fleetcarma
a division of GEOTAB

Enable clean, reliable and affordable power for all homes by integrating electric vehicles with the grid.

Charge the North

Results from the world's largest electric vehicle charging study.

12.4 million miles of driving data
4,721 MWh of EV charging load
727,000 EV charging events
1,000 EV owners and drivers
25 EV makes and models
10 utility companies
2 years

Answers to the most pressing questions utility companies have related to the impact of electric vehicle charging on the grid.

Charge the North
Results from the world's largest electric vehicle charging study.

On June 14th, 2017 a groundbreaking research project was launched to address the impact of electric vehicles in Canada. The Charge the North project, which was developed with support from Natural Resources Canada's Energy Innovation Program, set out to better understand how electric vehicles are being charged and driven as well as the related effects on the existing electrical infrastructure. It also tackled a number of other questions asked by utility companies regarding home versus workplace or public charging, the impact of time-of-use (TOU) rates on peak load, and the effects of seasonal climate, geography and commute distance on charging behaviour. With the cooperation of 10 utility companies and the University of Waterloo, FleetCarma reached out to EV drivers across the country and sent out 1,000 of their C2 devices, technology which gathers data through the OBD II port. With these devices FleetCarma could track driving distance, charging location, energy consumption, battery efficiencies, demand associated to cabin climate control, and weather conditions, including temperature. Totaling 1,000 electric vehicles, consisting of a mix of Plug-in Hybrid EVs (PHEV), Short Range Battery EVs (SR BEVs), and Long Range Battery EVs (LR BEVs), this became the largest EV profiling study ever conducted.

Charge the North represents:

- 12.4 million miles of driving data
- 4,721 MWh of EV charging load
- 727,000 EV charging events
- 1,000 EV drivers and vehicles
- 25 EV makes and models
- 10 utility companies
- 2 years
- One of the most comprehensive studies on EV charging load ever conducted.

This report represents a summary of Charge the North, a study conducted by FleetCarma, a division of Geotab with support from Natural Resource Canada.

For more information, high resolution charts or access to the full report please contact FleetCarma.

Electric Vehicles will pose challenges for managing the distribution grid

One of the main focuses of this study was to assess if EVs will present a risk to the grid and the results showed that they will, at the distribution level. At the generation and transmission levels of the grid the load is aggregated across many EVs, which results in a smooth profile with low coincident peaks.

So while there is value for shifting load at these levels, such as having the demand align with over-generation, the data suggests that EV charging load is unlikely to negatively impact generation or transmission assets. The risks that utilities need to prepare for are at the distribution level. EV clustering is a trend that shows that EV owners are not distributed evenly across a territory, which creates areas where there is a higher concentration of vehicles. This clustering is what poses the greatest threat for utilities as it was proven that EVs have the potential to overload residential transformers on their own without adding any additional household demand *(fig. 1)*. During the study annual load curves were created for three groups of EVs that included a different mix of vehicles types based on battery capacities. The load on a local transformer is the sum of a limited number of vehicles so the curves are much more volatile with notably higher peaks.

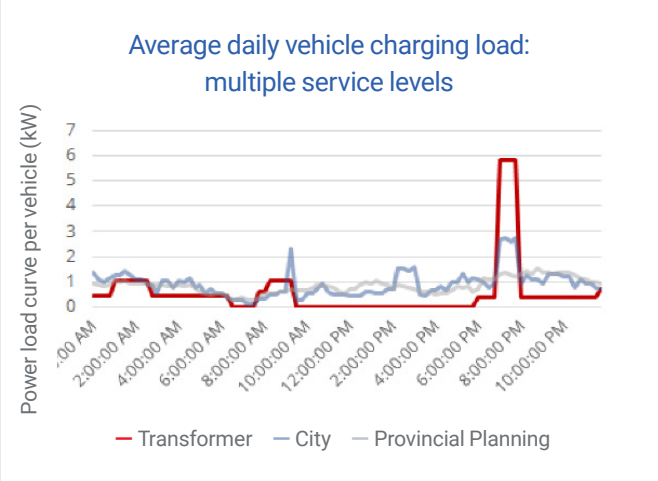


fig. 1

On one of the days the long-range BEV group created a daily peak of over 72 kW, which could easily damage a residential transformer on its own. With EVs tendency to cluster in specific neighbourhoods, more workplaces beginning to offer charging to employees, and public charging stations becoming more common in places like retail outlets, universities or hospitals, it would not be uncommon that you could have 5 vehicles charging on the same transformer. *(fig. 2)*

