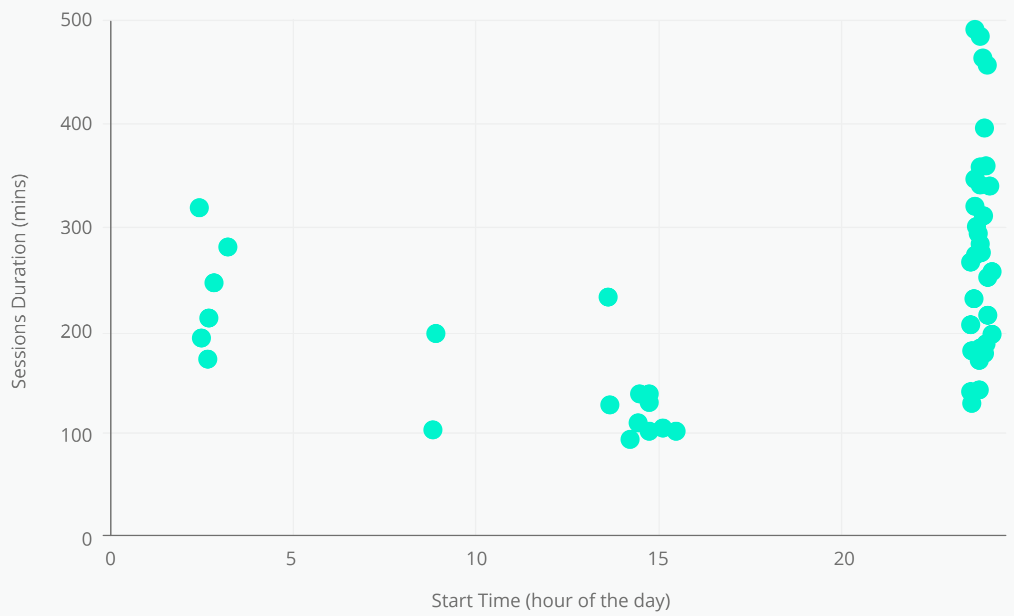
Given the high charging speed offered by the charging station, it is not necessary to charge every day to have enough range every day. Charging 3 times a week is enough.

Figure 11 shows all the charging sessions of a typical household clustered in the profile eco.

FIGURE 11

All the charging session durations (in minutes) against the time of the day when the charging session starts for a given household in the profile "Eco".

All charging sessions in the available data are shown.



Comfort

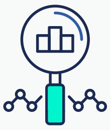
Households belonging to the comfort profile do not adopt a single determined charging strategy. The key characteristics of the comfort profile are:

Frequency

Nearly a charging session every day.

Time of the day

Whenever they arrive home in the evening or scheduled in the night.



Full analysis

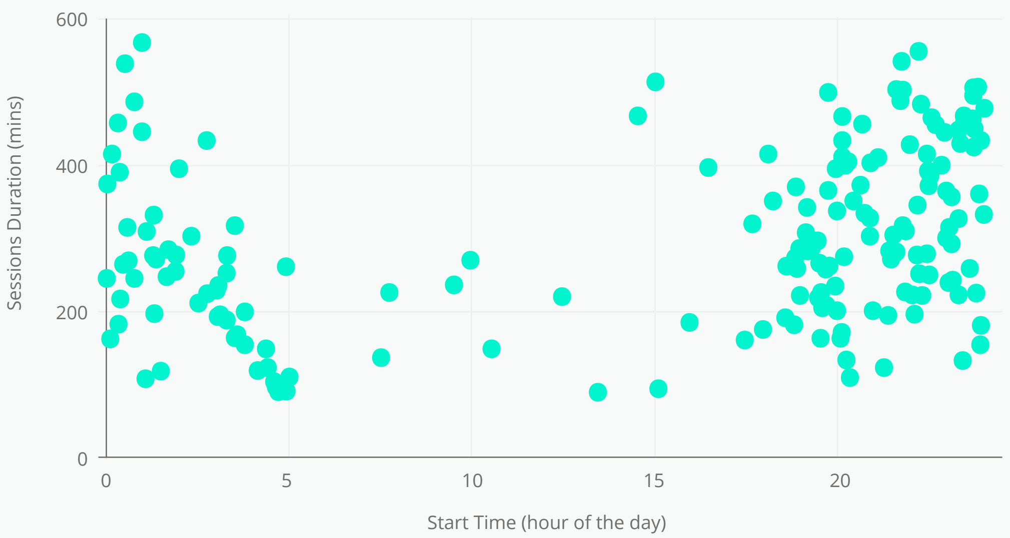
We can infer that households use a smart scheduling feature on their vehicle to define the off-peak hours and the time at which the battery must be at 100% ("I want my vehicle to be charged at 7:00").
If needed, the car automatically starts charging in the evening, otherwise it waits until the start of the off-peak period.

