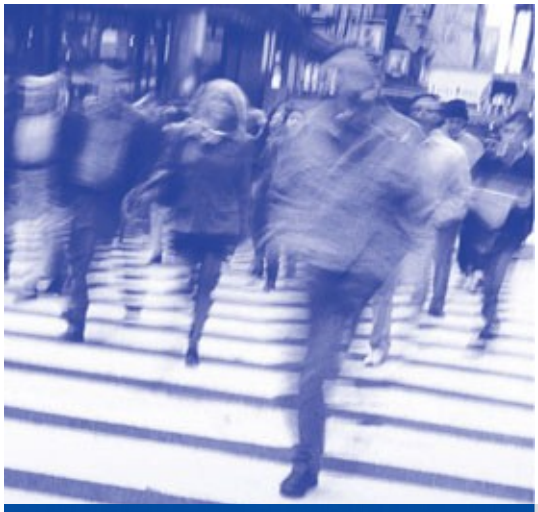

2020 CiViTAS
Cleaner and better transport in cities

ECCENTRIC

Evaluation of public charging for electric vehicles in Stockholm

Responsible author(s) & City:	City of Stockholm

This is a report produced by SWECO presenting results and lessons from CIVITAS ECCENTRIC WP6.

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Glossary

Electric vehicle – A vehicle powered either partially or fully by an electric motor with a battery that is charged from the electricity grid.

Battery electric vehicle (BEV) – An electric vehicle powered fully by an electric motor through a battery.

Plug-in electric hybrid (PHEV) – An electric vehicle that can be powered by both an electric motor and an internal combustion engine but is still able to be charged from the electricity grid.

Electric hybrid – A vehicle that can be powered by both an electric motor and an internal combustion engine but is not able to be charged from the electricity grid.

Charging station – A place where one or multiple chargers for electric vehicles are located.

Charging point – The point where the electric vehicle connects for charging to the electrical grid. A charger can have multiple charging points.

Charging session – The time period under which an electric vehicle is connected to a charging point and until the charging cable is removed.

Charging time – The time that the electric vehicle is connected to the charging point, whether there is an energy transfer or not[1].

Fast charging – Charging with a power output of 50 kW or above.

Normal charging – Charging with a power output below 50 kW.

Destination charging – Charging of electric vehicles that occurs at various types of destinations, such as shopping centres, travel hubs, sports activities and such.

[1] In this report, the definition of "charging time" is used as above, because information regarding when energy transfer has occurred during the charging session has not been available in the information provided.

Summary

The City of Stockholm is working on improving the charging infrastructure in Stockholm. The public on-street charging stations in place that are evaluated in this report are operated by E.ON Energilösningar AB, Fortum Charge & Drive and InCharge Vattenfall AB. Off-street normal charging at Stockholm Parkering's facilities has also been included in this evaluation. The purpose of this report is to evaluate how the charging stations are used and thus gain knowledge that can be useful for the continued expansion of charging infrastructure. The analysis is based on over 130 000 charging sessions that took place during the period between 1 January – 31 December 2019, as well as the results of a questionnaire answered by 377 respondents.

The number of electric vehicles in Stockholm has increased by about 35 percent from 2018 to 2019, and the total processed number of charging sessions increased by 46 percent from 2018 to 2019. Stockholm Parkering remain as the operator that offers the most public charging points in Stockholm, as well as the one with the most registered charging sessions of all the operators. The majority of charging sessions takes place during daytime on weekdays.

The usage pattern between weekdays and weekend varies, both with regards to when the charging session is initiated as well as for how long the user occupies the charging point. The public charging infrastructure is mainly used for destination charging, where a large part of the on-street normal charging takes place at night. Off-street normal charging continues to be important for those who charge their vehicles while they are at work.

The average occupancy of the charging stations has changed from the previous year, with an increase for the fast charging stations and a decrease for both on- and off-street normal charging. This may be due to the rapidly increasing number of established charging points collecting data.

Charging station popularity appears to not be linked to geographic location, as parking facilities both in and outside of central Stockholm have a high average number of charging sessions per day. Instead, it is likely to be linked to the activities that are nearby, such as homes, work, or shopping centres. The on-street fast charging stations have the highest average number of charging sessions per day, most likely due to established time constraints. Both the on-street fast charging stations and off-street normal charging stations had a significant amount of energy transferred per

charging point and day, on average. This may be due to the high charging power and the lack of time constraints.

The survey shows that most respondents were men over 46 years of age, with a relatively even distribution between owners of battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). Similar to the previous year, the majority of respondents have the car as a company car or have bought it for themselves within the last three years. The most important parameters that were taken into account when the respondents' purchased their electric vehicle were the environmental benefits as well as access to home- and public charging.

Respondents request improved control of the charging stations so that non-electric vehicles do not take up space. When a charging station is full, the respondents find it difficult to find alternatives. Some of the respondents suggest technical solutions to remedy the problem. Coordinated payment solutions, longer parking times as well as more charging stations are also requested.

Both the survey and the statistics clearly indicate how important public charging infrastructure is to the users. Respondents are also generally satisfied with how the public charging infrastructure works.

Based on the results of the report, the City of Stockholm is recommended to

- Continuously improve the control of the on-street charging stations, to ensure that those parked on the charging stations are electric vehicles.
- Improve signs and information associated with the charging infrastructure to clarify its function and avoid misunderstandings.
- Support the parking- and charging infrastructure owners in finding appropriate conditions to coordinate the payment system between them, so that it becomes a uniform system towards consumers. Also inform in cases where this type of solution already exists.

The charging infrastructure operators are recommended to

- Find the appropriate conditions for coordinating the payment system between them and the parking owners, so that a uniform payment system towards consumers is established. Also inform in cases where this type of solution already exists.

- Increase the number of on-street charging stations in connection with activities/destinations, such as shopping centres.
- Enable information on available/occupied charging points for the consumers, to facilitate finding locations of available charging points.

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Introduction

Background and purpose

The City of Stockholm is working on improving the charging infrastructure for electric vehicles in the city. In collaboration with various stakeholders and operators of public charging infrastructure, an increasing number of charging points have been installed in recent years (1500 in 2019 compared with 490 in 2016[2]).

This report presents an analysis of how various public charging stations in Stockholm were used during 2019. The purpose of the analysis is to find out how the charging stations are used and thus gain knowledge that can be useful in the current and future expansion of charging infrastructure. Among other things, the analysis focuses on:

- The time of the day when the charging session is initiated
- Charging session distribution over weekdays and months
- Energy transfer and charging session duration
- General location differences
- Differences between various categories of chargers.

The analysis is based on charging sessions that took place between 1 January and 31 December 2019. The data is distributed between public on-street normal and fast charging, as well as off-street normal charging in parking garages (including surface parking facilities). Charging session data from four operators of the public charging stations in Stockholm has been anonymized and analyzed. These operators are Stockholm Parkering, E.ON Energy Solutions AB, Fortum Charge & Drive and InCharge Vattenfall AB.

The public charging infrastructure in Stockholm has also been evaluated through a web survey sent to customers of E.ON, Fortum and Vattenfall. The qualitative analysis provides insight into how customers use and experience the public charging infrastructure in Stockholm.

Three previous reports have been produced by the City of Stockholm regarding the evaluation of the public charging infrastructure. Compared to last year's report, the data collected has been further analyzed, and additional questions were included to the survey in order to draw more relevant conclusions from the results.

This evaluation is part of the EU project CIVITAS Eccentric which receives funding from Horizon 2020 - European Union's

[2] According to the database ELIS, provided by Power Circle.

Framework Program for Research and Innovation under Grant Agreement no. 690699. In Eccentric, the City of Stockholm tests and evaluates new technology and new concepts for sustainable transport in the years 2016 to 2020 to develop markets and disseminate knowledge.

Charging infrastructure in Stockholm

In the municipality of Stockholm, the number of electric vehicles[3] (EVs) has increased by about 35 percent from 2018 to 2019, from 17 783 to 24 018 EVs[4]. Out of the EVs in Stockholm at the end of 2019, approximately 6 500 were battery electric vehicles (BEVs, compared to 2 650 in 2018) and 17 500 plug-in electric vehicles (PHEVs, compared to 14 500 in 2018). Off-street normal charging stations can be found in 41 different parking facilities operated by Stockholm Parkering, located in several different locations around the city according to Figure 1.

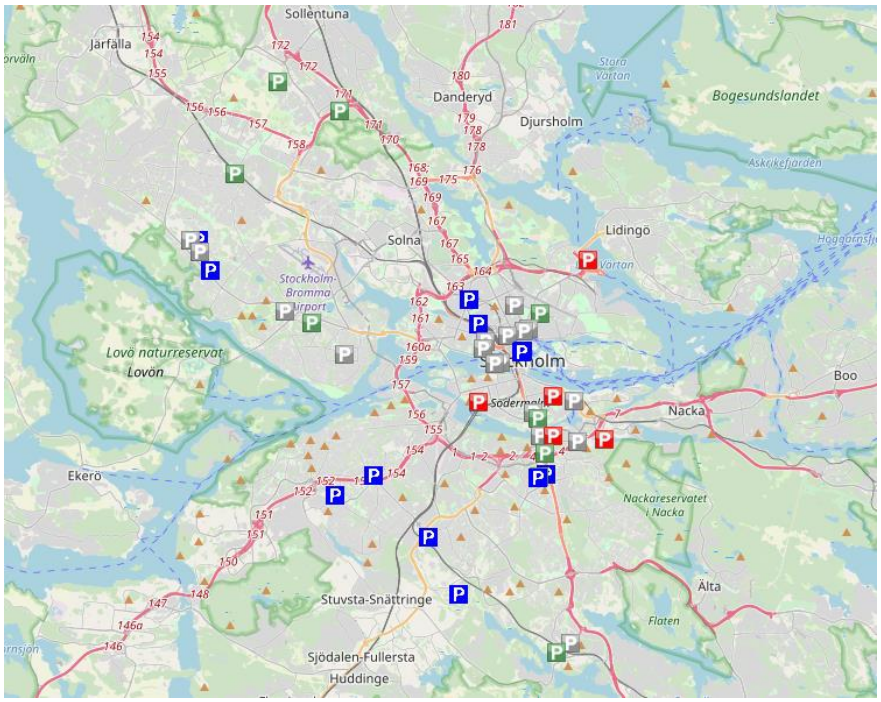


Figure 1. Location of parking facilities that offer public off-street normal charging operated by Stockholm Parkering as of January 16th 2020[5]. The various colors indicate operating status of the chargers at the time of the collection of the map.

[3] Including cars, light-duty vehicles, quad bikes and motorcycles.

[4] According to the database ELIS, provided by Power Circle.

[5] Collected from Stockholm Parkering's web portal https://stockholmparkering.oamportal.com

The total number of charging points in Stockholm increased from 1034 to 1500 between the years 2018 and 2019[6].

Data collected

The charging session data has been delivered from E.ON, Fortum and Vattenfall in excel format. Charging sessions from the Stockholm Parkering charging stations have been downloaded from Chargestorm's portal online.

Data on approximately 139 000 charging sessions were retrieved from these four operators for 2019, in comparison to the 95 000 charging sessions retrieved for 2018. After removing data errors, such as sessions where no energy transfer had been registered or duplicate sessions, approximately 137 000 charging sessions remained. These form the basis of the quantitative analysis in the following chapter. The number of charging points that have collected data during the year 2019 is 717, compared to 410 in 2018, see Table 1. Note that some of the added charging points may have already been installed before 2019, but data was not collected for them until this year.

Table 1. The number of charging points for which data was collected for the evaluation this year and the year before, separated per charging category.

Number of charging points	On-street normal charging	Off-street normal charging	On-street fast charging
2018	82	279	49
2019	148	507	62

The qualitative part of this report is based on the results of the web survey produced in previous years with adjustments from Sweco. The survey is sent by Fortum, E.ON and Vattenfall to their customers. In some cases, the survey also went to customers who live outside the Stockholm area. The survey was conducted between February 10th and March 4th, 2020. The analysis is based on responses from 377 respondents, relative to 535 in 2019 and 106 in 2018.

[6] According to the database ELIS, provided by Power Circle.

Public charging in Stockholm

Type of charging

Off-street normal charging accounts for the majority of all charging sessions included in the analysis, see Figure 2. Compared with the figures from the previous year, the on-street fast charging share has dropped (from 29 to 26 percent), while the share of off-street normal charging is unchanged (50 percent). The share of on-street normal charging sessions has increased (from 21 percent to 24 percent).

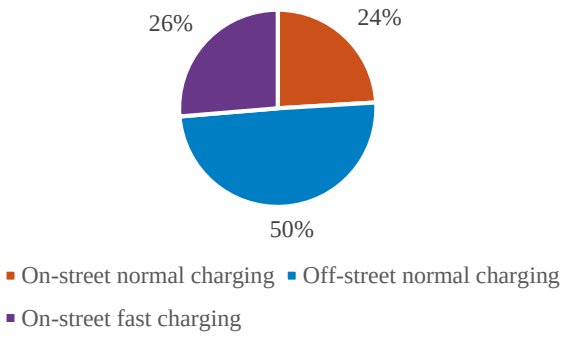


Figure 2. Share of sessions distributed per charging category for 2019.

Stockholm Parkering, which only offers off-street normal charging at its facilities, accounts for 50 percent of the number of charging sessions. The remaining operators share the other 50 percent, see Figure 3. This represents an increase of 1 percent of Stockholm Parkering's share from last year's report.

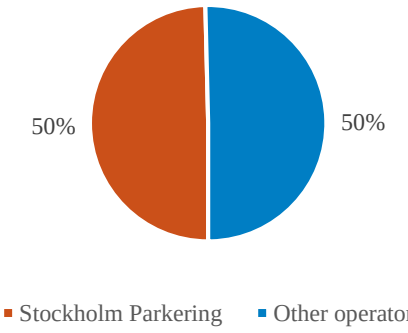


Figure 3. The distribution of charging sessions at Stockholm Parkering’s locations compared to the other operators for 2019.

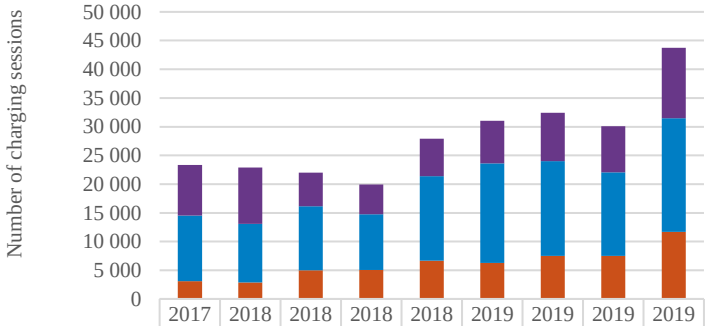
Charging over time

Significantly higher number of charging sessions during the 4th quarter of 2019

The number of charging sessions decreased during the first three quarters of 2018, to end with a larger increase in the fourth quarter. During 2019, the number of charging sessions continued to increase during the first two quarters, to decrease somewhat during the third quarter, as can be seen in Figure 4.

A decrease in charging sessions was also registered in the third quarter of 2018. The reduced number of charging sessions in Q3 may be due to a number of parameters, for example seasonal variations that result in lower usage during the summer months.

Similar to 2018, there was a significant increase in the number of charging sessions in the fourth quarter of 2019, as all charging categories increased by 40–55 percent compared to Q3. All charging categories had an increase in their number of charging sessions in 2019.



	2017 Q4	2018 Q1	2018 Q2	2018 Q3	2018 Q4	2019 Q1	2019 Q2	2019 Q3	2019 Q4
On-street fast charging	8 785	9 799	5 832	5 189	6 496	7423	8421	8003	12287
Off-street normal charging	11 435	10 224	11 190	9 703	14 752	17307	16500	14552	19750
On-street normal charging	3 119	2 849	4 981	5 022	6 658	6287	7497	7528	11705

Figure 4. Number of sessions per charging category from Q4 2018 to Q4 2019.

The maximum number of charging sessions was carried out in November, when more than 15 000 charging sessions occurred according to Figure 5. This can be compared with the previous year's (2018) maximum number of 9 500 charging sessions recorded during the month of October. In 2019, all the charging categories reached their peak in November with regards to the number of charging sessions.

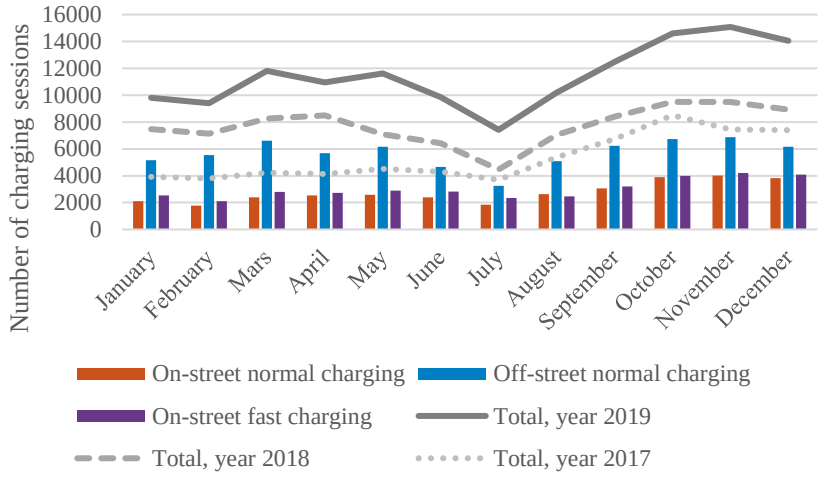


Figure 5. Monthly number of sessions per charging category during 2019.