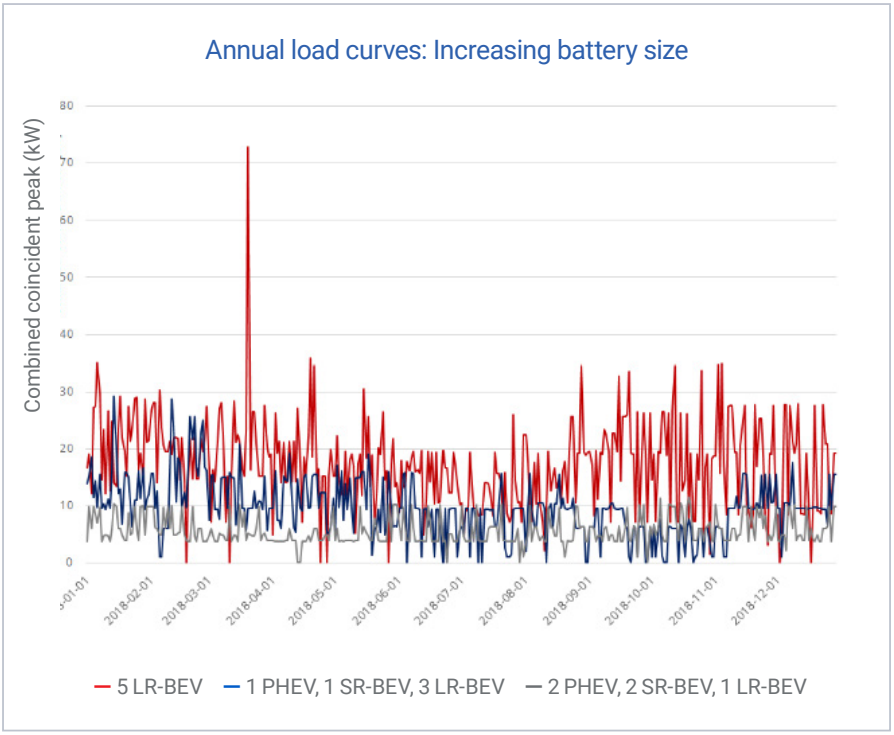
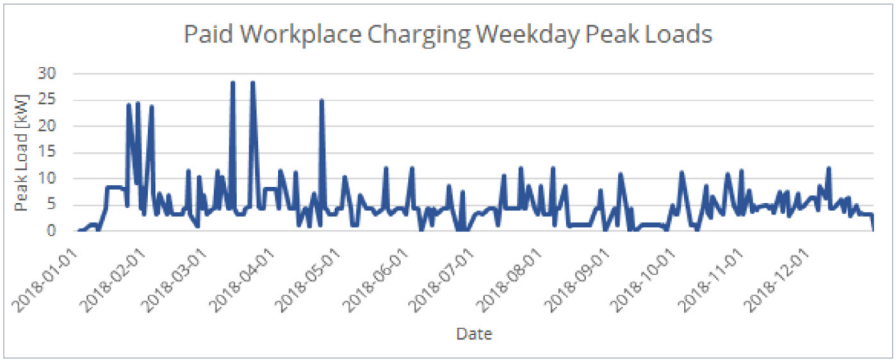


fig. 2

Where vehicles are charging and the impact of free workplace charging

It is critical for utility companies to understand where EV drivers in their territory are charging. Home-based charging is more likely to coincide with regular residential peak periods, but it can be shifted unlike workplace or opportunity charging. The majority of EV charging still occurs at the driver's home, however during Charge the North it was found that the percentage had decreased from 90% to 72% over the last few years. A large portion of this drop can be attributed to an increase in the availability of workplace charging. More companies are offering workplace charging and during the study it was discovered that 80% of all workplace charging was free. When surveyed the majority of the responding participants stated that they do not currently charge at work, but would if there was no cost to them. When comparing the load curves groups of EVs who utilized paid and free workplace charging there were some similarities, such as both types of charging had similar clustering peak times at 9am and 1pm, which would align with the start of the workday and shortly after a lunch break. There were more differences however when you compare the peak demand and usage throughout the year.