The figure below shows an example of all the charging sessions and their duration of a typical household with the maximizer profile. All available charging sessions in the energy data are shown.

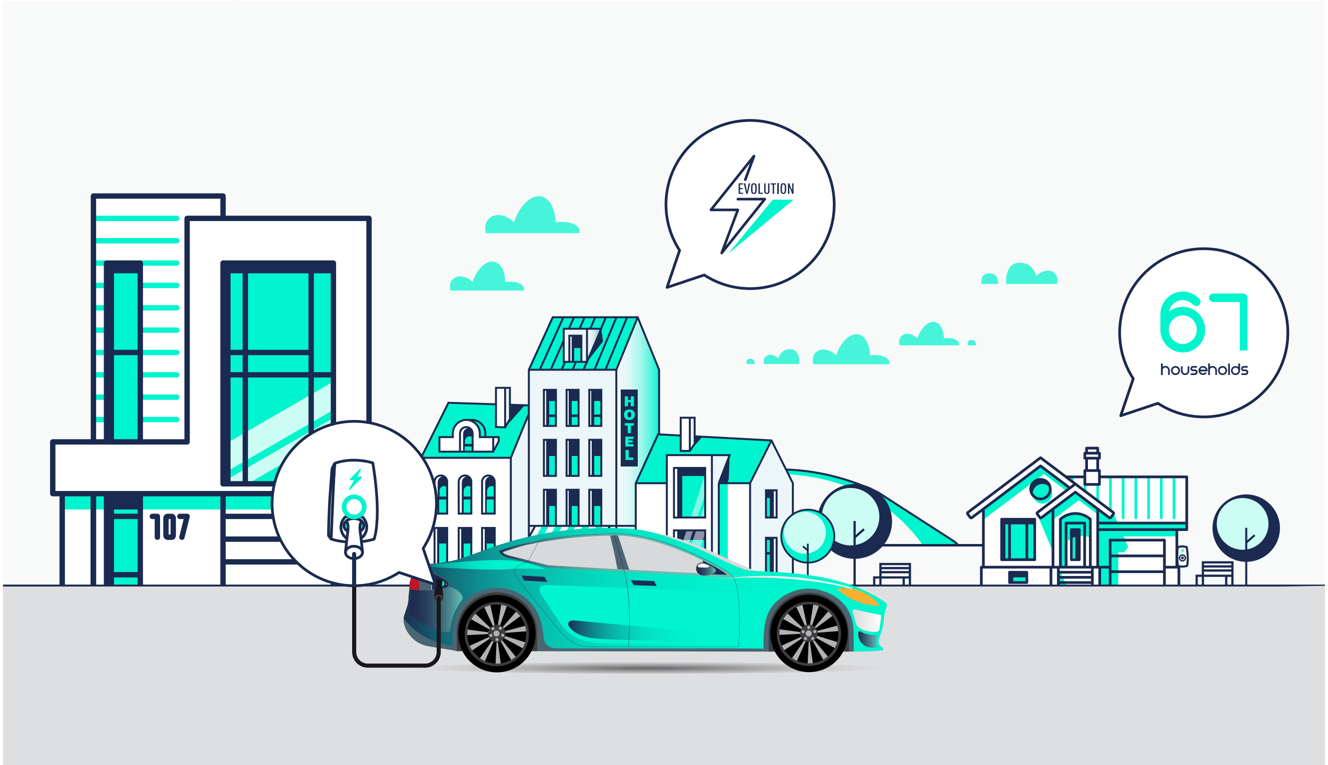
FIGURE 12

All the charging session durations (in minutes) against the time of the day when the charging session starts for a given household in the profile Comfort.

All charging sessions in the available data are shown.



Conclusion



This study analyzes a set of 67 households who installed a charging solution at home. A systematic collection of their smart-meter data addresses the two objectives of this study: electricity consumption evolution, and home charging habits.

We have measured the impact of installing a charging station on the electrical infrastructure of the home and on the energy bill for the household. Comparing the situation before and after installation, we observe that our respondents increase their energy by 21% and their peak power by 28%.

By adding a dynamic load management system to the charging solution, such increases are not an issue and no major infrastructure upgrades have to be made at the household level to avoid disjunctions or other annoying incidents.

We conducted a data-driven analysis of charging habits and used clustering algorithms to define the main home charging profiles. From the total household consumption measured by smart meters, our methodology detects charging sessions to provide three home habits profiles: zen, eco, and comfort.

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