March 23, 2023

IESO GRID INNOVATION FUND PROJECT: SMARTMAP EV & DER VISIBILITY

PREPARED FOR THE INDEPENDENT ELECTRICITY SYSTEM OPERATOR

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Disclaimer: This project is supported by the financial contribution of the Independent Electricity System Operator (IESO), through its Grid Innovation Fund. However, the views, opinions and learnings expressed in this report are solely those of Essex Powerlines Corporation

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Overview

The purpose of this project was to leverage the existing SmartMAP application to create a new module enabling the visibility of EVs and DERs. This tool will provide utilities, market operators, and third parties with detailed data that will ultimately allow for better planning, operation, and integration of distributed energy resources.

This final phase of the project included:

- Lessons learned
- Final testing
- Stakeholder Feedback

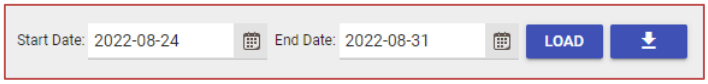
Section 1.0 - Lessons Learned

In the previous testing phase, it was found that even after fine-tuning the algorithm settings there were still many load profiles to review every day. Many false positives (i.e., pumping stations) were continuously surfaced and the lists were so long it was difficult to remember the profiles you had already reviewed. Additionally, we needed a page to track and manage the confirmed EV chargers to ensure that an EV charger has not been removed. Based on these lessons learned, additional development was completed to increase efficiencies and improve the overall user experience.

1.1 Proposed EV List

This page included a single date-picker that would surface all the suspected EV Chargers for the date selected. These lists were long and included many false positives and required significant time to review daily.

1.1.1 Date Picker



Adding a date picker now allows the user to enter a range of dates rather than a single day. This will allow the user to look at up to a month worth of proposed EVs at a time. Meters are grouped so that if they were surfaced more than once during that range they will still only show up in this list once. This greatly reduces the size of the list to review.

1.1.2 Times Surfaced

Times surfaced is a new column that identifies the number of times a meter was surfaced in the date range the user selected (see Date Picker). The list of proposed EVs is also sorted so that the meters that were surfaced the most times in the given date range appear at the top. This will allow the user to let the algorithm run uninterrupted for a length of time and then only review meters that were surfaced a certain number of times. For example, when looking at a month of proposed EVs it might not be worth reviewing the profiles of meters that were only surfaced once.

Figure 1 - A list of proposed EV's for an entire month sorted by the number of times the meter was surface.

1.1.3 Table Paging

Long lists made it easy to forget what profiles you had already reviewed. Table paging was implemented to make large lists easier to manage. The default page size is ten rows but can easily be changed by the user to 25, 50 or 100 rows.

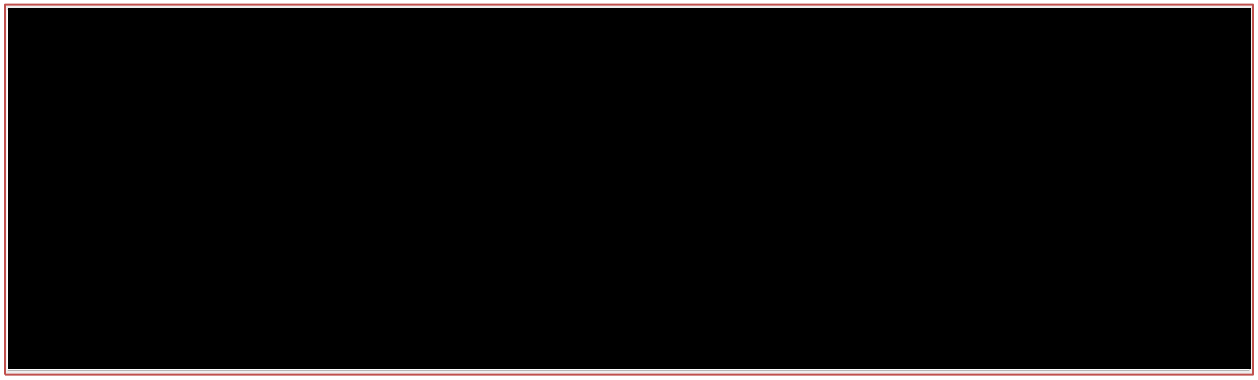


Figure 2 - Page size can be changed by the user using the dropdown. Also, the bottom right corner indicates the total number of rows in the table.

1.2 Exceptions

As previously mentioned, many false positives like pumping stations were continuously surfaced.