The majority of sessions occurs during weekdays

Most of the charging sessions in 2019 take place during weekdays, as can be seen in Figure 6. Off-street normal charging has the most charging sessions on Mondays, while on-street normal charging has the most charging sessions on Wednesdays. The number of on-street fast-charging sessions is highest on Fridays, similarly to last year.

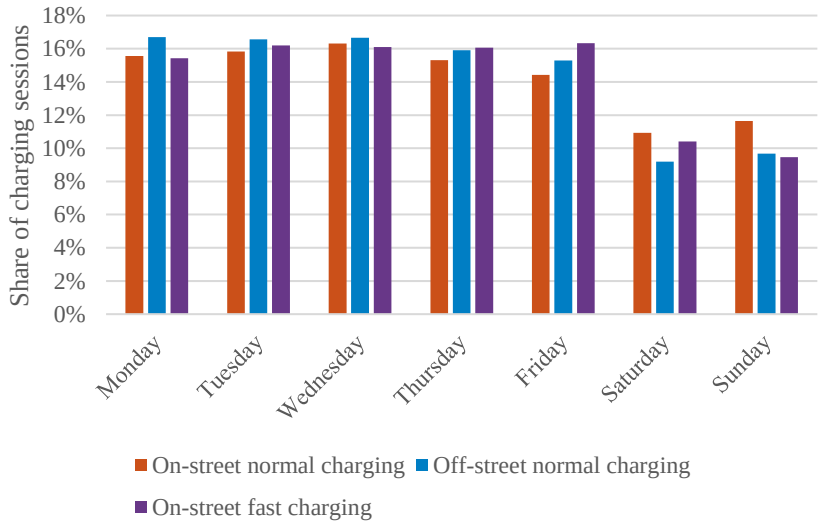


Figure 6. Share of sessions per weekday and charging category for 2019.

The infrastructure is mostly used during the day

Figure 7 presents how the different charging categories are used during weekdays. During 2019, off-street normal charging sessions usually start between 06:00 and 08:00 in the morning, and then decrease during the morning between 09:00 and 11:00. Then there is an increase until the afternoon. This is followed by a reduction

from 15:00-16:00 onwards. For on-street normal charging, the peaks occur between 08:00 and 10:00 as well as between 17:00 and 18:00. For on-street fast charging, as with the previous year, most charging sessions begin in the middle of the day between 11:00 and 13:00. The sessions that start at night are dominated by on-street fast charging. These usage patterns indicate that off-street normal charging is mainly used for destination charging, while on-street normal charging is used for charging both at home and at destinations.

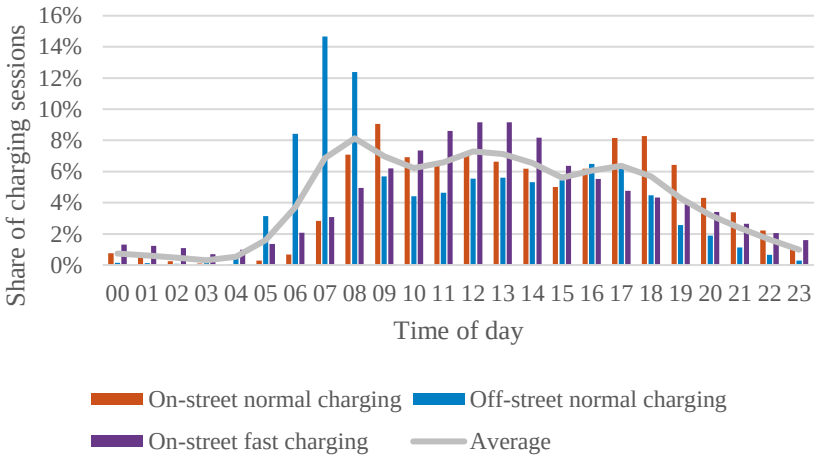


Figure 7. Charging sessions distributed per start time, weekdays 2019.

During the weekend, the different charging categories are used according to Figure 8. Similar to weekdays, on-street fast charging dominates during the night with the most on-street fast charging sessions occurring midday between 12:00 and 14:00. The number of off-street normal charging sessions initiated occur for the most part in the morning and until 15:00, decreasing in the late afternoon. On-street normal charging has a somewhat different usage pattern, where the peak for initiated charging sessions occurs around 16:00.

The results presented in Figure 8 indicate that off-street normal charging is mainly used for destination charging on weekends as well, as most of the charging sessions are initiated during the late morning through early afternoon. On-street normal charging sessions increase in the afternoon, indicating that they are used for destination charging as well as home charging during the weekend.

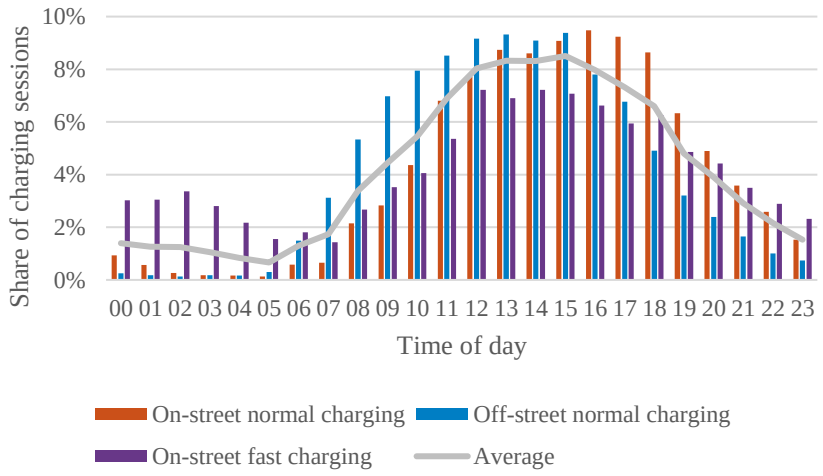


Figure 8. Charging sessions distributed per start time, weekends 2019.

Occupancy

During 2019, the occupancy of all charging points during an average day was at most around 110 vehicles between 10 and 12 o'clock similar to the previous year, see Figure 9. Off-street normal charging accounts for most of the charging sessions and has the greatest variation during the day. It should be noted that the figures presented below are based on the duration from when the charging cable has been plugged in to when it is removed, rather than the time during which energy transfer has taken place. In other words, the EVs are likely plugged into the charging point for a longer time period than necessary to reach a full charge. Data on when the energy transfer took place during each session was not made available for this report.

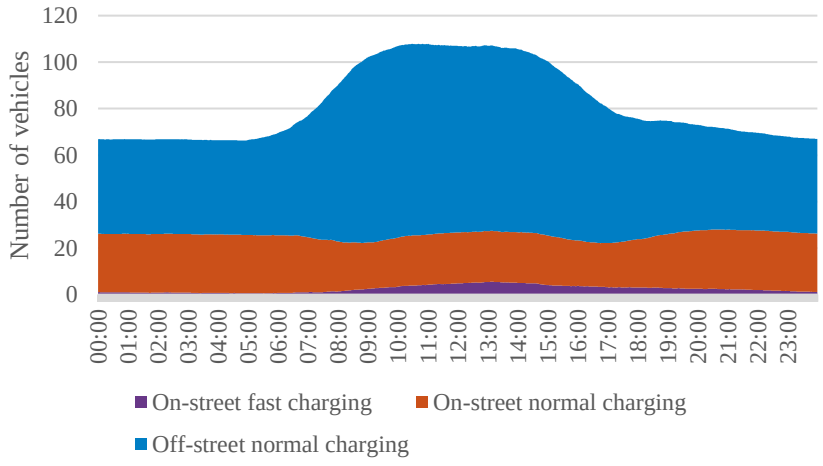


Figure 9. Number of electric vehicles occupying public chargers in Stockholm during an average day in 2019. The data resolution is per minute.

Figure 10 presents the share of on-street fast charging points used during weekdays in 2018 compared to 2019. The design of the

curve for the year 2019 is similar to the previous year but shows a generally higher share of charging points used at the same time. Peak-occupancy of about 10 percent on weekdays in 2019 is reached around 13:00, which can be compared with the corresponding 8 percent at 12:00 for 2018.

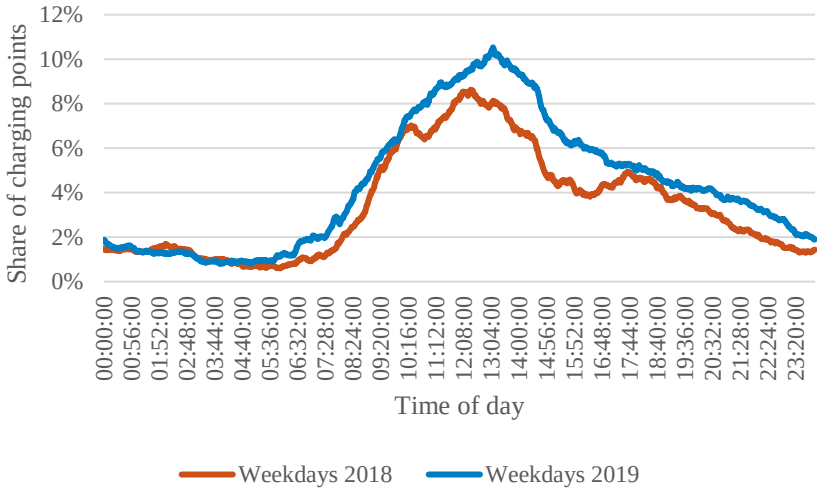


Figure 10. Share of on-street fast charging points used simultaneously on an average weekday in 2018 and 2019.

The share of on-street fast charging points used simultaneously during the weekends of 2019 also follows the previous year's curve. Similar to the occupancy during weekdays, Figure 11 shows an increase in the variation between high and low occupancy, as the occupancy amounts to over 5 percent between 13:00 and 16:00. This can be compared to around 4 percent in 2018. The reason for the increased occupancy may be due to several parameters, such as the increased number of EVs in Stockholm in relation to the number of charging stations or the number of EVs in taxi fleets. This may also be due to newly established on-street fast-charging stations have a better average occupancy than before, due to better geographical locations. The number of on-street fast charging points has increased by 27 percent, from 49 in 2018 to 62 in 2019.

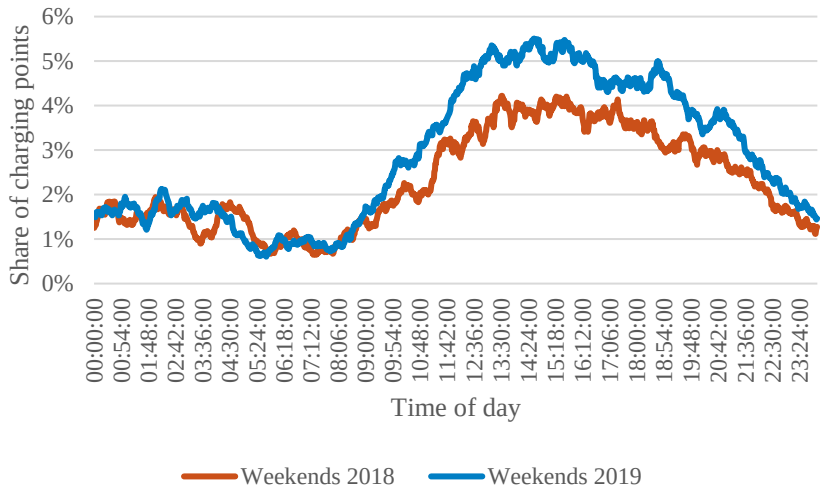


Figure 11. Share of on-street fast charging points used simultaneously on an average weekend in 2018 and 2019.

In terms of occupancy for on-street normal charging during weekdays in 2019, the curve follows a similar pattern to the previous year, see Figure 12. Both the number of charging sessions and the number of charging points that collect the statistics have increased. For on-street normal charging, statistics have been collected from 148 charging points in 2019, which is an increase of 80 percent from the 82 charging points in 2018. The share of charging points used at the same time is lower than the previous year throughout the day and amounts to a maximum of 17 percent between 06:00 and 07:00. The curve indicates that the on-street normal charging is mainly used for destination and home charging during weekdays.

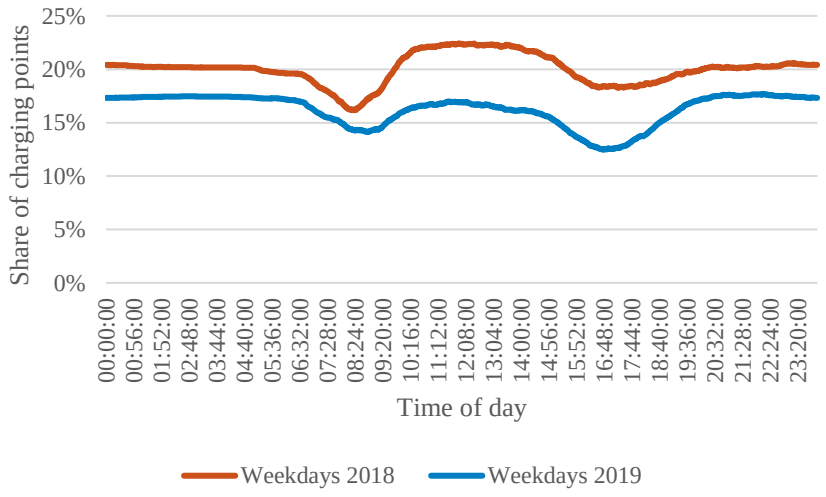


Figure 12. Share of on-street normal charging points used simultaneously on an average weekday in 2018 and 2019.

During the weekends in 2019, the occupancy follows a similar pattern to that of last year with marginal deviations, as can be seen

in Figure 13. At most, an occupancy rate of just over 16 percent is achieved at night, compared to around 17 percent during 2018. The lower occupancy can be explained by the sharply increased number of charging points. The usage pattern indicates that on-street normal charging is mostly used for home charging during normal weekends.

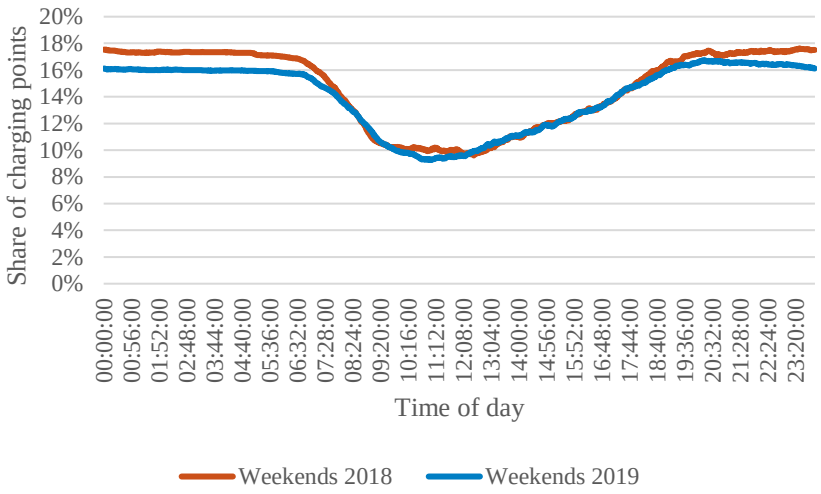


Figure 13. Share of on-street normal charging points used simultaneously on an average weekend in 2018 and 2019.

For off-street normal charging in 2019, the pattern is similar to that of 2018, with a slightly more even distribution throughout the day, see Figure 14. Similar to the previous year, there is a sharp increase in occupancy during the weekday morning hours, which decreases from 11.00 onwards for the rest of the day.

There is a slightly lower occupancy in 2019 relative to 2018, which may be due to the increased number of charging points. These increased by about 82 percent, from 279 to 507 in 2018 to 2019. At present, there are significantly more charging points installed at Stockholm Parkering's facilities than those which provided data for this report, which can affect how well the figures correspond to reality. The number of charging points per parking garage that reported data at the end of 2018 and in 2019 is presented in Table 2.

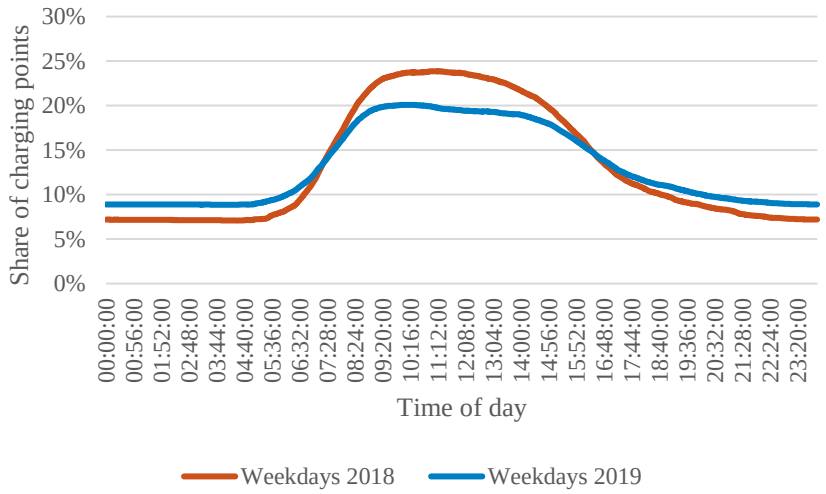


Figure 14. Share of off-street normal charging points used simultaneously on an average weekday in 2018 and 2019.