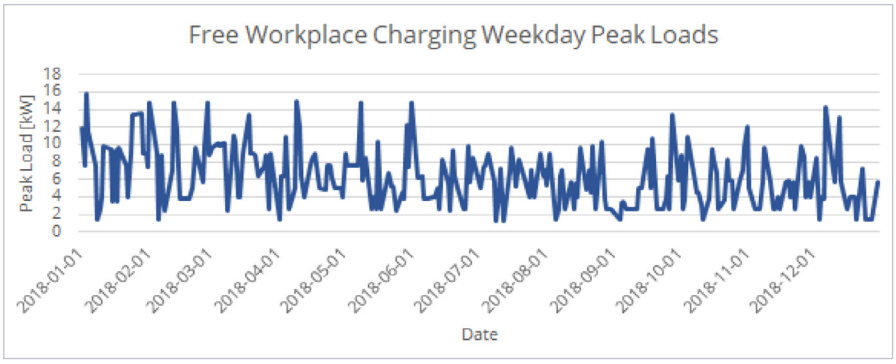
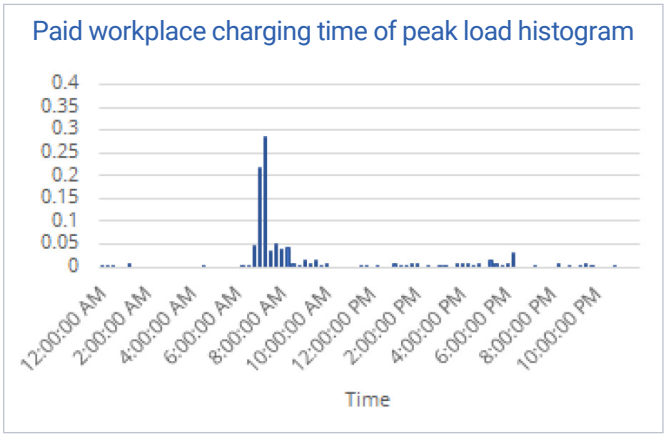


fig. 3

Locations with free charging had charging events every day, which resulted in slightly higher overall load. In comparison, there were days when no charging occurred at the paid locations, but they had higher peak demands, specifically during the winter months. This would indicate that driver's who would not normally pay for workplace charging were concerned about reduced battery performance when the weather was colder. The difference in charging based on temperature was another clear finding in the study as it was proven that climate, along with geography, and commuting distance, significantly changed EV charging patterns.



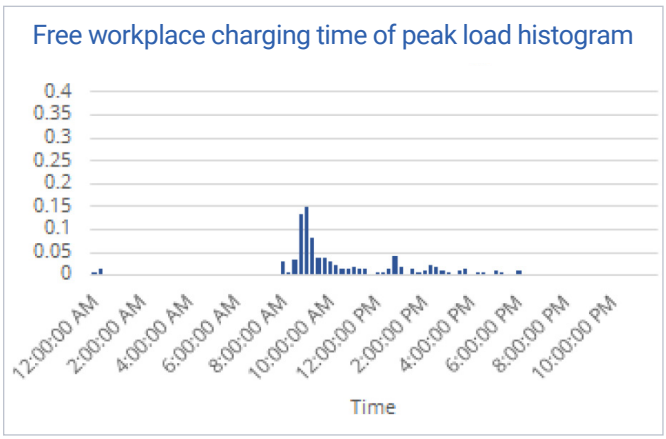


fig. 4

The effects of seasonal climate, geography and commute distance on charging behaviour

Cold temperatures directly affect the battery performance of electric vehicles as energy needs to be used to protect the battery as well as keep the cabin of the car comfortable for the driver. It was no surprise when there was a higher energy consumption during the Canadian winter months, when the average monthly temperatures can be lower than -11°C (12°F), even though there was less daily driving. What is interesting was that this higher consumption did not correlate with the maximum peak coincident load. The months with the highest peaks lined up with the months which had the highest driving distances.