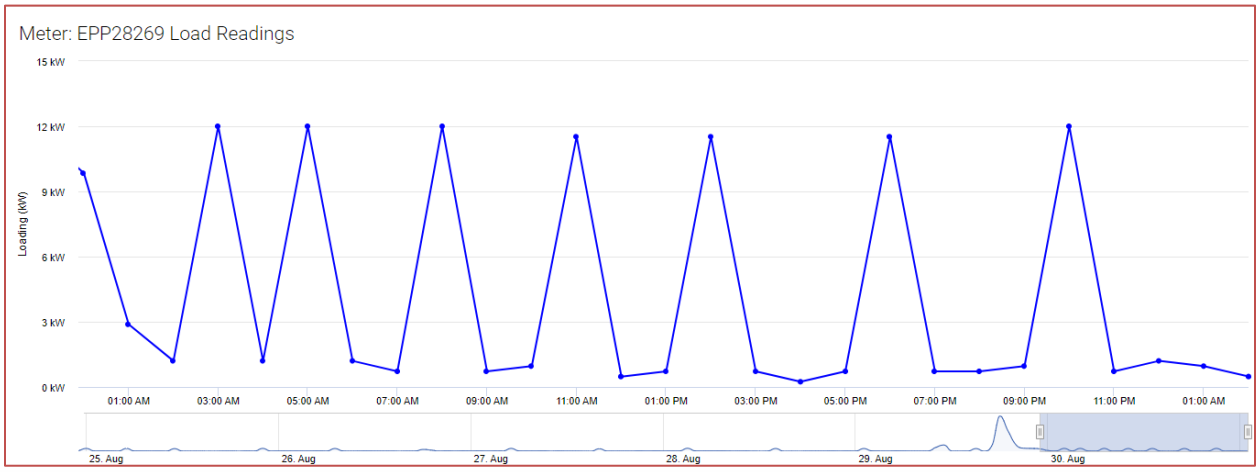


Figure 3 - An example of a pumping station where the increase in load closely resembles a level-2 EV Charger.

The ability to add a meter as an exception to the algorithm will prevent that meter from appearing on the 'Proposed EV' list reducing the clutter on the page. Additionally, a new page was added to review and manage all meters that have been added as an exception.

Figure 4 – A list of meters added as exceptions (mostly pumping stations and utility closets).

The user can remove meters from the exception list and that meter(s) will then be reconsidered the next time the algorithm is executed.

1.3 Confirmed EV List

This page was added to track and manage the confirmed EV chargers and to surface chargers that have possibly been removed or are no longer in use. There are no date pickers on this page as it surfaces all meters that have been flagged as an EV charger.

1.3.1 Last Detected

The 'Last Detected' column includes the date when the specific meter was last detected by any active EV Configuration. 'Days Since Last Detected' is automatically calculated based on 'Last Detected' and the current date and the column can be sorted or filtered as desired.

Figure 5 -In the above example, the meters with a blank 'Last Detected' were meters that were flagged as EV's before this feature was added.

Meters in this list with a high 'Days Since Last Detected' might indicate that a charger has been removed or is no longer in use and these examples should be reviewed by the user. Clicking on any row in this list will provide the user with a dialog where they can remove the EV flag for that specific meter if necessary.

Figure 6 – Clicking on any of the rows in the 'Confirmed EV List' will give the option to remove the EV flag from that meter.

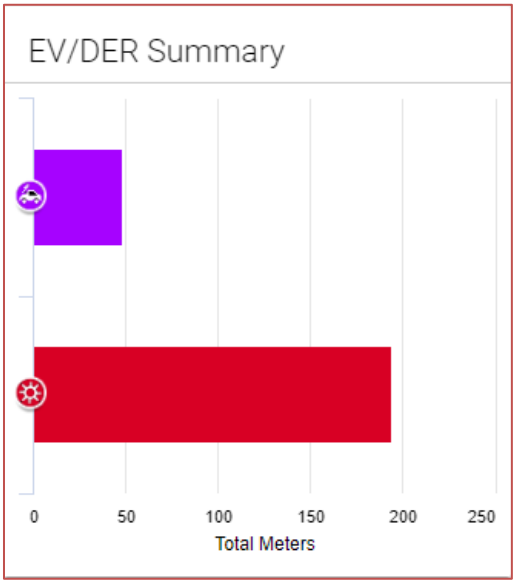
1.3.2 Table Paging

Like the Proposed EV List page, table paging was implemented to make large lists easier to manage. The default page size is ten rows but can easily be changed by the user to 25, 50 or 100 rows.

Figure 7 - Page size can be changed by the user using the dropdown. Also, the bottom right corner indicates the total number of rows in the table.

1.4 Dashboard Tile

A new tile was added to the SmartMAP dashboard to give users a high-level view of all the currently flagged EVs and DERs in their system. Hovering over any of the bars in the chart will display a tooltip showing the exact count for that specific flag type.



The ability to manually flag a meter as a DER (wind, solar or battery) was also added and will provide valuable insight when comparing aggregated load types at the feeder level. Unfortunately, Essex Powerlines does not have any battery or wind generation within their service territory, but they do have many examples of solar that range from private 5-10 kW systems all the way up to 300 kW large rooftop and ground-mount systems.

A long list of solar meters was surfaced from the connection requests stored in EPL's 'Work Request' application. These meters were all validated individually (in SmartMAP) to ensure that the accounts were still active and that the assets were still generating. They

were then manually flagged in SmartMAP so that they will be identified in the aggregate solar load on the feeder page and highlighted on the Map Page.