Table 2. Number of charging points that collected data for this evaluation at Stockholm Parkering's facilities at the end of 2018 and 2019. The number of charging points collecting data may have increased or decreased in this table independent of any change in the actual number of stations installed in the parking garages, due to the operating status of the charging stations[7].

	2018	2019
Brunkebergstorg	0	15
David Bagare	8	6
Enskedehallen	4	4
Eriksdals Nya Simstadion	6	6
Farsta infarts P	8	8
Farsta Sim och Idrottshall	6	6
Fleminggatan P-hus	4	4
Gallerian Herkulesgatan	34	25
Glasbruket	2	2
Humlegården P-hus	4	4
Husbyhallen	1	1
Högalidsgaraget	10	10
Kölnan P-hus	3	3
Medborgarplatsen	0	66
Mälarhöjdens IP	4	4
Norr Mälarstrand	1	0
Norra Latin	12	10
Norra Real P-hus	9	6
Norra Tornsgaraget	0	33
Palmfelt Center	6	6
Parkören	13	70
Ropsten Shell Infarts P	6	6
Råcksta P-Hus	12	12
Rådhusgaraget	2	2
Rågsved Infarts P	2	2

[7] For example, a station may have been installed prior to 2019, but haven't collected data until then.

S:t Eriksplan, P-hus	4	4
Sjöstaden, P-hus	4	19
Slakthusplan	4	4
Solurgaraget	4	4
Spånga Tennishall Infarts P	0	1
Stigbergsgaraget	58	56
Stora Mossen IP	4	3
Torns Torn	0	12
Vartofta P-hus	4	56
Viking P-hus	2	2
Väderkvarnen	4	4
Väll-in	6	6
Västertorpshallen	6	6
Åkeshov, P-hus	4	4
Åregaraget	4	2
Åsögaraget	6	6
Älvsjö IP-Infart	8	7

The occupancy rate for off-street normal charging during the weekends of 2019 is slightly lower than the previous year, see Figure 15. The biggest change can be seen during the day when the occupancy rate has dropped from around 8 percent between 12:00 and 16:00 to around 7 percent during the corresponding time. This may be due to the higher number of charging points from which data was collected.

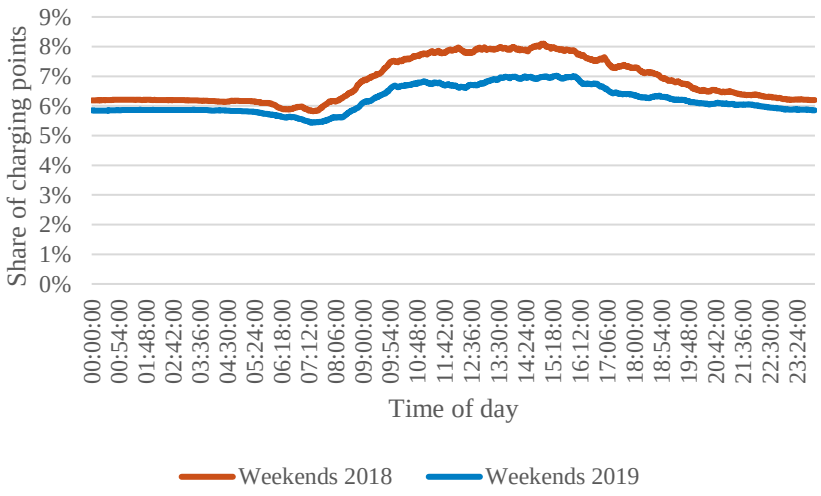


Figure 15. Share of off-street normal charging points used simultaneously on an average weekend in 2018 and 2019.

Charging time

The time that the EVs spend connected at a charging point for each session varies considerably, from a few minutes up to a several days for all charging categories. It should be noted that the data presented shows the time from which the EV is connected to the grid, and until it is disconnected. It does not show the time under which the

vehicle is actually charging. Figure 16 shows that a large share of the sessions lasts for two hours or less (41 percent), which is in line with the previous year.

The main reason why a large share of charging sessions has a duration of 3 hours or less is the prevailing time constraints for on-street fast and normal charging. On-street fast charging has a time limit of 30 minutes throughout the day. On-street normal charging has a time limit of three hours during the day (07:00-19:00)[8]. Worth noting is that the time at the charging stations in the parking garages is also largely less than three hours, even though Stockholm Parkering have different rules depending on the facility.

A small increase can be seen in the share of off-street normal charging sessions with a duration of around 7-10 hours, which occurs only during weekdays. For on-street normal charging, the number of charging sessions increases around 12–16 hours, which can be seen on both weekdays and during the weekends.

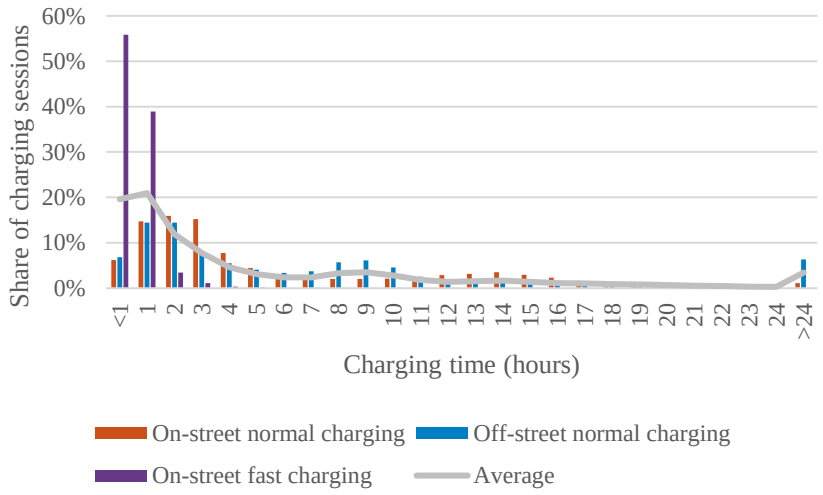


Figure 16. Charging time distribution per charging type, 2019. Note that the charging time is the duration the vehicles are connected to the charging point.

On-street fast charging duration

56 percent of the on-street fast charging sessions have a duration of 30 minutes or less, which is in line with established time limits (Figure 17). The average charging time per session is overall slightly more than 30 minutes.

[8] Important to note is that the time limit is only applied for on-street charging. Stockholm Parkering have separate rules for their parking facilities.

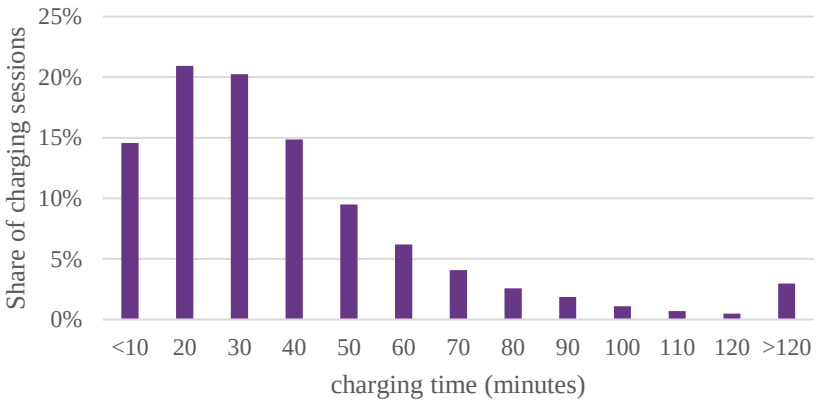


Figure 17. On-street fast charging session duration distribution, 2019. Note that the charging time is the duration the vehicle is connected to the charging point.

Normal charging duration

Both on- and off-street normal charging have a similar pattern regarding charging time, although with some differences. During weekdays, the majority of normal charging sessions last about 2 hours for both on- and off-street normal charging.

Figure 18 presents the number of on-street normal charging sessions during weekdays, separated based on the session duration. Most charging sessions occur with a charging time of about 1-3 hours, with a small increase in the number of sessions with a duration of about 12-15 hours.

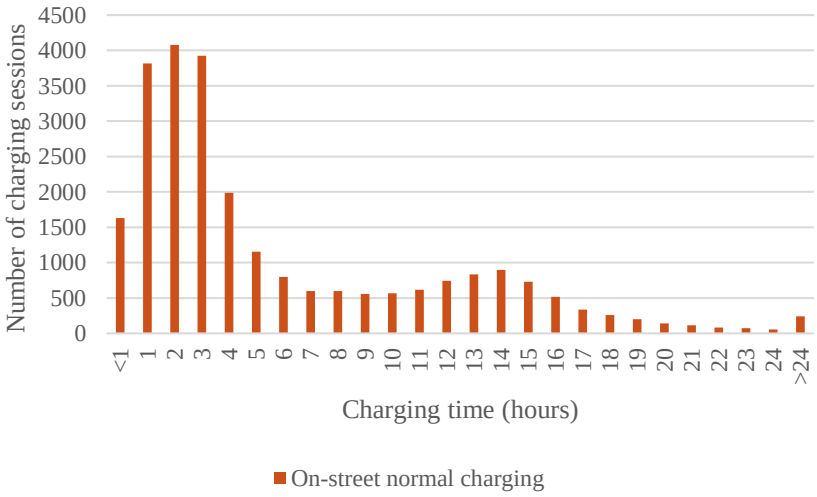


Figure 18. On-street normal charging session duration distribution, weekdays 2019. Note that the charging time is the duration the vehicle is connected to the charging point.

The highest number of charging sessions for off-street normal charging have a duration of 2 hours or less, with another peak at a charging time of 8-10 hours, see Figure 19. It is important to note that the highest number of off-street normal charging sessions on

weekdays is almost twice as high as that of on-street normal charging. Off-street normal charging has a larger share of charging sessions with a duration of 8-10 hours relative to on-street normal charging during weekdays.

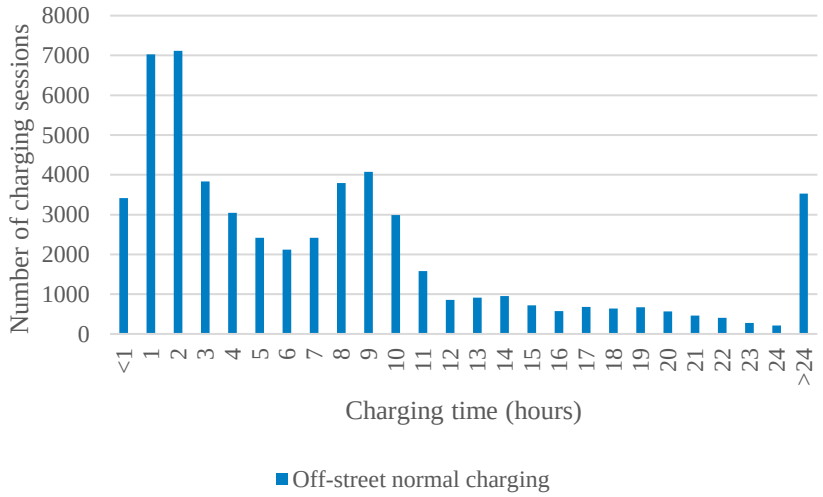


Figure 19. Off-street normal charging session duration distribution, weekdays 2019. Note that the charging time is the duration the vehicle is connected to the charging point.

For on-street normal charging, there is a similar pattern of duration for the charging sessions occurring during weekends as to those occurring during weekdays. An increased number of sessions occur with a charging time of between 12-17 hours, as can be seen in Figure 20.

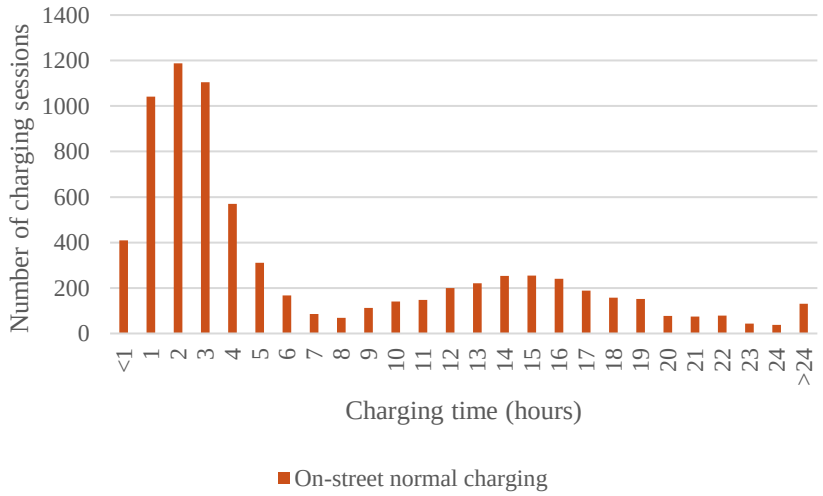


Figure 20. On-street normal charging session duration distribution, weekends 2019. Note that the charging time is the duration the vehicle is connected to the charging point.

The distribution of charging sessions separated on the charging time differs between weekdays and weekends for off-street normal charging. Partly due to a lower number of sessions, and partly due

to the charging sessions being mostly shorter. A majority of these sessions have a duration of 3 hours or less, see Figure 21.

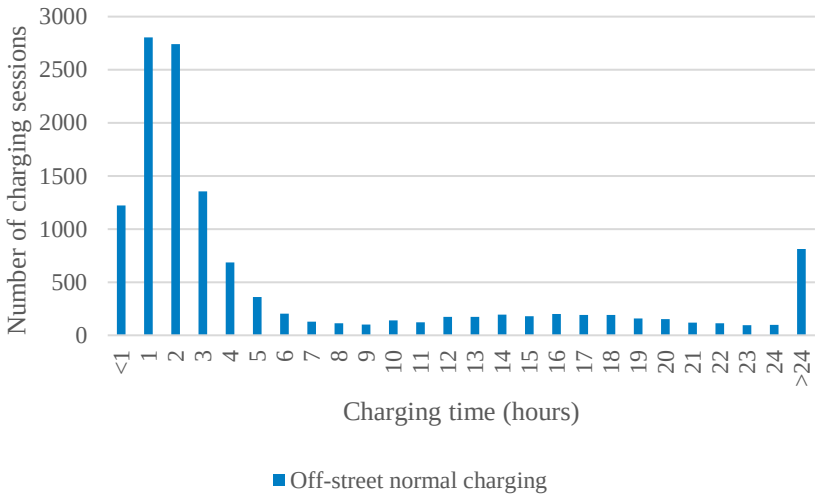


Figure 21. Off-street normal charging session duration distribution, weekends 2019. Note that the charging time is the duration the vehicle is connected to the charging point.

The results presented in Figure 18 - Figure 21 indicate that off-street normal charging is used during working hours on weekdays, due to an increased number of charging sessions lasting 8-10 hours. Such corresponding pattern of charging session duration is not seen during weekends. Regarding on-street normal charging, there are more sessions with a duration of around 15 hours on weekends than weekdays. This may indicate that this type of charging is used for over-night parking on weekends. However, it should be noted that the majority of on-street normal charging sessions have a duration of 3 hours or less. This is in line with the previous year's evaluation, showing that the infrastructure is mainly used for destination charging.

On-street normal charging is limited to three hours during the day, which a majority of the users comply with. However, 31 percent of all on-street normal charging sessions exceed this time limit during the day, which is a decrease compared to the previous year (38 percent in 2018). Figure 22 presents the share of on-street normal charging sessions which exceeds the time limit and by how much[9]. In 2019, 303 fines were issued for cars that exceeded the time limit,

[9] The reason for the significant amount of charging sessions with a duration of 9 hours or longer can partially be explained by the fact that some are initiating their session after 16:00, which means they can remain parked at the station until 10:00 the next day. The sessions included in this figure are ones that have parked after 16:00 day 1, but exceeds the daytime time limit the following day.

and 1641 fines were issued for non-EVs that were parked at the charging stations[10].

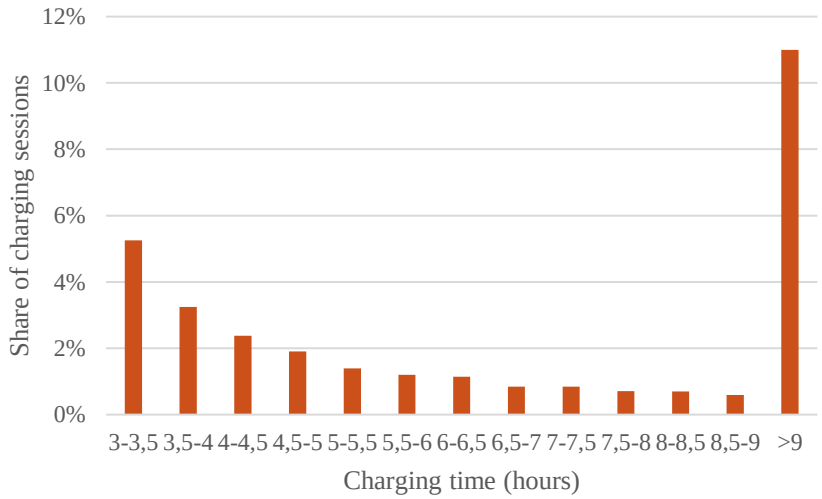


Figure 22. Distribution of on-street normal charging sessions violating the daytime time limit, 2019. Note that the charging time is the duration the vehicle is connected to the charging point.