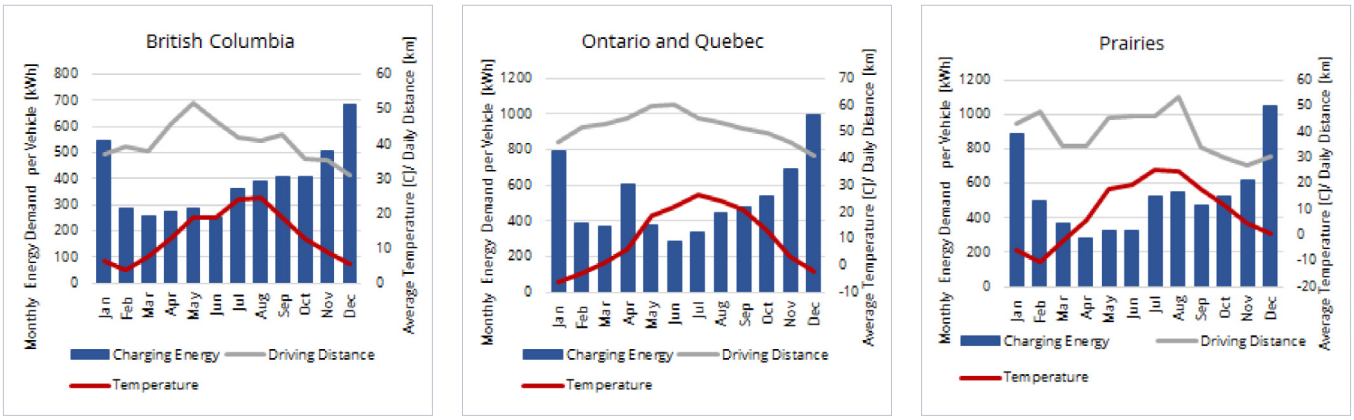


fig. 5

Another consideration is that the shape of EV charging load greatly differed when comparing rural, urban and suburban territories. Two of the factors that influence the change in this demand are based on commuter habits, and the amount of EV clustering. Drivers in a suburban territory drove on average 80% farther daily than their urban counterparts, which meant they would charge more, and localized sales data also showed that they are the most susceptible to EV clustering. When all of these factors are combined it leads to more volatile load curves with substantially higher peaks. As climate, geography and commuter habits are going to unique for every area it is imperative that utilities properly profile their own service territory.