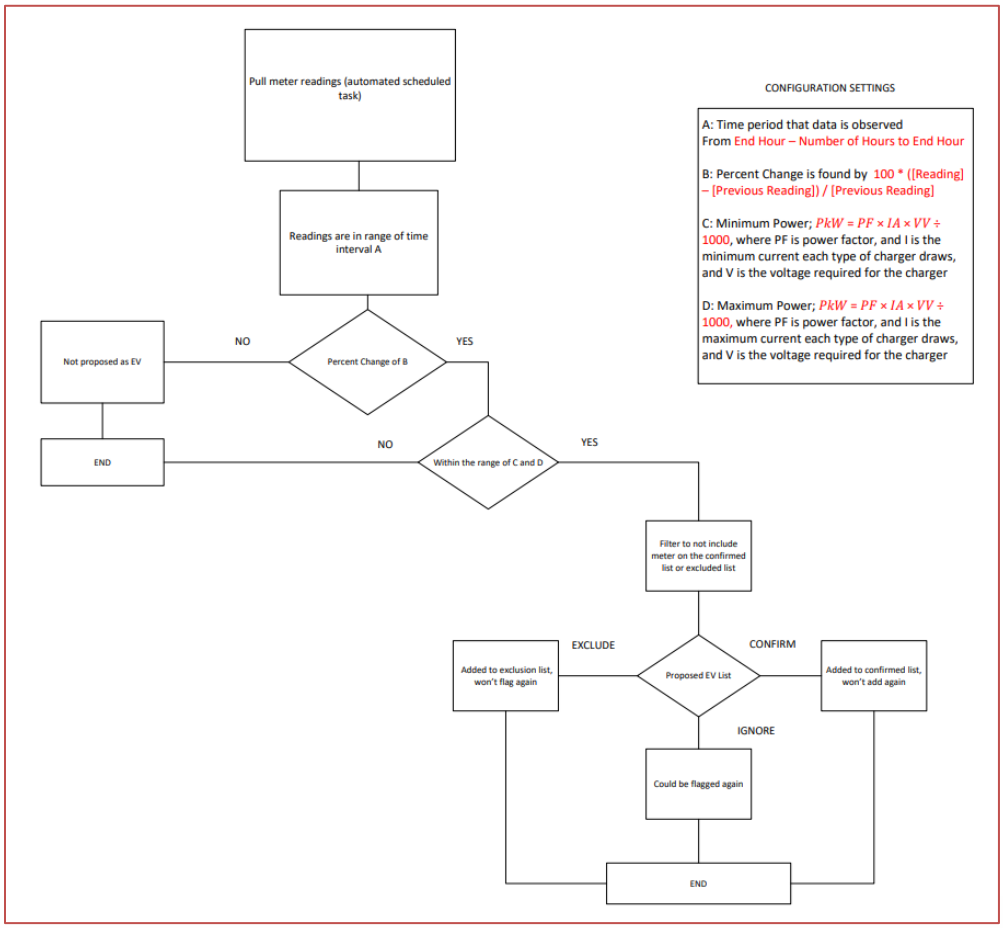
1.5 Conclusion

The additional features streamlined the profile review process significantly. Once a meter is confirmed or excluded it no-longer appears in the Proposed EV List which makes future lists more focused. We can see evidence of this in our August 2022 summary as there were only two meters that needed to be added as exceptions (compared to eight and twelve in the previous months). The most significant improvement from previous testing is the ability to allow the algorithm to run for an entire month before reviewing and only looking at the meters that were surfaced multiple times. That process, combined with regular cleanup of the proposed list (confirming meters and adding exceptions), reduces the amount of effort and resources required to manage the EV module in SmartMAP. Basically, what started as a one-two hour per day process is now a one-two hour per month process.

Section 2.0 - Final Algorithm

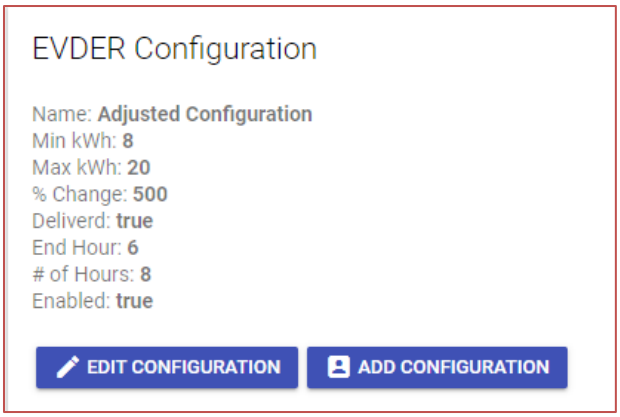
2.1 Pseudocode

Please refer to Recommended Algorithm Configuration for the recommended initial settings described in this flowchart.



2.2 Recommended Algorithm Configuration

When considering the peak reading, a range of 8 kW to 20 kW should suffice. Percentage increase should range from 400% to 600% and could be adjusted accordingly depending on the number of EV's being surfaced. Based on our findings the algorithm should only look at readings after-hours (e.g., 10pm to 6am). Even if an EV customer primarily charges during the day, they only need to charge once after-hours to be surfaced by the algorithm. Additionally, the presence of additional base loads during the day makes the EV chargers more difficult to differentiate since the percentage increase between readings is less pronounced.



Section 3.0 - Final Testing

Testing for the previous milestone was completed in February and March of 2022 and it is assumed that due to the winter weather, not as many electric vehicles were being charged during that testing period (eight of the meters surfaced were confirmed as EV chargers). Additionally, the issues covered in Lessons Learned made the data difficult to work with. Final testing was completed using data from the spring/summer months and as expected; more EVs were surfaced. The enhancements described in Proposed EV List made the data easier to manage as it was possible to look at proposed EV's one month at a time.

3.1 June 2022

A total of fifty-six load profiles were surfaced for the month of June and seventeen of those profiles were surfaced more than once. Those seventeen profiles were closely reviewed and twelve of them suggested the presence of an EV charger. This list was surfaced to the Engineering department, and they are confident that at least ten of the twelve are EV charger locations. Additionally, eight of the initial meters surfaced were added to the exception list (pumping stations, utility closets and a golf course).