The distribution of the average on- and off-street normal charging duration based on when the charging session was initiated is presented in Figure 23. Several of Stockholm Parkering's facilities have registered sessions that last for hundreds and sometimes thousands of hours. The EVs can technically be connected to the charging point during this entire time, but the actual energy transfer occurs mainly at the beginning of the charging session. The extreme

[10] Note that the definitions of the violations are relatively broad and may therefore be used for a variety of appropriate violations. An example is if one has exceeded an established time limit in a local center of a suburb where there is regulation regarding time, but no associated fines.

values have therefore been removed.

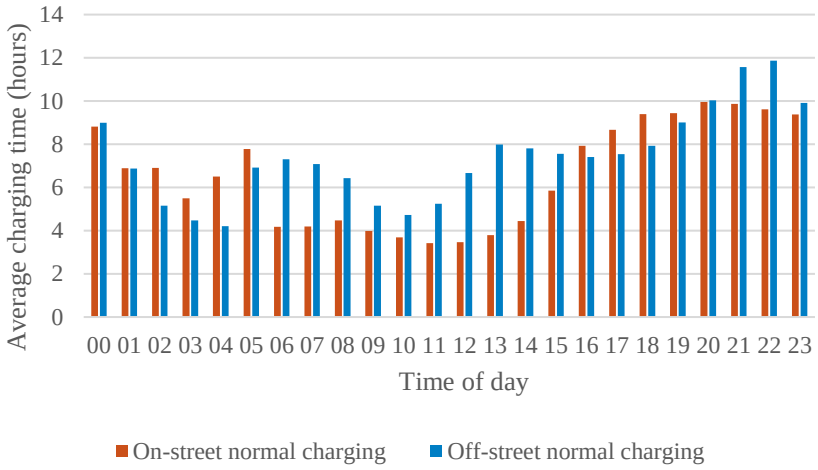


Figure 23. Average charging session duration distributed based on the time of session initialization 2019, extreme values removed.[11]

Geographical differences

The average charging time per parking facility owned by Stockholm Parkering is presented in Figure 24[11]. The parking garage Parkören and Viking P-hus account for the longest average charging times of approximately 17.5 hours, followed by Norra Tornsgaraget.

In 2018, Stigbergsgaraget had the longest average charging time, followed by Vartofta Parkeringshus and Viking Parkeringshus.

[11] Charging sessions with a duration longer than two consecutive days have been excluded from the analysis (about 3,4 percent of Stockholm Parkering's sessions). Extreme values have only been observed in a few off-street parking facilities, including Parkören, Stigbergsgaraget and Medborgarplatsen. There have been some reported problems when it comes to charging at Parkören, but no other disturbances have been reported with the charging in Stockholm Parkering's facilities in 2019.

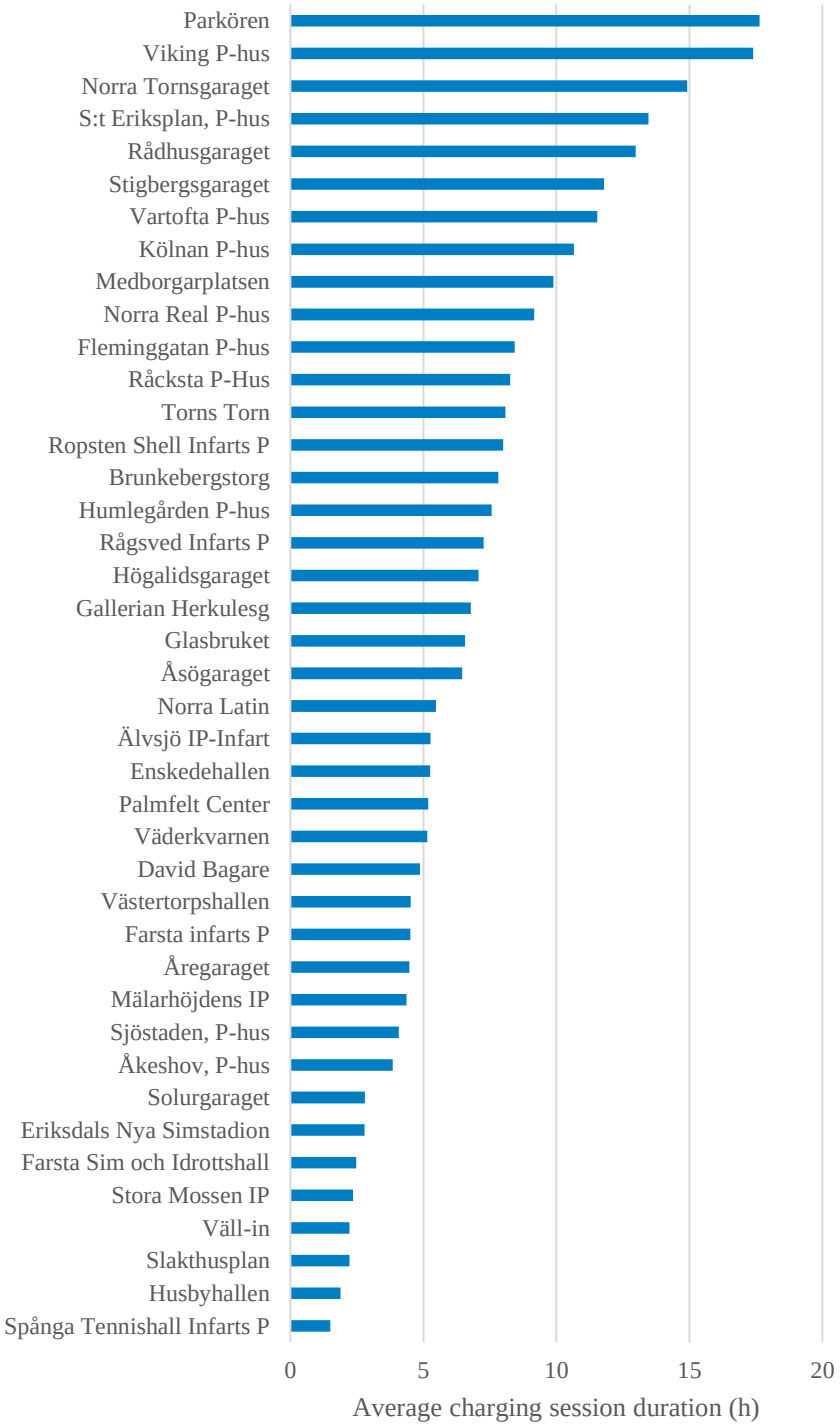


Figure 24. Average charging session duration for off-street normal charging at parking facilities operated by Stockholm Parkering in 2019, with extreme values not considered for the analysis. The number of charging points varies per station. Note that the charging time is the duration the vehicle is connected to the charging point.

The three most frequently used on-street fast charging stations when it comes to the average number of sessions per charging point and day had between 3.8–4.3 sessions per weekday (Fast charging station 1-3) in 2019, see Figure 25. The three most used fast-

charging stations on weekends had between 2.0–2.7 sessions (Fast charging station 3, 5, 1). The fast charging stations that had almost no charging sessions were most likely installed relatively late in the year.

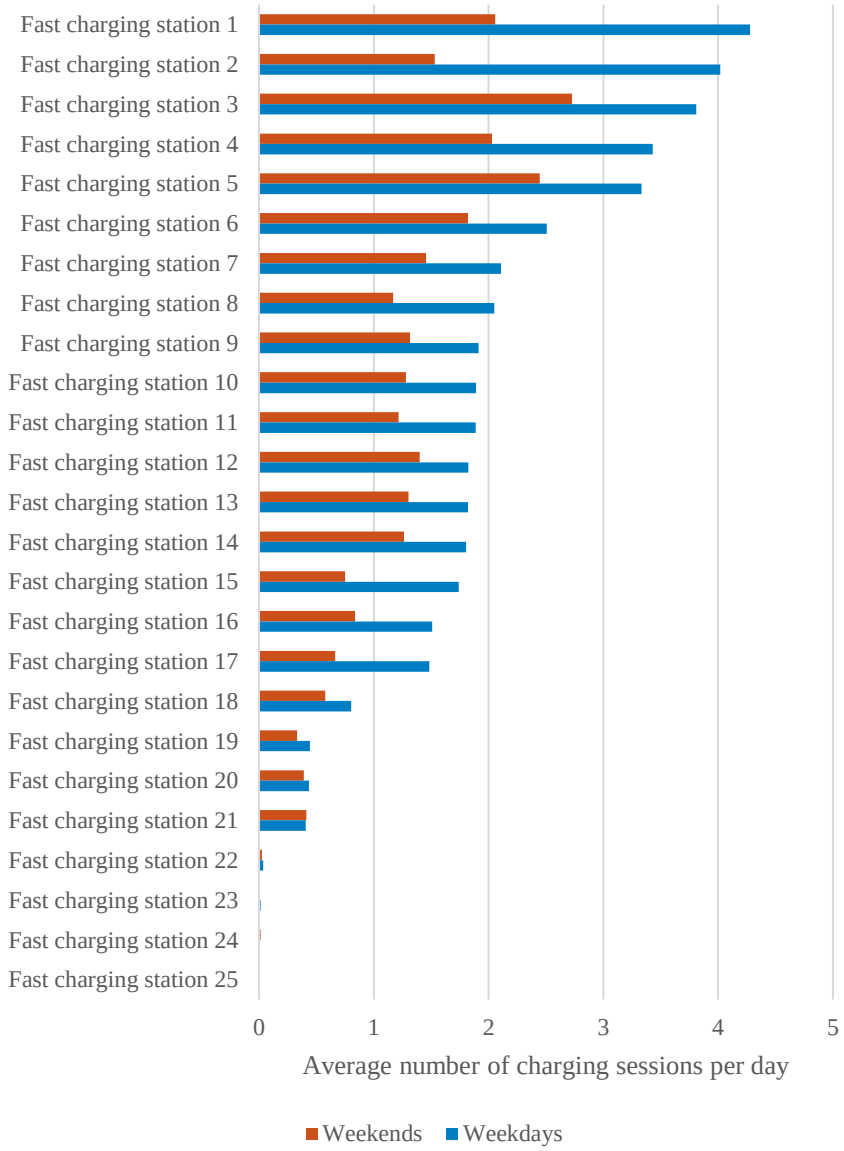


Figure 25. Average number of sessions per on-street fast charging point in Stockholm, weekdays and weekends 2019. Charging stations belonging to E.ON, Vattenfall and Fortum have been anonymized according to a new system from the previous report (however same throughout this report). The number of charging points varies between 1-3 per station.

Figure 26 presents the average number of sessions per on-street normal charging point and day. The three most popular stations had about 1.3-1.5 sessions per weekday (Normal charging station 1-3), while the corresponding number on weekends is 0.9-1.3 sessions per weekend (Normal charging station 2, 1, 4). The station that had almost no charging sessions was probably installed relatively late in the year.

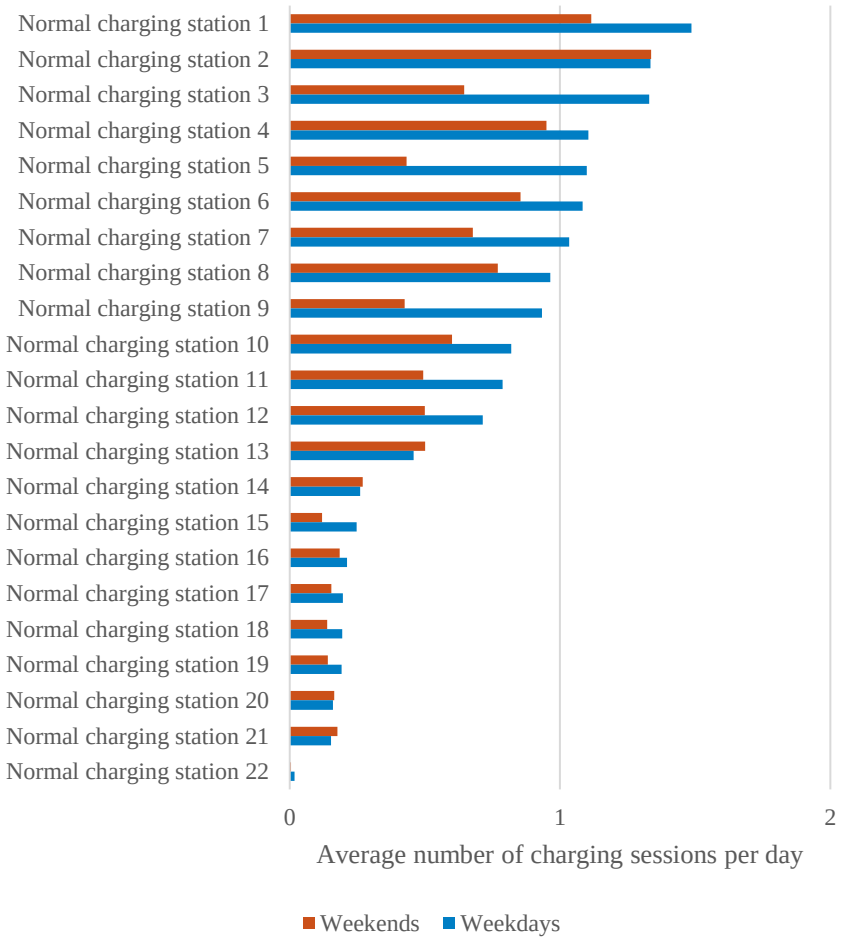


Figure 26. Average number of sessions per on-street normal charging point in Stockholm, weekdays and weekends 2019. Charging stations belonging to E.ON, Vattenfall and Fortum have been anonymized according to a new system from the previous report (however same throughout this report). The number of charging points varies between 1-8 per station.

The most popular off-street normal charging stations during weekdays in 2019 were Solurgaraget (2.7 sessions per weekday), Åregaraget (1.7 sessions per weekday) and Eriksdals Nya simstadion (1.5 sessions per weekday), see Figure 27. The most popular charging stations during the weekend were Solurgaraget (2.4 sessions per day), Farsta Sim- och idrottshall (1.6 sessions per day) and Eriksdals Nya Simstadion (1.5 sessions per day).

Similar to last year, the statistics indicate that the popularity of a station is not geographically dependent on whether the charging infrastructure is in the city center or not, as both parking facilities closer to the center (Eriksdals Nya simstadion) and outside the inner-city (Solurgaraget, Åregaraget) have a high number of charging sessions. It is more likely linked to the destinations and

activities close to the parking facilities, such as homes, work, shopping centers, swimming pools or the like.

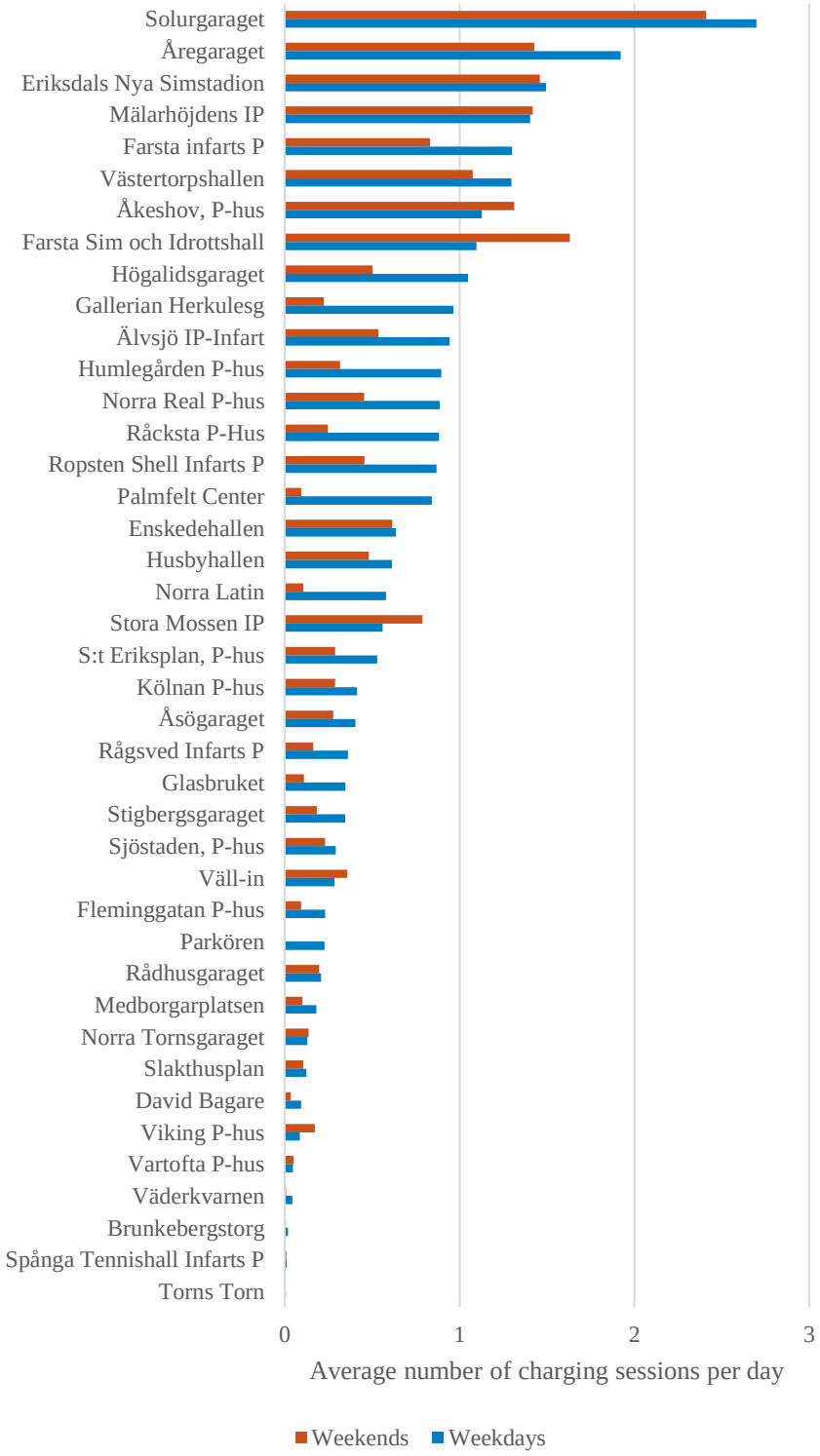


Figure 27. Average number of sessions per off-street normal charging point in Stockholm, weekdays and weekends 2019. The number of charging points varies per station.