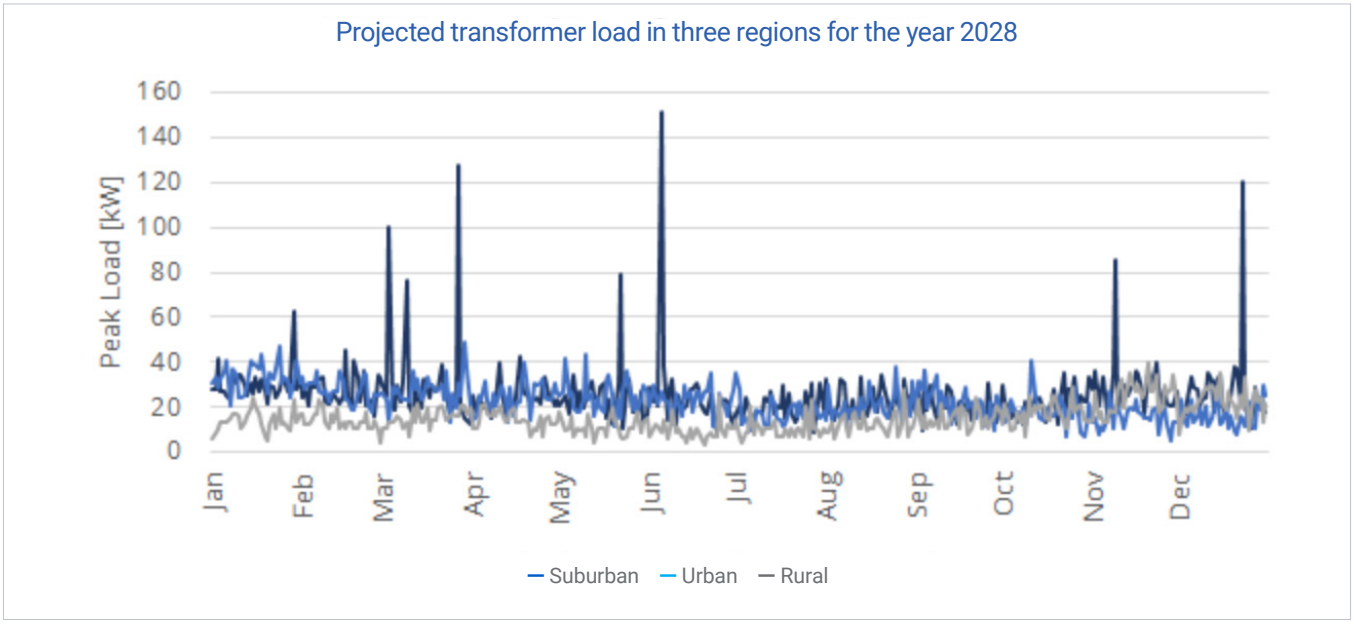
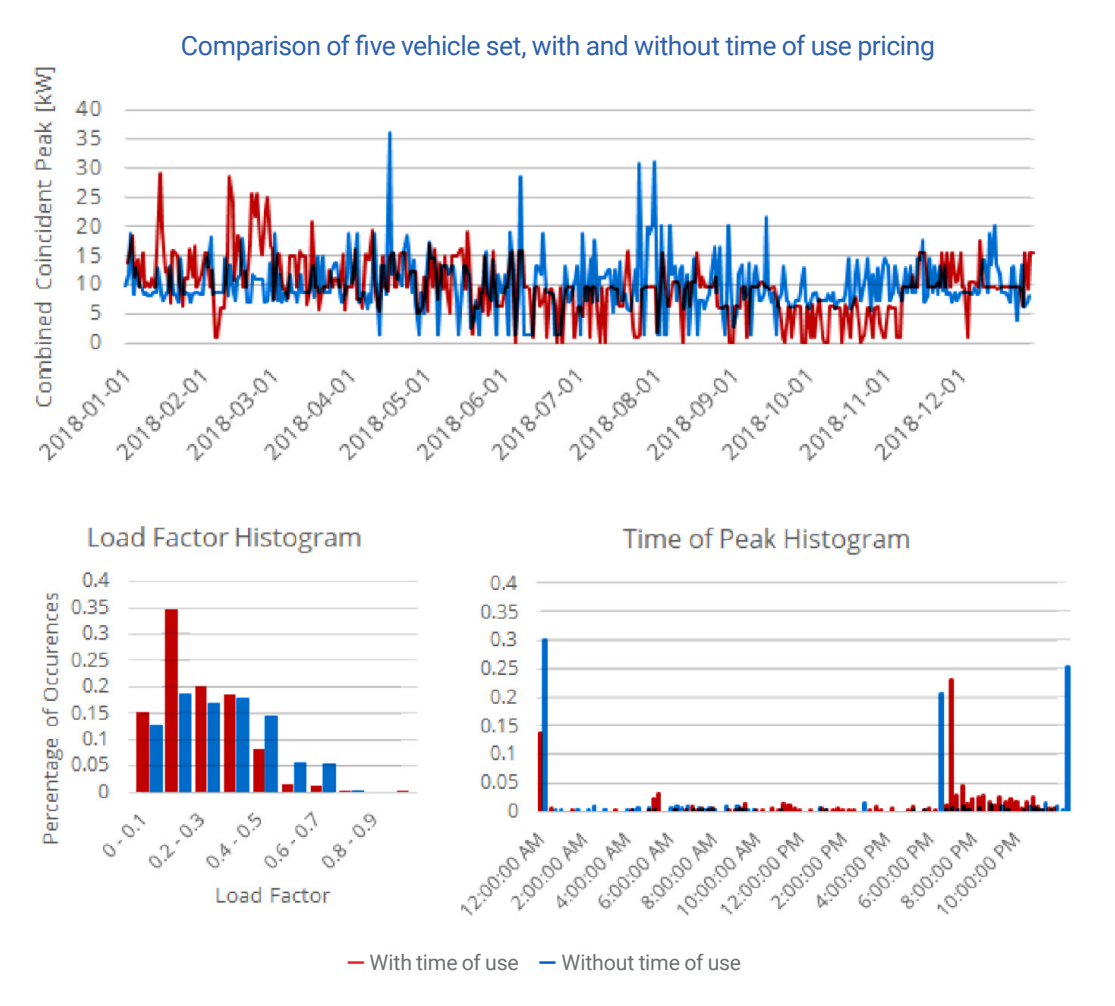