- Surfaced: 56
- Reviewed: 17
- Exceptions added: 8
- Possible EV: 12
- Confirmed EV: 10

3.2 July 2022

A total of eighty-one load profiles were surfaced for the month of July and sixteen of those profiles were surfaced more than once. Those sixteen profiles were closely reviewed and nine of them suggested the presence of an EV charger. This list was surfaced to the Engineering department, and they are confident that all nine are EV charger locations. Additionally, twelve of the initial meters surfaced were added to the exception list (pumping stations and a machine shop).

- Surfaced: 81
- Reviewed: 16
- Exceptions added: 12
- Possible EV: 9
- Confirmed EV: 9

3.3 August 2022

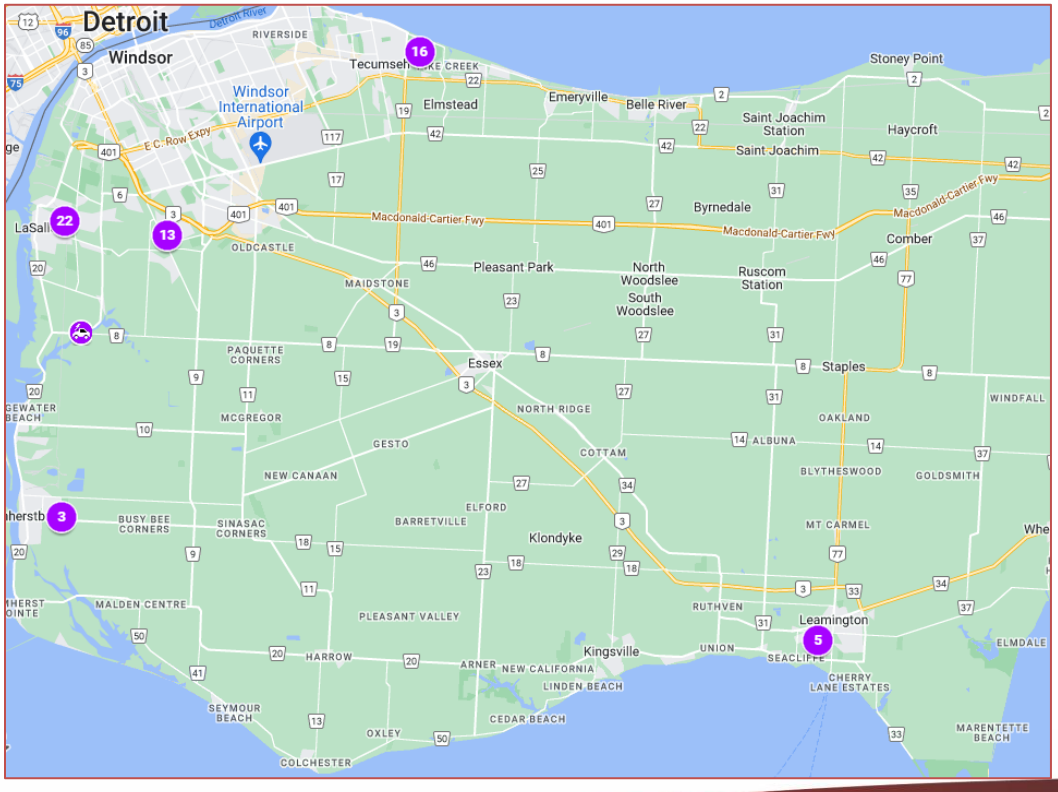
A total of sixty-seven load profiles were surfaced for the month of August and thirteen of those profiles were surfaced more than once. Those thirteen profiles were closely reviewed and eight of them suggested the presence of an EV charger. This list was surfaced to the Engineering department, and they are confident that all eight are EV charger locations. Additionally, two of the initial meters surfaced were added to the exception list (a pumping station and a manufacturing facility).

- Surfaced: 67
- Reviewed: 13
- Exceptions added: 2
- Possible EV: 8
- Confirmed EV: 8