Energy transferred

In 2019, the registered energy transfer from public charging stations in Stockholm totaled approximately 1 485 000 kWh, which corresponds to a driving distance for an EV of approximately 9 900 000 km or approximately 247 laps around the Earth. The amount of energy transferred distributed quarterly can be seen in Figure 28[12].

This corresponds to about 1482 tonnes of reduced carbon dioxide emissions compared to average values for a diesel car[13]. Note that the total energy transfer increased substantially during the fourth quarter of 2019, which is likely due to an increase in the size of the electric car fleet in addition to the increasing battery capacity in EVs.

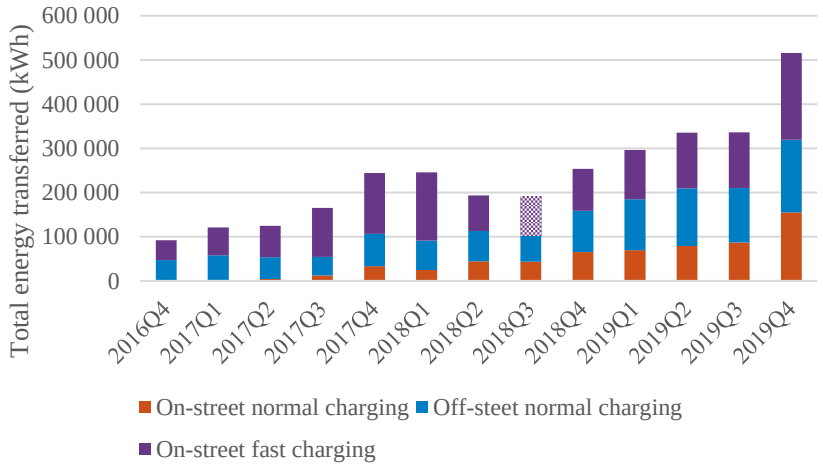


Figure 28. Total energy transferred from public charging stations in Stockholm, distributed quarterly.

As can be seen in Figure 29 the main energy transfer takes place during weekdays between 06:00 to 20:00. During weekends, the main energy transfer is more concentrated to the afternoon, with a peak around 15:00 to 17:00. It is worth noting that this is only the average energy transfer and thus does not indicate when the power

[12] Following a data logging error at one of the operators for the on-street fast charging infrastructure, the data for the third quarter in 2018 has been adjusted through a linearization between the second and fourth quarter in 2018.

[13] The calculation is based on energy use and emission factors for electric and diesel-powered vehicles from the report ER2018:17 “Drivmedel 2017 redovisning av uppgifter enligt drivmedelslagen och hållbarhetslagen” published by the Swedish Energy Agency.

demand is greatest, and that it is scattered in different geographical areas.

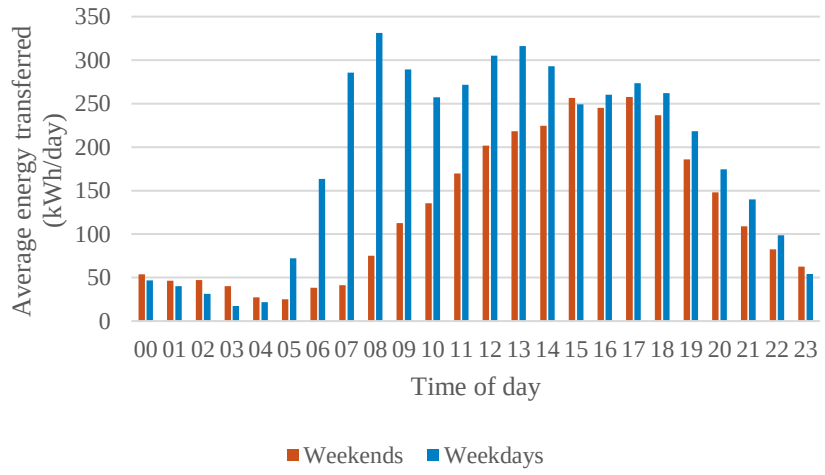


Figure 29. Average energy transferred at public charging stations distributed per the time of day, weekdays and weekends 2019.

Most charging sessions have an energy transfer of up to 10 kWh per session, which can be seen in Figure 30. Approximately 80 percent of the on-street normal charging sessions and about 70 percent of the off-street normal charging sessions have an energy transfer of up to 10 kWh per session, while the corresponding share for the on-street fast-charging sessions is about 45 percent. This is similar to the previous year's data, with the exception of off-street normal charging sessions, where the share of sessions with up to 10 kWh in energy transfer in 2018 amounted to about 80 percent.

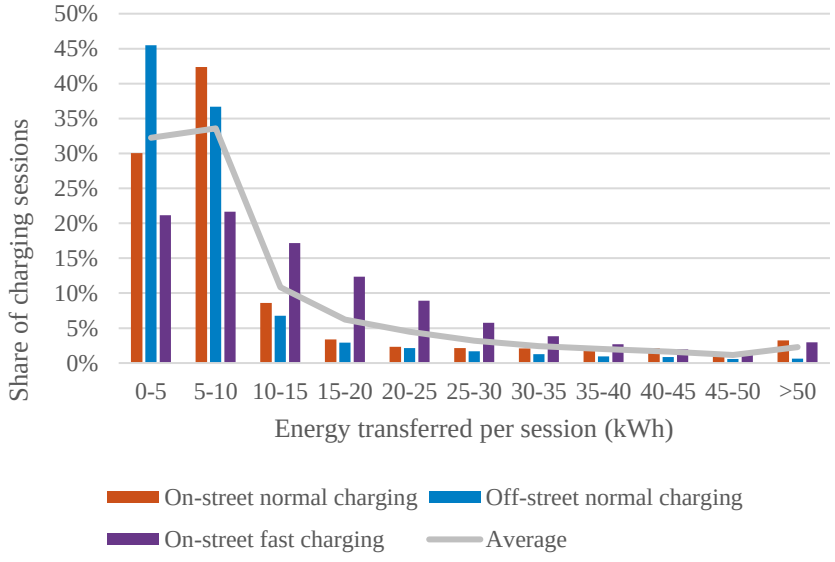


Figure 30. Distribution of energy transferred per session and charging category, 2019.

Figure 31 presents the average energy transfer per session in kWh for Stockholm Parkering's facilities. Rådhusgaraget has the highest value of about 31 kWh, followed by Norra Tornsgaraget and Norra Real P-hus at just under 16 kWh each. The reason for Rådhusgaraget's high energy transfer may be due to the fact that several carpool vehicles are parked there. In 2018, the top list was Viking Parkeringshus (approx. 15 kWh), Norr Mälarstrand (approx. 12 kWh) and Rådhusgaraget (just under 12 kWh).

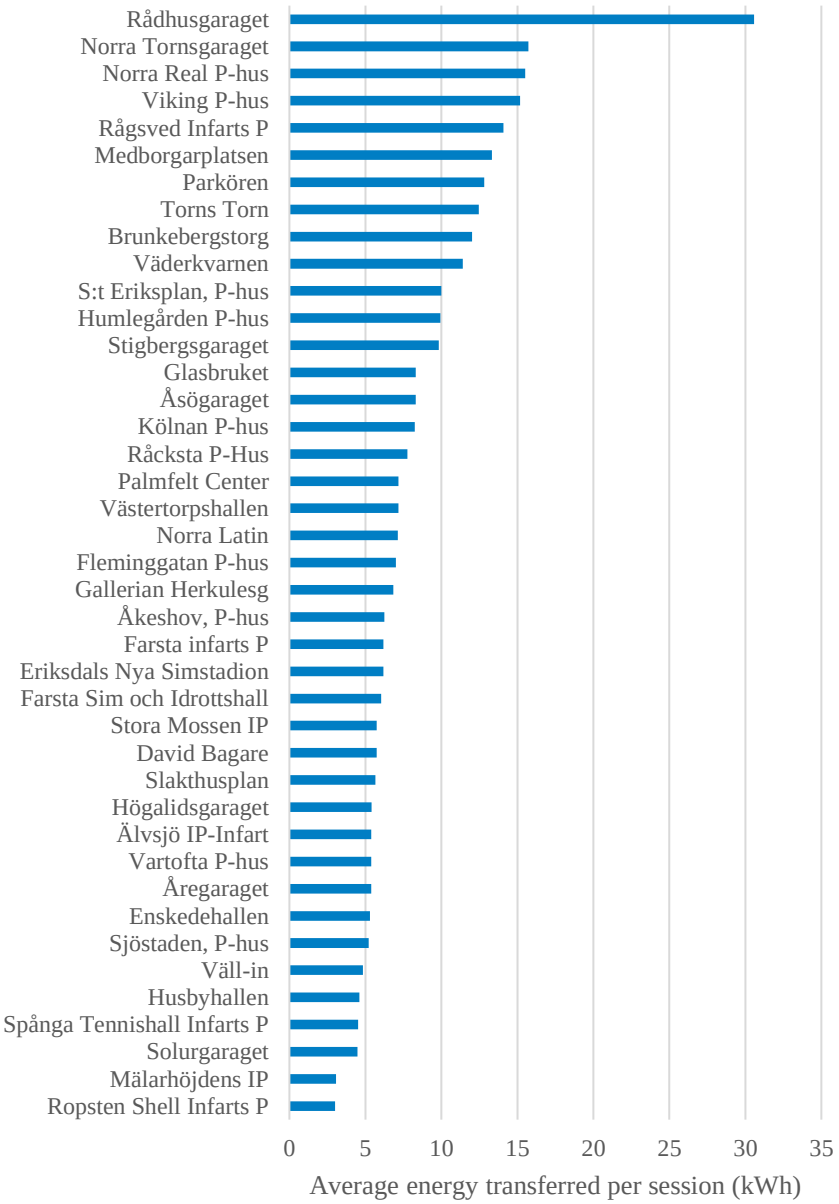


Figure 31. Average energy transferred per session in kWh for parking facilities operated by Stockholm Parkering, 2019.

In addition to the average energy transfer per charging session, Figure 32 shows the average energy transfer per parking facility and day. During weekdays, the parking garage Parkören shows the

highest energy transfer of about 205 kWh, which corresponds to 12 percent of the energy transfer per average weekday in Stockholm Parkering facilities. This is followed by Stigbergsgaraget of about 185 kWh (11 percent) and Gallerian Herkulesgatan of about 162 kWh (10 percent). The reason why the parking garage Parkören has a high energy transfer per day during weekdays and not weekends may be due to its charging points are largely used for work and carpool vehicles within SISAB and Stockholm Parkering, which are mostly not used during weekends.

During weekends, Stigbergsgaraget (114 kWh) is the most used parking garage in terms of energy transfer, followed by Medborgarplatsen (107 kWh) and Norra Tornsgaraget (80 kWh).

Last year during weekdays, Gallerian Herkulesgatan (180 kWh), Stigbergsgaraget (77 kWh) and Farsta Infartsparkering (71 kWh) had the largest energy transfer. For weekends it was mainly Stigbergsgaraget (54 kWh), Farsta Infartsparkering (44 kWh) and Eriksdals Nya Simstadion (39 kWh).

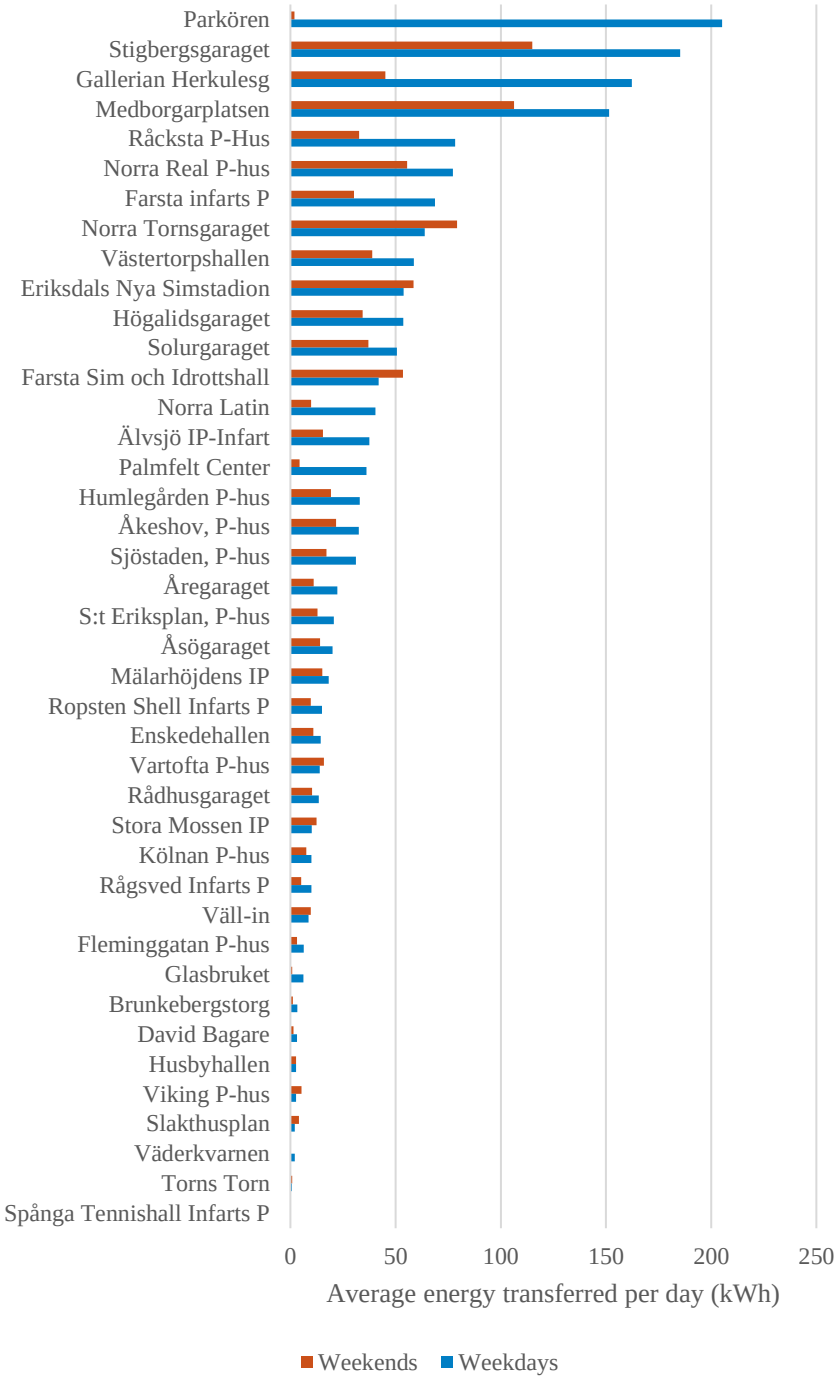


Figure 32. Average energy (kWh) transferred per off-street normal charging station operated by Stockholm Parkering, weekdays and weekends 2019. The number of charging points varies per station.

For on-street fast charging, the highest average energy transfer per day occurs during weekdays, see Figure 33. During weekdays, the top three are fast charging station 2 (169 kWh), fast charging station 5 (159 kWh), and fast charging station 3 (157 kWh). This can be compared with the previous year's figures, as the top three energy transfers for fast charging stations varied between about 240-95

kWh per day. The change in the amount of energy transferred from the previous year may be due to changed pricing models at the fast charging stations, which affects how long the station is used at each charging session.