fig. 6

The impact of time-of-use (TOU) rates on peak load

Time-of-use rates are one of the most common ways to manage load, however Charge the North proved that it may not be as effective, or at least as simple, when applied to EV load. A comparison was created for groups of five EVs charging in two suburban areas, one of which utilized TOU pricing with an off-peak rate between 7pm and 7am. Although the magnitude of the daily peak loads was consistent for both regions, with most days under 20 kW, the rates did make a difference in when these peaks occurred. The group with no TOU rate had peak loads around 6pm and midnight, whereas the group that used TOU pricing had peaks at 7:30pm and midnight. The price signal did shift the load, however it shifted it to immediately after the peak pricing ends. This means the EV load would coincide with other shifted household load, creating an unintentional secondary peak. So while time-of-use rates are effective at shifting the load, a separate EV-specific rate would need to be used for it to work properly. This is not a desirable approach as it would require sub-meters, which are expensive and whose installation is intrusive for customers. Alternatively, some utility companies are using a behavioural load shifting program like SmartCharge Rewards to manage the EV load in their territory, while also creating a platform to communicate with their customers in a positive manner.



Vehicle-side data is critical for infrastructure readiness

Almost all of the questions that the utility companies wanted to be addressed in this study could not have been answered without vehicle-side data. Seemingly simple questions like “Where are vehicles charging?” can only be accurately answered when all charging events are captured regardless of location, charging level and if the infrastructure is networked or not. Other more in depth questions, such as “How does charging behaviour differ between vehicle-type and between rural/urban owners?” and “What are the seasonal impacts on charging?” can only be answered with vehicle-side data as EV charging infrastructure does not gather any information related to vehicle utilization or efficiency. Finally, a study that covered this large of a geographical area, while incorporating such a large number of EVs of different EV makes and models, would have been next to impossible to coordinate and execute without a vehicle-side solution.

Conclusion

Charge the North is one of the most important case studies related to electric vehicles that has ever been conducted. There has never been a project of this size related to EV charging load and the data collected will help everyone better understand the EV ecosystem. It not only answered some of the most common questions from utility providers, but it also created one of the largest real-world EV datasets in the world. It has proven that EVs will have a large impact on the grid and that we will be seeing the effects in the very near future. Although this data provides a lot of information and insight it is important that utilities conduct their own profiling studies to ensure they are prepared for their territory’s unique situation. Only after they have an accurate profile of their territory can they properly manage their EV charging load and fully integrate electric vehicles with the grid.

Request the full Charge the North report

If you would like to receive a copy of the full Charge the North report or to discuss findings from this study, please contact us via the contact information below.

Start managing EV charging across your service territory

SmartCharge Platform provides a complete understanding of the impact of EV charging load and the ability to shift charging off peak demand. We do this in three ways:

SmartCharge Profile provides accurate, real-time load profiling of all electric vehicles across your service territory. As no two utility territories are alike, knowing when and where electric vehicles charge is key to effective planning. As more EVs connect to the grid, real-time data will inform demand management strategies. This is the first step toward managing electric vehicle charging load.

SmartCharge Rewards is a behavioral load shifting and customer engagement platform for EV drivers that rewards good charging habits. This mitigates the negative impacts of charging load to your network and encourages the adoption of clean transportation. Customers love earning rewards and saving from charging when energy is less expensive.

SmartCharge Manager is a direct load control solution for managing electric vehicle charging load across your service territory. With this, EV charging load is curtailable via demand signals while monitoring how much charge each vehicle's battery has. It is the only EV direct load control solution that can guarantee EV drivers will have enough charge for their next trip.

Ready to get started?

We've created solutions that fit every business and scales with your needs. Contact FleetCarma to begin managing the EV charging load in your service territory and properly integrate electric vehicles with the grid.

About the SmartCharge Platform team

We care about the environment and we love electric cars. This is what drives us to make driving clean and easy for everyone. We do this by designing the best solutions for electric utilities to understand and manage electric vehicle charging. We create better experiences for drivers to encourage cost-effective, greener and smarter charging. Together we'll make it possible to drive and charge clean in a way that makes everyone smile.

Contact us

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