3.4 Geospatial EV and DER Locations

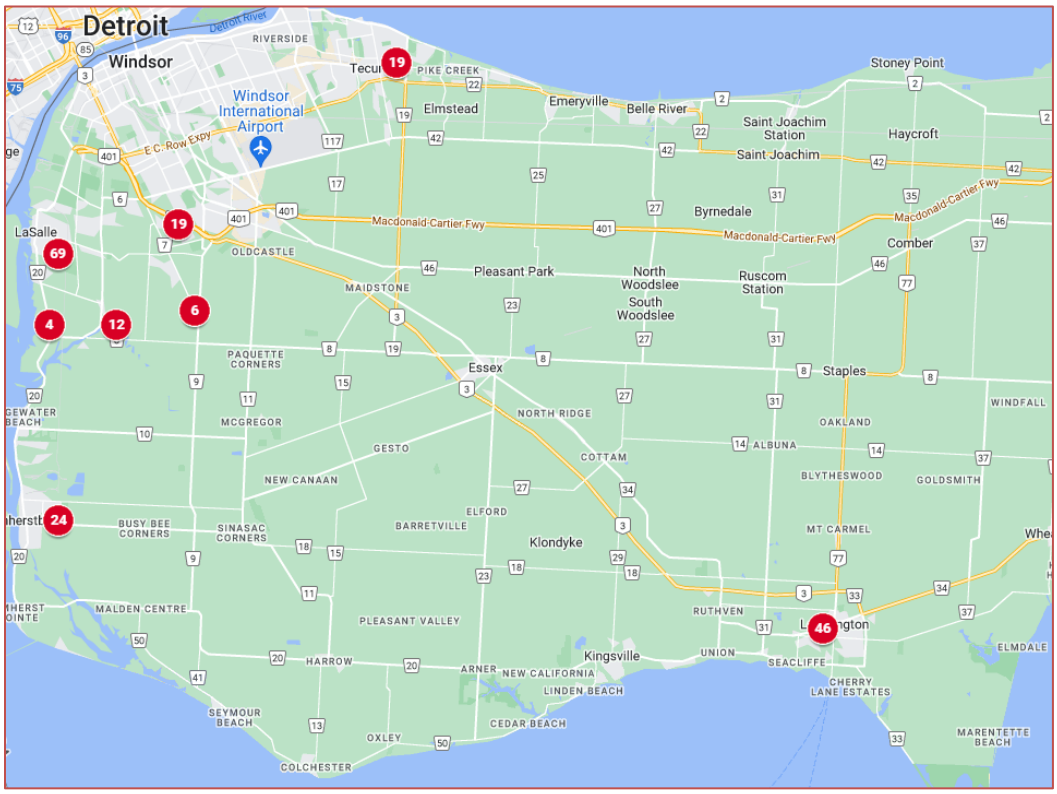
3.4.1 EV Locations

In addition to the 27 profiles confirmed in the Final Testing section of this report, an additional 26 profiles have been surfaced (as of January 31, 2023) for a current total of 60 electric vehicle chargers (7 were surfaced in the Milestone 3 Report).



3.4.2 DER Locations

We can see that there is an abundance of solar (199) mainly due to the success of the FIT and microFIT programs offered in the early 2000's. Unfortunately, there are no examples of wind or battery storage currently within the Essex Powerlines boundaries.



Section 4.0 - Feeder Impact

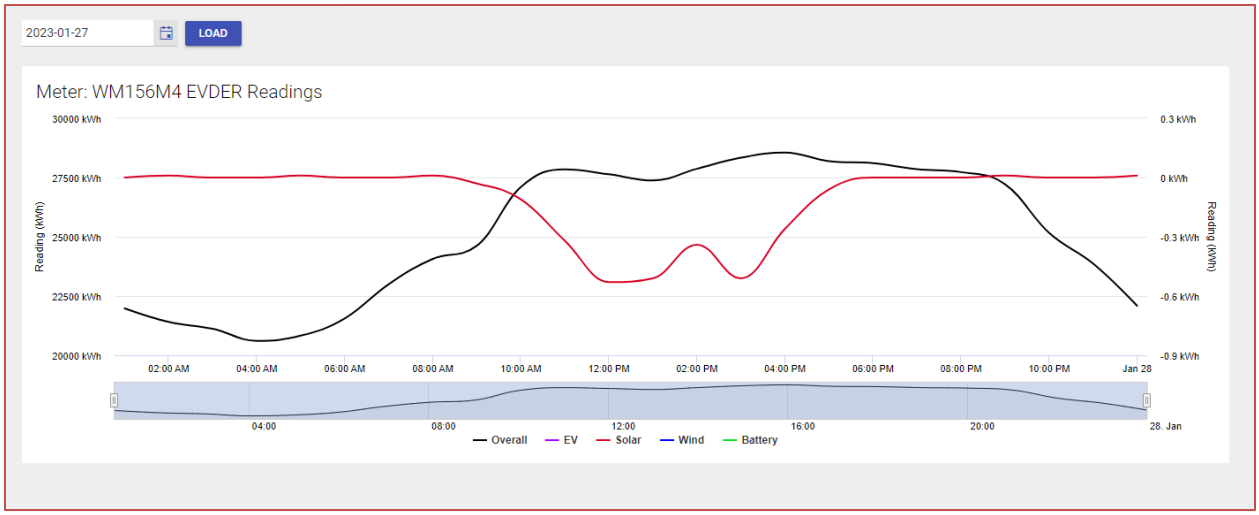
4.1 EV and DER Load By Feeder

This section includes the aggregate load by feeder based on readings from January 27, 2023.