During weekends, however, the average energy transfer is slightly lower, where the three highest values are given by fast charging station 5 (128 kWh), fast charging station 3 (124 kWh) and fast charging station 6 (108 kWh). The largest average energy transfer during the weekends last year was just over 138 kWh.

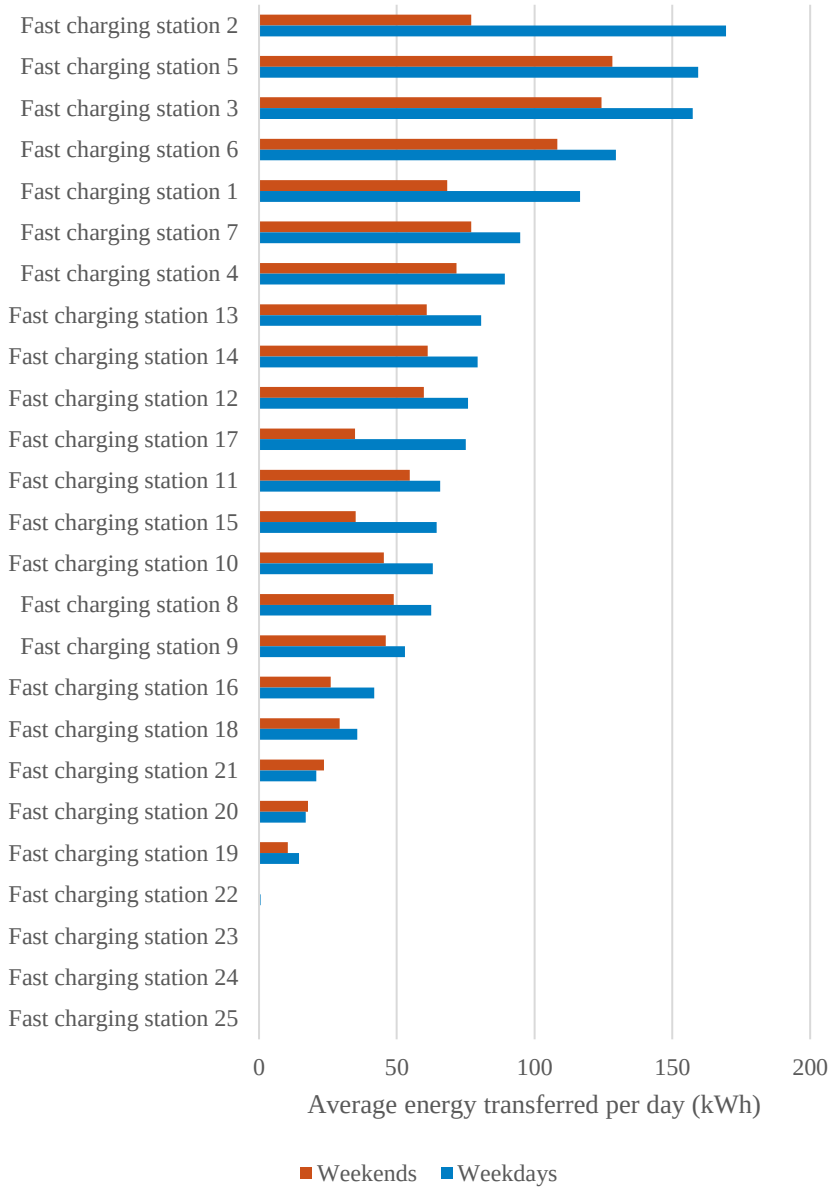


Figure 33. Average energy (kWh) transferred per on-street fast charging station, weekdays and weekends 2019. Charging stations operated by E.ON, Vattenfall and Fortum have been anonymized according to a new system from the previous report (however same throughout this report). The number of charging points varies between 1-3 per station.

In terms of on-street normal charging, normal charging station 1 had the highest average energy transfer per weekday (172 kWh), followed by normal charging station 6 (102 kWh) and normal charging station 3 (101 kWh). On weekends the situation is slightly different, where the list was topped by normal charging station 1 (130 kWh), normal charging station 2 (106 kWh) and normal charging station 6 (82 kWh). During the previous year, the highest energy transfer per normal charging station for weekdays and weekends was approximately 82 kWh and 62 kWh respectively.

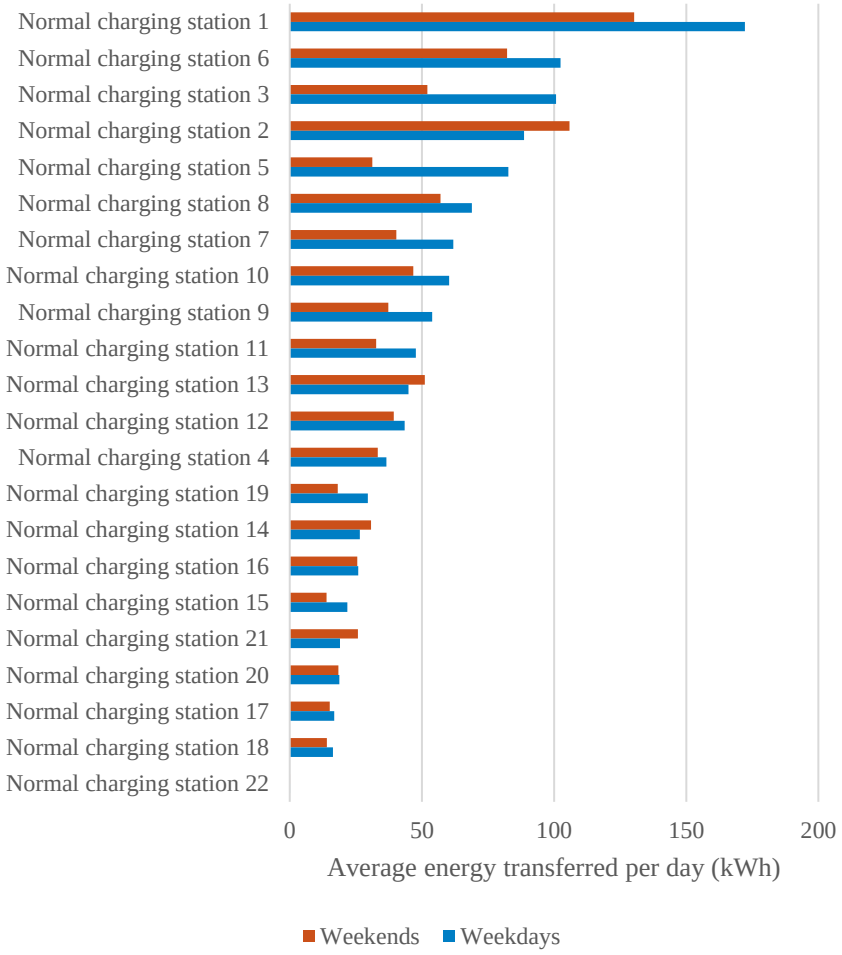


Figure 34. Average energy (kWh) transferred per on-street normal charging station, weekdays and weekends 2019. Charging stations operated by E.ON, Vattenfall and Fortum have been anonymized according to a new system from the previous report (however same throughout this report). The number of charging points varies between 1-8 per station.

Survey

In order to evaluate who is using the public charging infrastructure in Stockholm, and gain knowledge of when and why, an anonymous survey was conducted during the period of February 10th – March 4th, 2020. The survey was sent out to users of EON's, Fortum's and Vattenfall's charging stations via their customer records. A total of 377 responses were received, which is a decrease from last years' 535. A possible explanation to the reduced number of respondents is the somewhat longer survey sent out this year compared to the previous. In 2018 there were 106 respondents.

About the respondents

Of the 377 respondents, 47 percent live in Stockholm municipality, 52 percent in the other Stockholm area and one percent live in the rest of Sweden. About 87 percent are men, 12 percent are women and one percent identify with another option. The age distribution among the respondents shows that 94 percent of all EV owners are over 36 years, with an increasing share for each interval: "36–45 years", "46–55 years" and "Over 55 years", see Figure 35. In relation to last year, the share of men increased by about one percent, and the share of respondents over the age of 55 increased by about 5 percent.

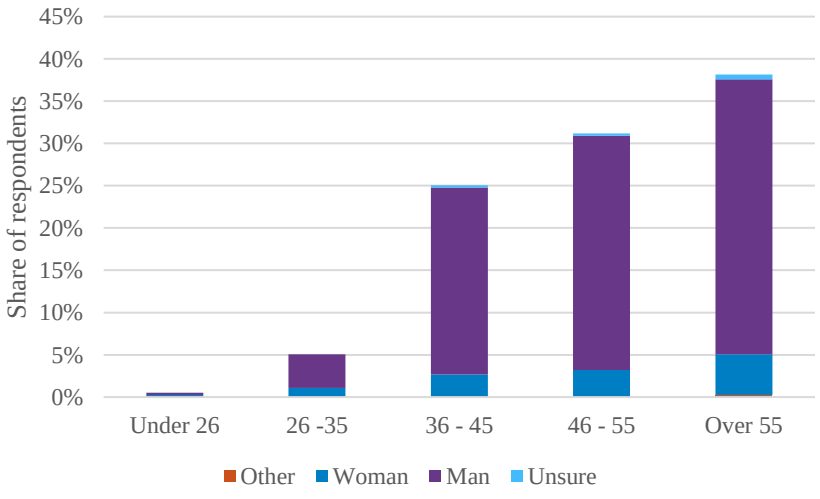


Figure 35. Age and gender distribution of the 377 respondents to the survey, 2020.

47 percent of the 377 respondents own a BEV and the remaining 53 percent own a PHEV, see Figure 36. From the previous year, the share of PHEV owners increased by 4 percent. 56 percent use their car both at work and privately, 42 percent only use the car privately and only 2 percent use it just for work.

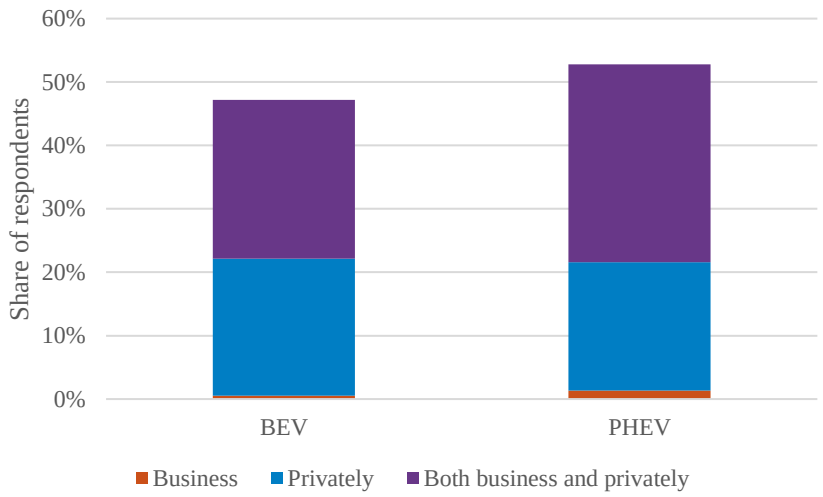


Figure 36. Use per vehicle type between the 377 respondents, 2020.

Similar to last year, a majority of the respondents own the car as a company car or have bought it themselves, but a significant share also lease their car, see Figure 37. A large share of the respondents who drive a BEV own it, unlike those who drive a PHEV where company cars represents the largest share.

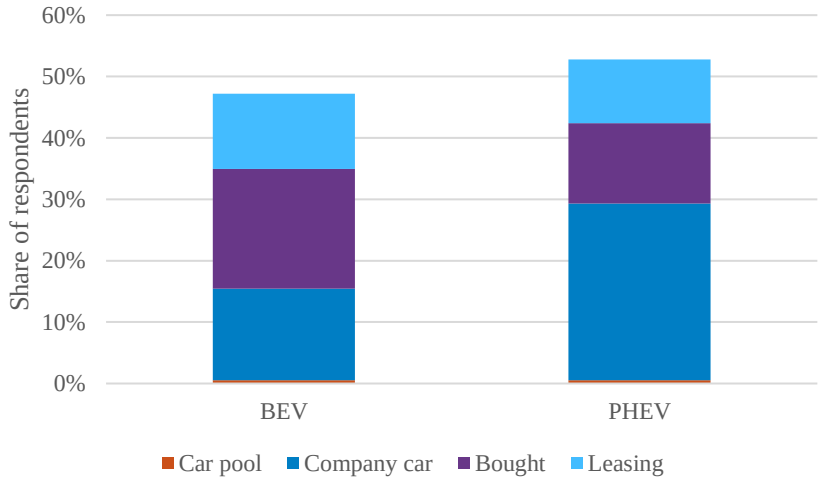


Figure 37. Ownership per vehicle type between the 377 respondents, 2020.

A significant share of the BEV owners who answered the survey have owned their vehicle for less than a year. This is a possible indication of the rapid development that the electric vehicle market is currently undergoing. Most of the owners of PHEVs have owned their vehicle for between 1-3 years (see Figure 38).

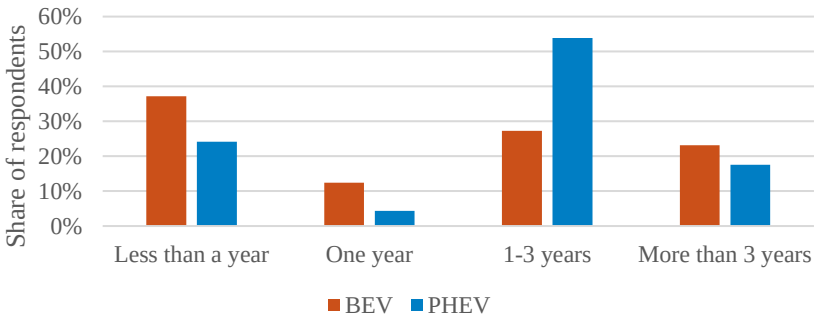


Figure 38. Duration of ownership for 212 respondents, separated per vehicle type, 2020.

64 percent of respondents state that the EV is the only vehicle in the household, evenly distributed between PHEVs and BEVs. Of the remaining respondents who stated that there are more vehicles in the household, about 23 percent own a BEV and 13 percent a PHEV.

67 percent of the respondents state that they have vehicles that can be charged at 50 kW, see Figure 39. Of these, 51 percent are BEV owners. 33 percent state that they cannot fast charge, of which a majority own a PHEV.

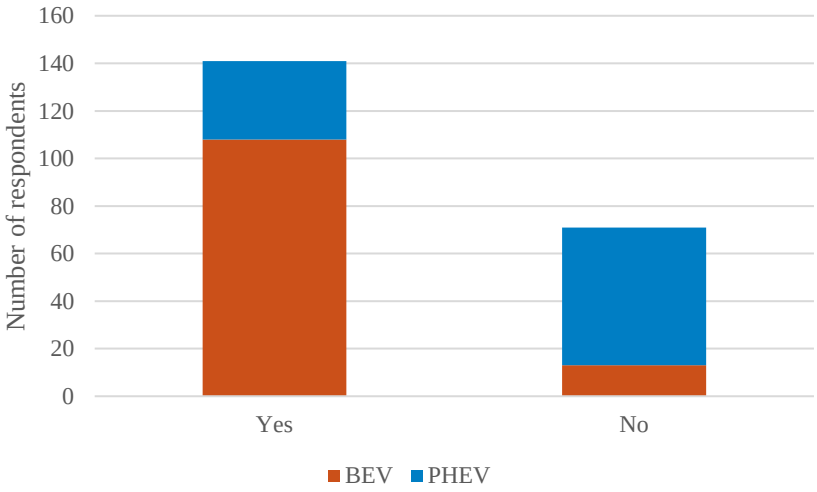


Figure 39. Responses (212) to the question if their vehicle can utilize fast charging of 50 kW, 2020.

Charging habits

70 percent of the respondents have access to charging at a separate parking space, i.e. home charging. 12 percent rely on public charging stations for charging in connection with their home, and 18 percent of the respondents surveyed state that they do not have access to any form of charging near their home, see Figure 40. While access to home charging is quite high, there is still a significant share of respondents who have no opportunity to charge

at home. For these, access to other types of charging, such as public charging or charging at work, is even more important.

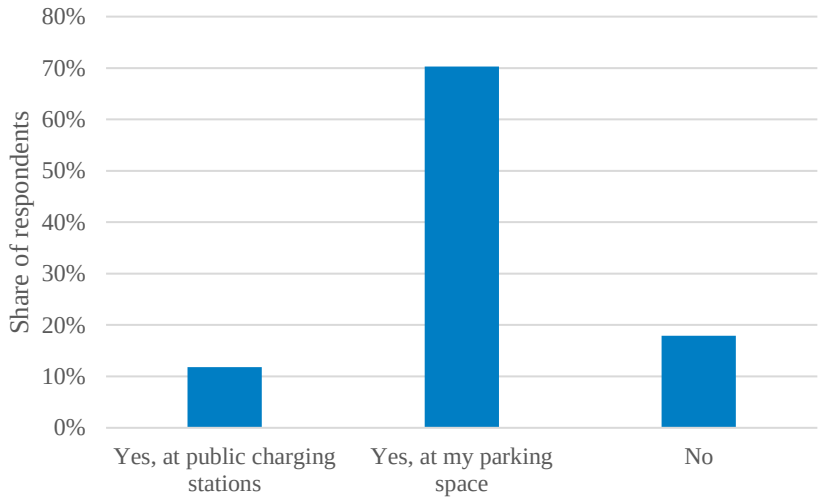


Figure 40. Responses (212) regarding if the respondents have access to charging in/near their home.