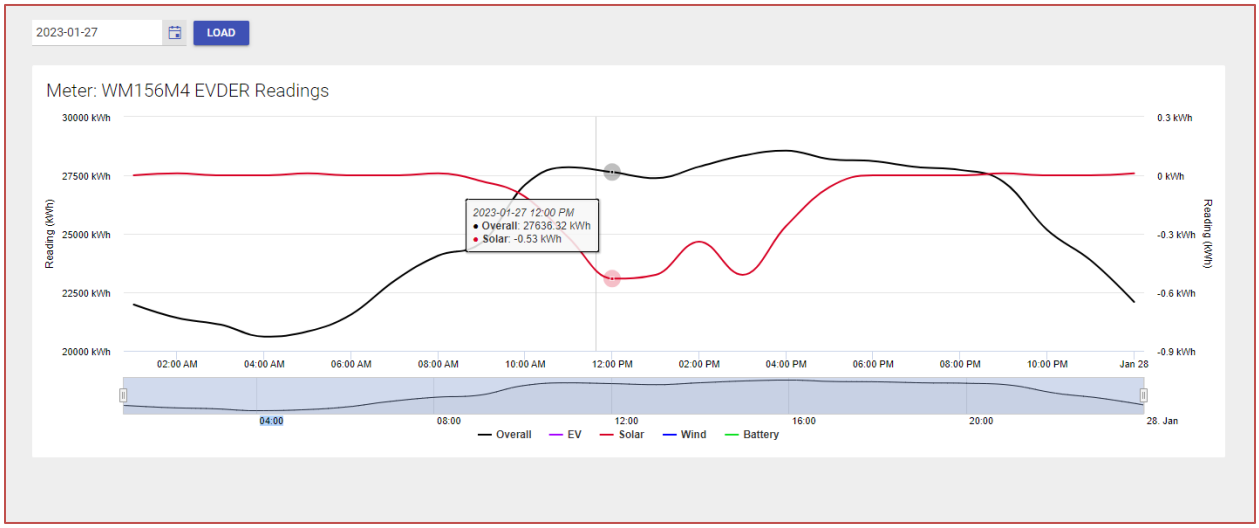
4.1.1 Tecumseh

56M4

EV Peak: 0kWh



DER Peak: -0.53kWh



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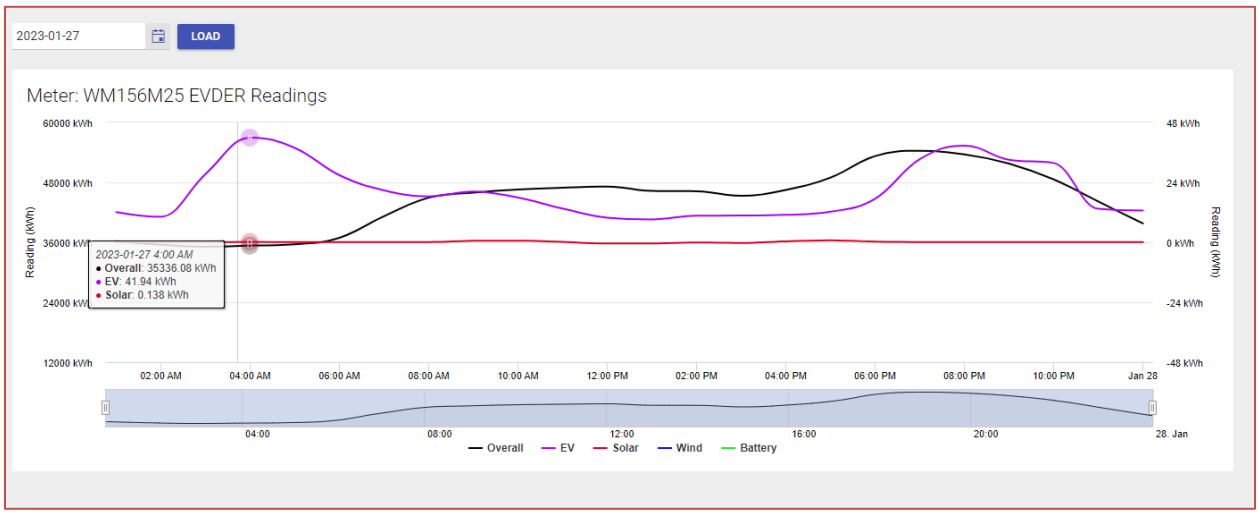
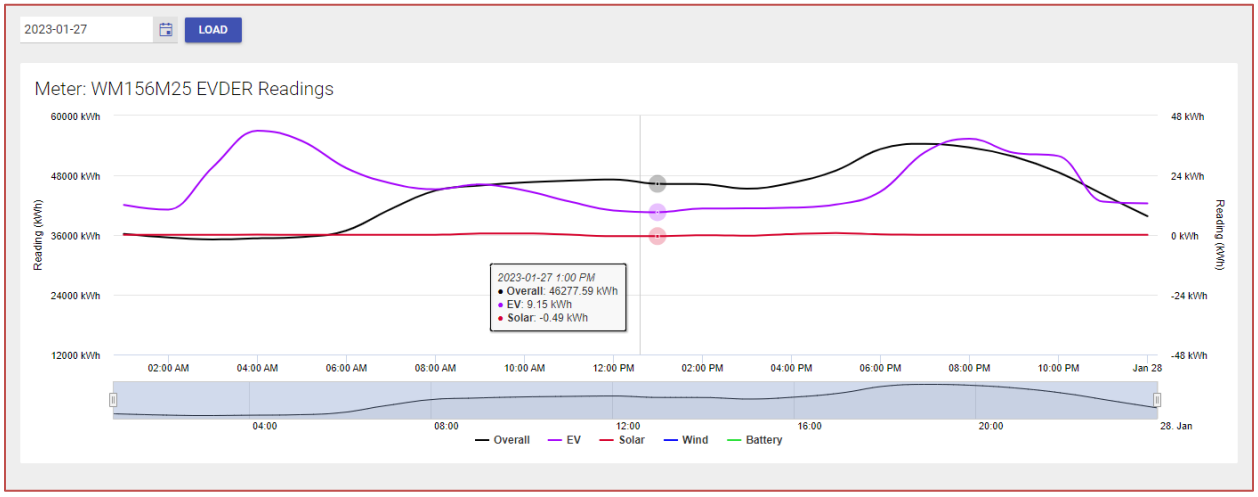
56M25