In general, respondents indicate that they use on-street fast charging less than once a month or not at all, see Figure 41. On-street fast chargers are used primarily at work (where taxi companies and courier companies are probably highly represented), followed by shopping centers, central Stockholm, at fuel stations, at other locations and at restaurants. At the same time, the respondents wish for more on-street fast charging stations at mainly shopping centres, along major roads outside urban areas and at larger parking facilities, see Figure 42. The answers are similar to what was observed in the previous year's survey.

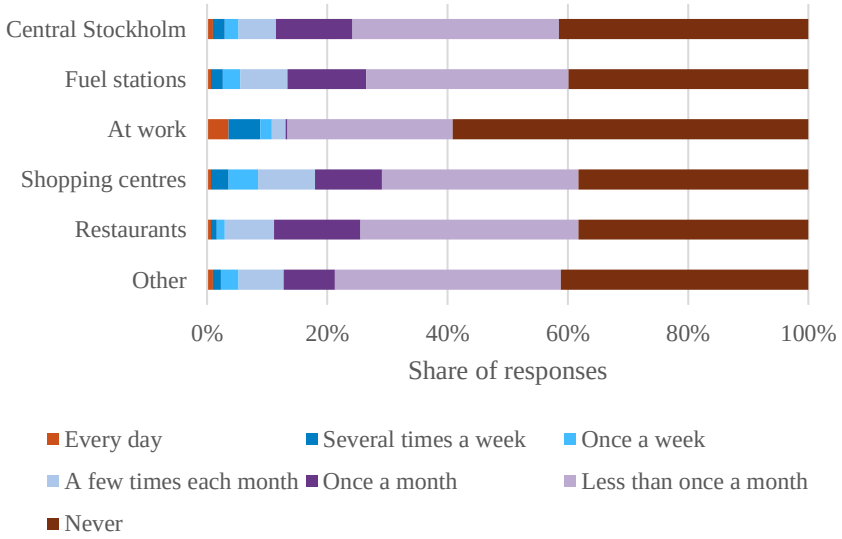


Figure 41. Share of responses (306) as to how often the respondents use fast charging for their vehicles, 2020.

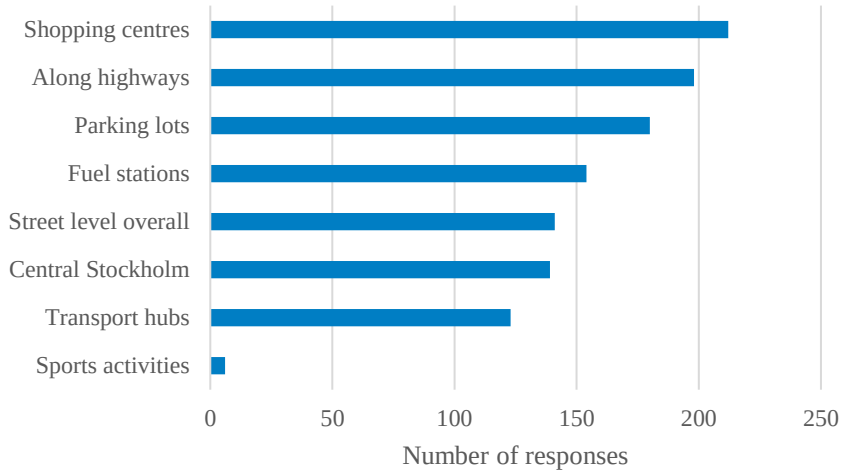


Figure 42. Where the respondents want more fast charging stations, 2020. Multiple choices were accepted from each respondent.

Instead, it is mainly normal charging that is used today, and especially at home, at work, at shopping centers or in general at street level according to Figure 43. 40 percent of the respondents charge their EVs with normal chargers at home every day, which probably not only refers to public normal charging but also home charging at individual parking spaces. Normal chargers are less frequently used along highways, sports activities, and other places. This correspond to what was observed in last year's survey.

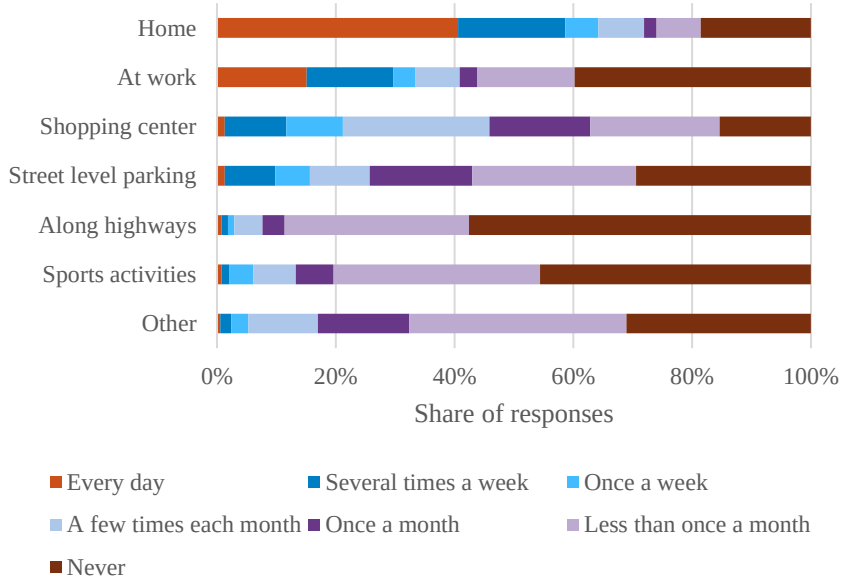


Figure 43. Share of responses (377) as to how often the respondents use normal charging for their vehicles, 2020.

Like the previously mentioned responses, Figure 44 illustrates that a clear majority relies on home charging for their electric vehicles, followed by public normal charging and public fast charging.

However, a non-negligible share of respondents use both public normal and fast charging for up to half of their charging sessions.

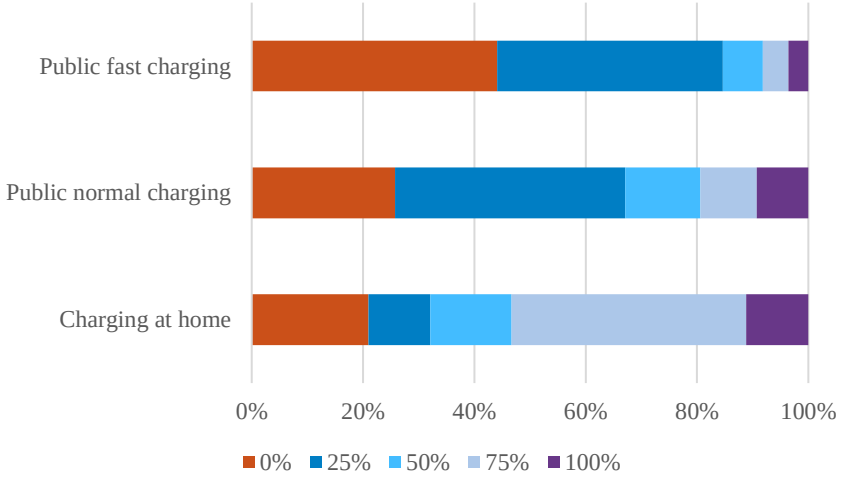


Figure 44. 306 respondents estimated share of charging infrastructure usage, 2020.

Opinions

The parameters that were stated as most important in connection with the respondents' purchase of their EV are mainly the environmental benefits that arise and that there is access to home charging, according to Figure 45. Access to public charging is considered very important by about 40 percent of the respondents. The economy and range of the vehicle are considered to be important by most respondents but very important to about 25 percent of the respondents. The parameters that most respondents rated as not important were smart features and a quiet car. Most responses were stated as "Very important" or "Important".

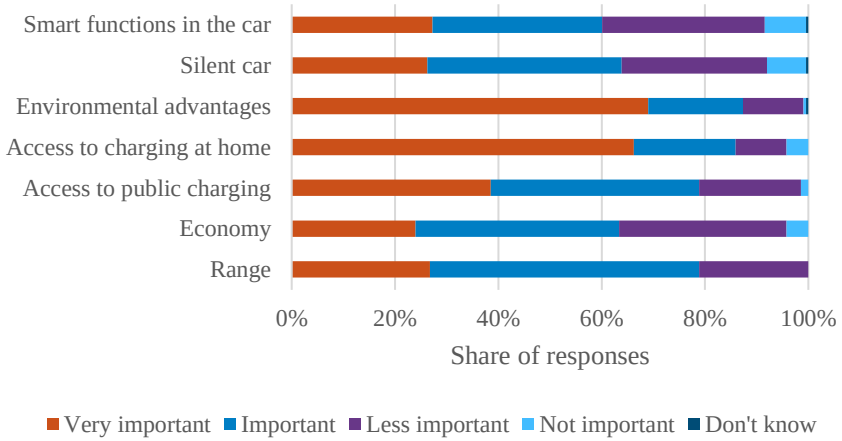


Figure 45. Respondents (213) opinion on what were deciding factors when purchasing their electric vehicle, 2020.

Range anxiety perception

Similar to the previous year, range anxiety is not perceived as a significant problem among the respondents in the survey, see Figure 46. It also seems to be a diminishing problem, as the share of respondents who feel that they never or more rarely than every month experience range anxiety has increased from about 57 percent in 2019 to 69 percent in 2020. The share of respondents who experience range anxiety several times a week or more frequently have decreased from 20 percent in 2019 to 14 percent in 2020.

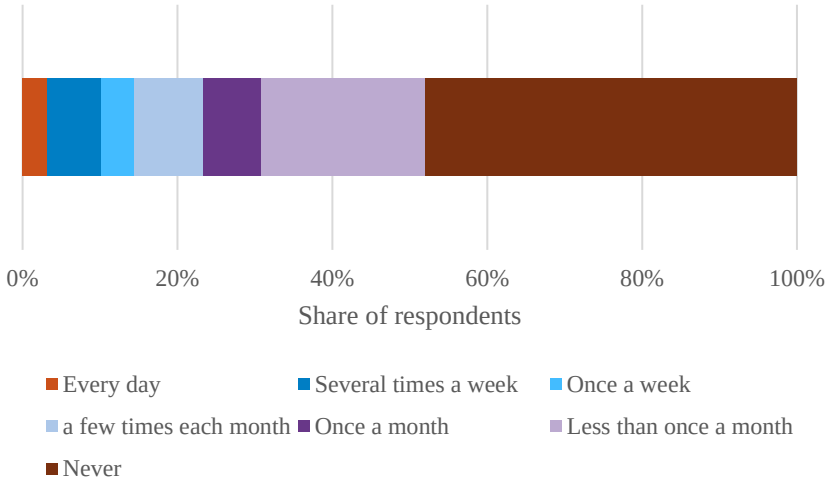


Figure 46. 377 respondents answer on how often they experience range anxiety, 2020.

Occupied chargers

A clear majority of respondents feel that the charging stations are sometimes or often occupied, as can be seen in Figure 47. Like last year, both on- and off-street normal chargers are considered more busy than on-street fast chargers, which can be explained by different time constraints during the day. The share of respondents who feel that it is sometimes or often full at the fast charging

stations has decreased to 57 percent from 61 percent last year and 48 percent in 2018.

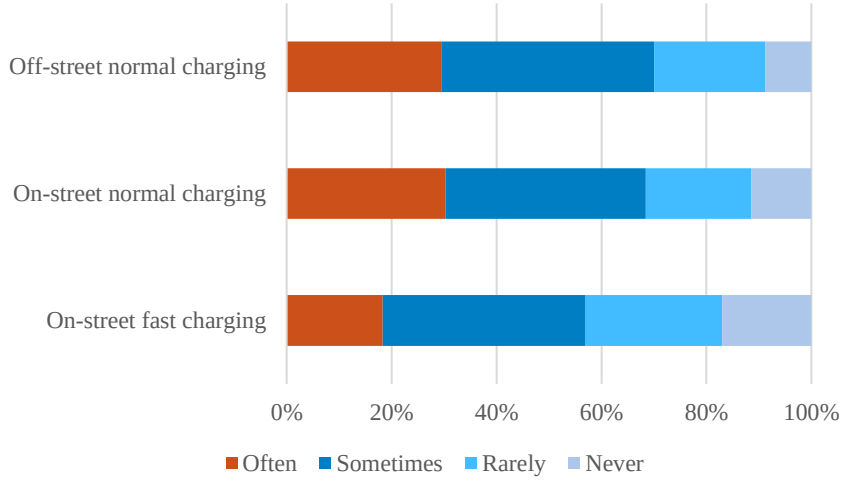


Figure 47. How often respondents (377) experience that the charging stations are occupied, 2020.

Perception of time limitations

In general, the experience of the established time constraints for on-street public charging infrastructure is positive. Among the respondents who utilize fast charging, 51 percent feel that the 30-minute time limit is sufficient, which can be compared with 45 percent last year. 48 percent think it should be longer, and one percent indicate that the time limit should be shorter, see Figure 48. The reason why respondents do not have time to fully charge their vehicle in 30 minutes is that the charging points often have inadequate installed power, as well as hot or cold weather conditions may increase the required charging time for a full charge.

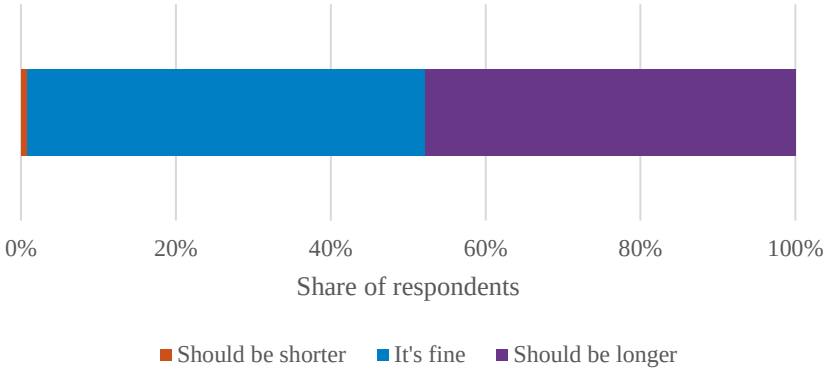


Figure 48. 255 respondent's opinion regarding the on-street fast charging time limitation, 2020.

For on-street normal charging, 37 percent think the time limit is sufficient, compared to 32 percent last year. Remaining respondents want an extension of time, see Figure 49.

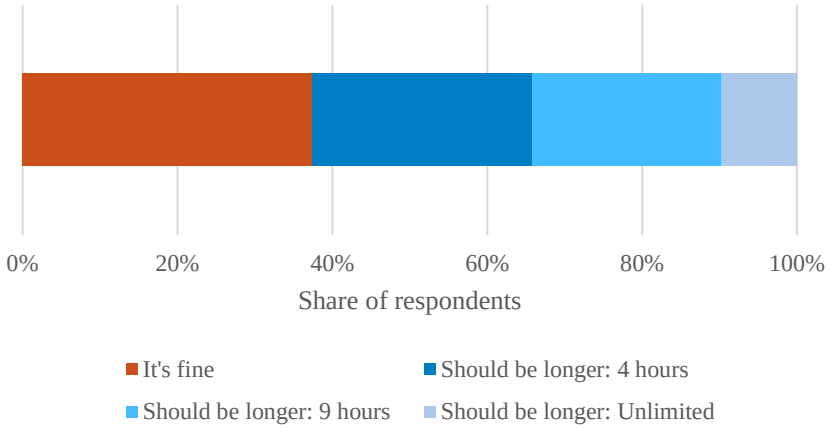


Figure 49. 348 respondent's opinion regarding the on-street normal charging time limitation, 2020.

Finding available charging points

Most respondents use an application in their smartphone to find an available charging point for their EV, see Figure 50. The corresponding answer was given by 60 percent of the respondents in the previous year's survey. Otherwise, the respondents find a vacancy when they see one while driving, via the car's built-in search function, web page on the computer or something else.

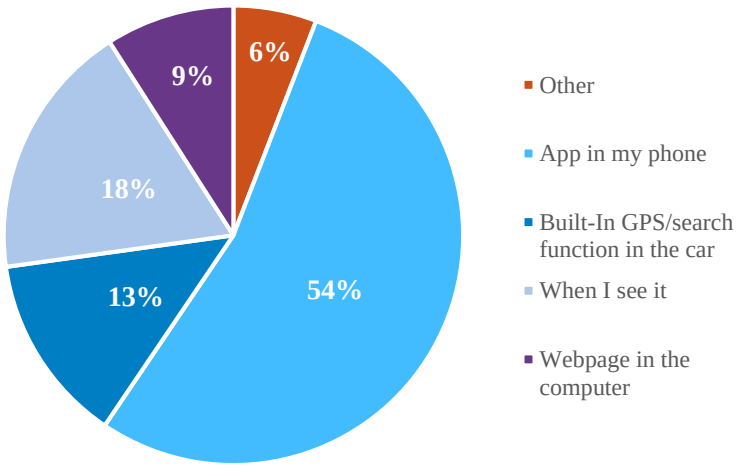


Figure 50. Share of 377 respondent's answers on how they primarily locate their charging points.