EV Peak: 41.94kWh

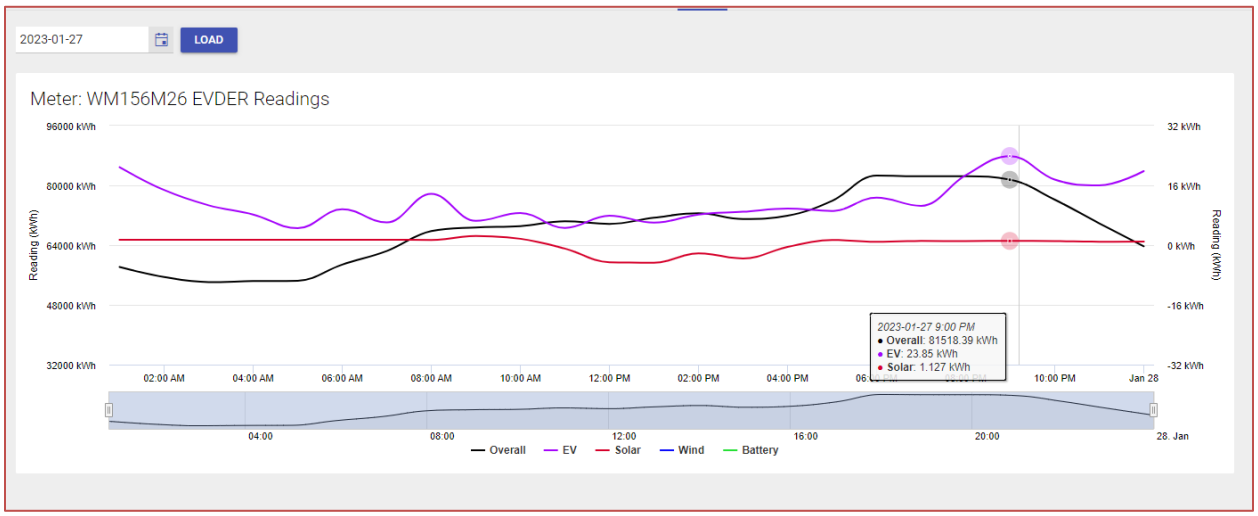


DER Peak: -0.49kWh

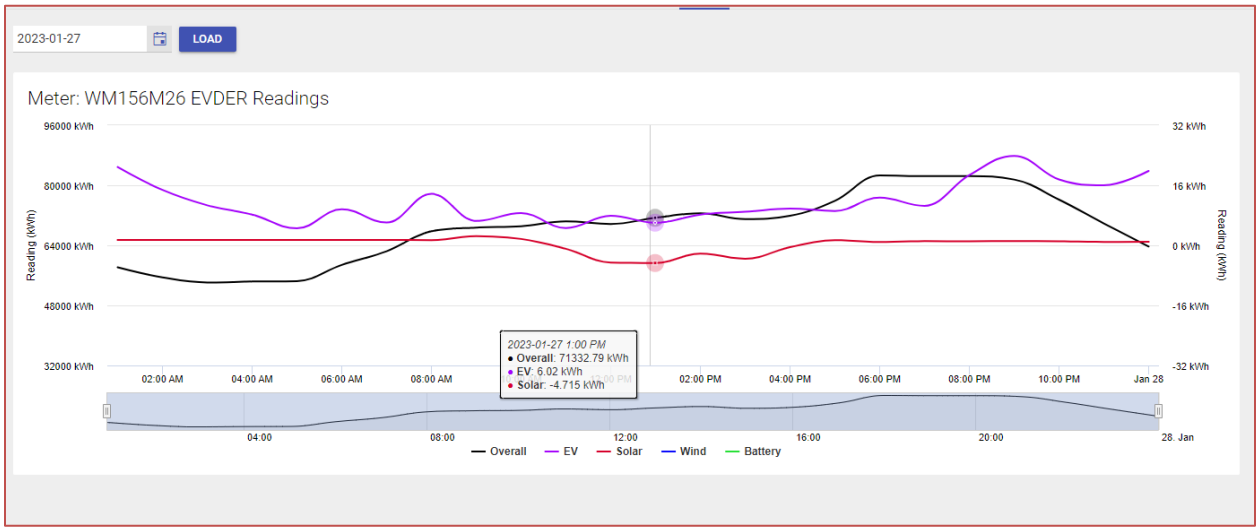


56M26

EV Peak: 23.85kWh



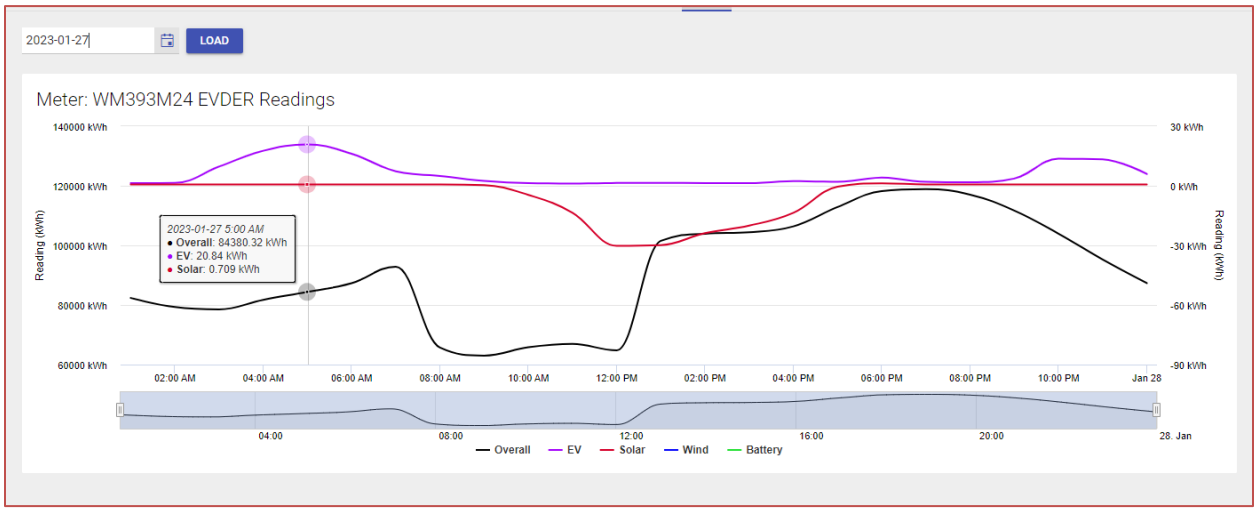