If the charging station they located beforehand is full, the respondents find it difficult to locate an alternative as can be seen in Figure 51.

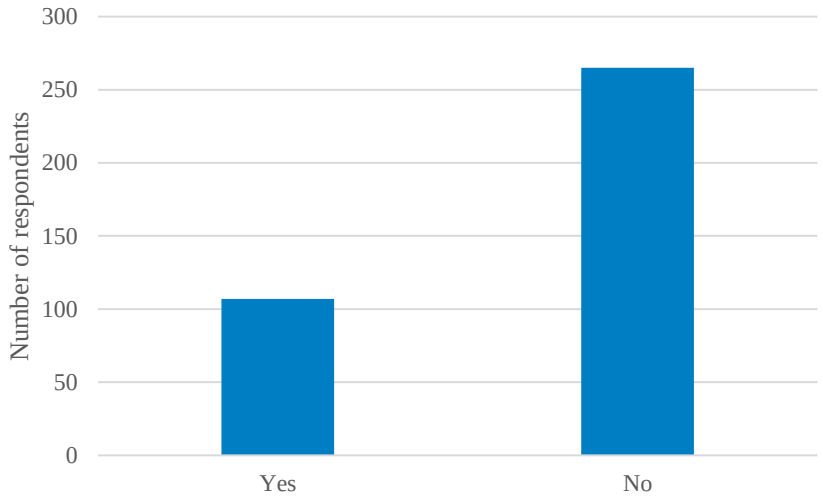


Figure 51. 376 responses on whether it is easy to find alternative public charging points if the initial one was occupied, 2020.

The function of the charging infrastructure, and suggestions for improvements

Overall, the respondents have a positive opinion of the charging infrastructure, while there is room for it to be improved as can be seen in Figure 52. It has also been expressed that the charging infrastructure does not always work well, where about 18 to 22 percent of the respondents think it works poorly or not at all. What the respondents think is not working well today and that needs improvement varies widely but has been sorted according to categories in Figure 53.

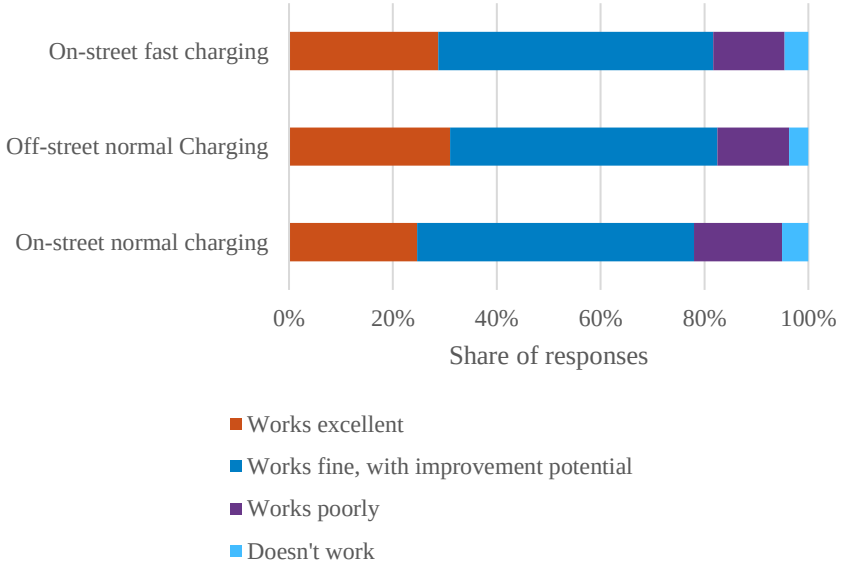


Figure 52. 377 respondent's opinion on the public charging infrastructure in Stockholm, 2020.

As in the previous year, the comments on the charging infrastructure mainly concern joint payment systems between the chargers, improved monitoring to ensure that only EVs in need of charging are connected to the charging infrastructure, more charging stations, etc. Below are a number of quotes from the survey[14]:

• *“You have to have a lot of payment apps, since all operators have different. Difficult!"*

• *"I would like to see better monitoring of charging stations, as non-EVs park there as well as EVs that violate the time limit."*

• *"Active monitoring/fining on charging stations important. It is still common with blocked chargers (which is not visible in apps because they only indicate if the charger is busy)."*

• *“The signs at the charging stations are confusing for the uninitiated (personally I learned, but it took a while). Also - thanks for the recently introduced 3 hour residential parking daytime, very much appreciated by me with a residential parking permit!”*

• *“Very positive that there are public charging stations along the street. Strong driving force for getting electric vehicles. "*

• *"You want to charge where you park, not park to charge, therefore the term"charging streets" with many charging places at one and the same place is always a worse alternative for the EV owner than having spread out the chargers on multiple streets."*

[14] These have been translated from Swedish.

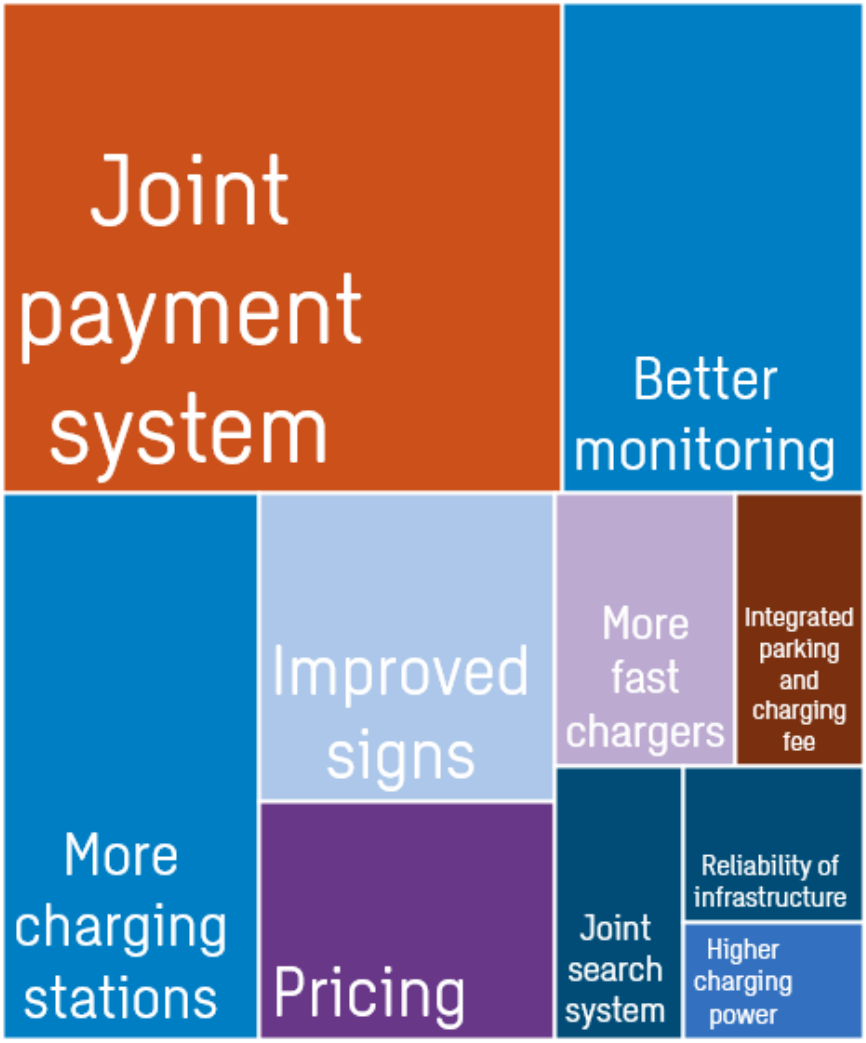


Figure 53. The respondents free text responses if there were anything they would like to add to their previous responses. The size of each colored box represents the number of respondents giving the comment.

In addition to the aggregated themes presented above, it has also been proposed that the municipality should regulate the price of charging, introduce a search engine combined with short-term reservation of vacant charging points, faster response times for operational disruptions, among others.

Discussion

Both the statistics analysis and the survey give a clear picture that access to both public and home charging is important for a large part of the users. Most people are satisfied with how the public charging infrastructure works in Stockholm; however, they also mention that there is potential for improvement. Some of the areas of improvement highlighted in this year's survey are recurring from previous years. These include challenges regarding signs and information provided at the charging stations, the need for a coordinated payment system between parking and charging infrastructure operators, and improved monitoring at existing charging stations.

Increased usage of the public charging infrastructure

The number of EVs in Stockholm continues to increase at a rapid rate, which leads to increased demand for charging stations and improved charging infrastructure. The number of charging stations has significantly increased, which seems to be in line with the development of EVs since the occupancy of the charging points is similar to the previous year. However, the occupancy has decreased by a few percent for both on- and off-street normal charging. This may be due to the amount of normal charging points significantly increased during the year, and that the charging points in Stockholm Parkering’s facilities reporting data are only part of the total number.

The continued relatively low average occupancy rate at the stations indicates, as in previous years, that it is not primarily the total number of charging points that need to increase, but rather that more chargers are needed at the correct location near the home, work, shopping centers and other destination activities.

As in the previous year, the usage pattern during the day indicates that the public charging infrastructure is mainly used for destination charging. An example of this is the at-work charging that occurs in off-street normal charging stations, which is confirmed in the survey. There is also a non-negligible share of respondents who state that they use on-street normal charging stations as home chargers (12 percent of respondents), which is confirmed in the statistics.

Furthermore, the respondents mainly want more charging stations at commercial locations. More charging stations are also in demand in central Stockholm, but not as frequently as other alternatives. A

large share of the public on-street charging is centrally located, relative to other districts.

Previous years' surveys have indicated that the installed charging power should be higher, while the current survey shows that fast charging is used less frequently than on-street normal charging. However, the statistics indicate that the fast charging stations generally have more charging sessions and higher energy transfer per charging point compared to the other types of charging.

More generous time limitations are requested

According to the statistical data, about 44 percent of those who use on-street fast charging and 31 percent of those who use on-street normal charging exceed the established daytime time constraints. Just as the previous year (41 percent and 38 percent, respectively), this is a non-negligible share, which is also noted in the survey.

A clear majority of about 63 percent (70 percent in 2019) of the respondents believe that the time limit for on-street normal charging should allow for longer charging times. This is likely due to the difficulty of moving the car after three hours if, for example, when one is charging while working. In addition to that, the time limit may be too short for being able to fully charge the vehicle. Given that the survey indicates that range anxiety is diminishing among respondents, it is more likely that the car owners are primarily driven by the need for finding parking spaces and not a need to recharge their batteries. As one respondent puts it: "*You want to charge where you park, not park to charge*". This is a challenging problem to face, as ambitions for fewer vehicles in the city center don't go hand in hand with providing more parking spaces for EVs.

Parking violations and fully charged EVs continue to be an issue

A continuing frustration for the EV owners is that other types of vehicles as well as fully charged EVs occupy the charging stations, which limits the availability to EVs that need to charge. Non-EVs are violating the parking rules for the on-street charging stations and can therefore be fined. An increased parking guard presence can remedy the problem to some extent. However, EVs parked at the charging station which are fully charged or not connected but still within the established time limit have every right to park there. The alternative is to make more charging places available in order to remedy the issue.

Some of Stockholm Parkering's facilities do not distinguish between EVs and non-EVs, as the organization's strategy is more closely

linked to relieving the street network by providing attractive parking spaces with high utilization rates. Therefore, they sometimes allow non-EVs to park at their charging stations as well.

The share of respondents who feel that it is sometimes or often full at the on-street fast charging stations (57 percent in 2020) has decreased with about 4 percent (61 percent in 2019), which is still higher than that what was indicated in the survey in 2018 (48 percent).

When encountering a charging station that is full, most respondents find it difficult to find an alternative. Even though most people use an application on their smartphone, use the car's GPS or drive around and look for a parking space, frustration arises when not being able to park at a desired location. Thus, there may be a need for improved integration between the users' applications and the charging infrastructure operators' systems for monitoring which charging points are occupied or not. This could allow for easier planning for the EV owners looking for a charging station without wanting to drive around searching for a station. A number of respondents have suggested that it should also be possible to reserve the charging point for a short period (about 10 minutes) in order to avoid this problem. This could however lead to other issues, such as conflicts regarding EV owners reserving a space without actually using it.

Conclusions and recommendations

The number of EVs in Stockholm has increased by 35 percent from 2018 to 2019, and in line with this the use of the public charging infrastructure has increased as well. The total number of charging sessions analyzed and presented in this report increased by about 46 percent from 2018 to 2019, and the number of charging points where data was collected for this report increased by 79 percent over the same time period. Stockholm Parkering is still the operator that offers the most public charging stations and has the most recorded charging sessions among surveyed operators in public charging infrastructure in Stockholm.

As with the previous year, most of the charging sessions take place during weekdays, where a majority of users comply with the time limits that apply to both on-street fast and normal charging (30 minutes and 3 hours daytime, respectively). The public charging infrastructure is mainly used for destination charging, where a large share of the on-street normal charging takes place at night. Off-street normal charging continues to be important for those who charge while they are at work.

The rapidly increasing numbers of EVs, charging points and charging sessions conducted in Stockholm affect the usage patterns of the public charging infrastructure surveyed. The occupancy has increased for the on-street fast charging stations, while at the same time it has decreased for both on- and off-street normal charging.

The popularity of charging stations is probably not mainly dependent on their geographical location in relation to the center, as parking facilities both in and outside central Stockholm have a high average number of charging sessions per day. Instead, it is likely to be more closely linked to surrounding destinations, such as the home, work, shopping venues or other activities.

The on-street fast charging stations have the highest number of charging sessions per day, due to established time constraints. Both the fast charging stations and the off-street normal charging stations have a significant amount of energy transfer per charging point and day, probably due to the high charging power and the lack of time constraints.

377 people responded to the survey whose results is presented in this report. Among the respondents, a clear majority were men over 46 years of age. Most of the respondents own a PHEV, and the vehicle is used both privately and at work. Like the previous year,

the majority of the respondents drive the car as a company car or have bought it themselves, but a significant share also leases their car. A majority of the respondents have had their EV for less than three years, where many BEV owners bought the car less than a year ago. This is a possible indication of the rapid development that the electric vehicle market is currently undergoing. The most important parameters that were taken into account when the respondents' purchased their vehicle were the environmental benefits as well as access to home and public charging.

A clear majority of respondents feel that the charging stations are sometimes or often occupied, as in previous years' surveys. The frustration surrounding parking offences or fully charged EVs occupying the charging stations continues to be mentioned frequently among the respondents. Incorrectly parked vehicles can be fined, but the EVs that park at a charging station without charging and are within set time limits are legally entitled to park there and cannot be forced to move.

When a charging station is full, respondents find it difficult to find alternatives. There are requests for improved systems regarding this, in order to more easily find a new place to park and charge.

Despite the aforementioned room for improvement, both the survey and the statistics express how important the public charging infrastructure is to the users. Respondents are also generally satisfied with how the public charging infrastructure works.

Based on the results of the report, the City of Stockholm is recommended to

- Continuously improve the control of the on-street charging stations, to ensure that those parked on the charging stations are electric vehicles.
- Improve signs and information associated with the charging infrastructure to clarify its function and avoid misunderstandings.
- Support the parking- and charging infrastructure owners in finding appropriate conditions to coordinate the payment system between them, so that it becomes a uniform system towards consumers. Also inform in cases where this type of solution already exists.

The charging infrastructure operators are recommended to

- Find the appropriate conditions for coordinating the payment system between them and the parking owners, so that a uniform system towards consumers is established.

Also inform in cases where this type of solution already exists.
- Increase the number of on-street charging stations in connection with activities/destinations, such as shopping centres.
- Enable information on available/occupied charging points for the consumers, to facilitate locating available charging points.

Suggestions for improvements of the report

The purpose of this report is to find out how public charging stations are used in Stockholm, in order to gain knowledge that can be useful in the continued expansion of charging infrastructure. Therefore, it is interesting to continuously reflect on how the report can be improved.

An outlook that relates to the work in the City of Stockholm with other similar initiatives, both nationally and internationally, could contribute to an improved development of the charging infrastructure. It could consist of literature studies, but also dialogue with other municipalities with similar conditions as Stockholm.

Like last year, it would have been interesting to supplement aggregated information with interviews of the major charging infrastructure operators to see what trends they are seeing, and to know what conclusions they have drawn in their work.

One possible next step that is not within the scope of this report is to try to clarify what can be done by whom when it comes to the requests for improvements in the charging infrastructure. Many of the suggestions received are not related to the City of Stockholm or the charging infrastructure operators but should rather be discussed together with the parking companies, the Swedish Association of Local Authorities and Regions (SALAR, or SKR in Swedish) or other relevant authorities.

Data management has improved from the last report, where individual charging points have been identified in order to improve the analysis of the stations' occupancy among other things. The request for more information from the charging sessions was raised with the charging infrastructure operators, who unfortunately could not share more due to technical constraints.