DER Peak: -4.715kWh



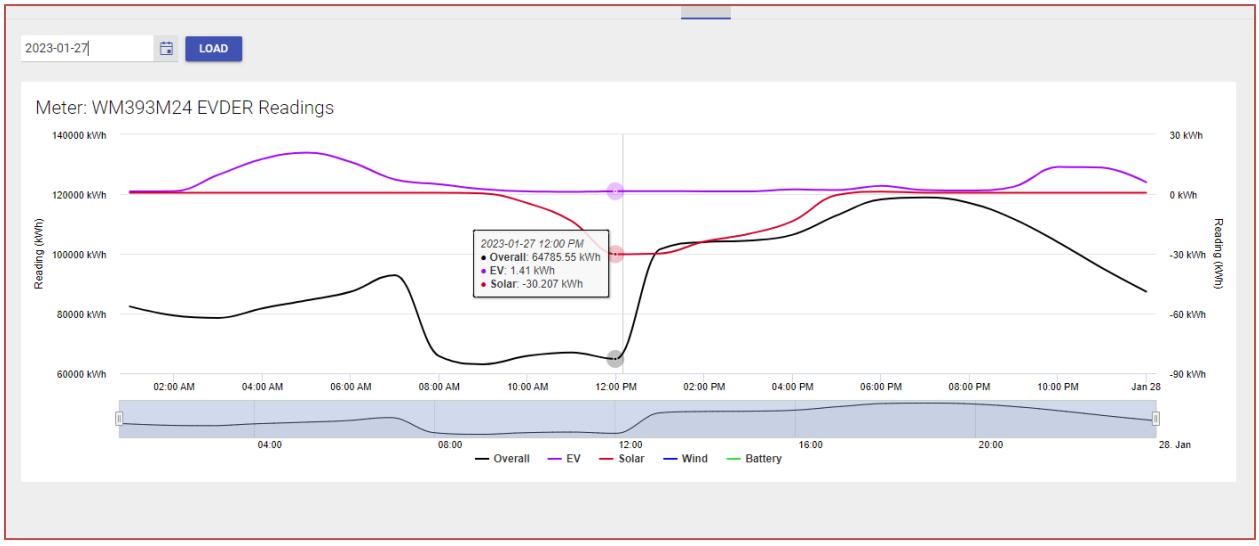
4.1.2 Leamington

93M24

EV Peak: 20.84 kWh

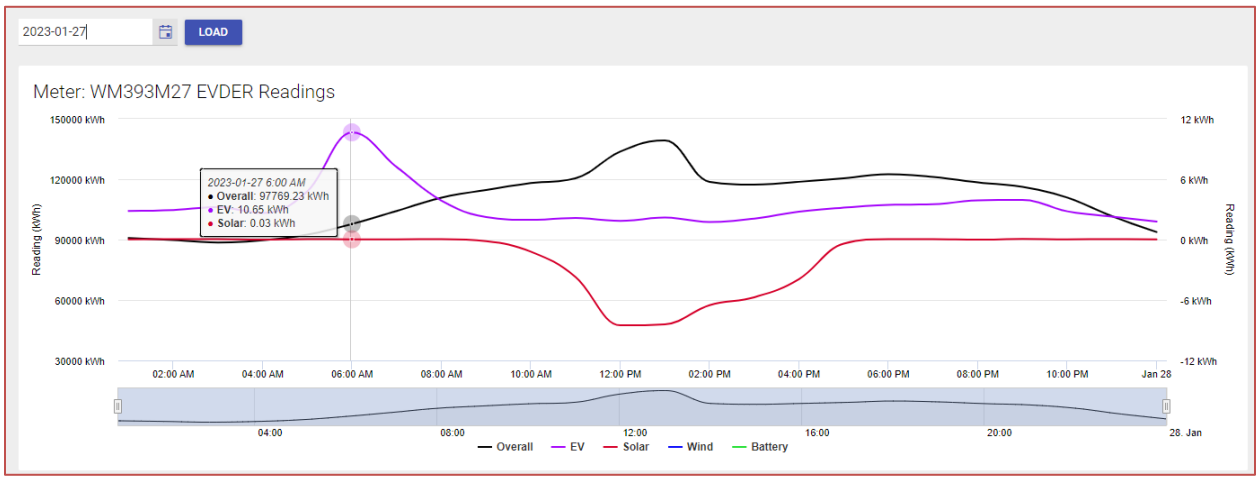


DER Peak: -30.207 kWh



93M27

EV Peak: 10.65kWh

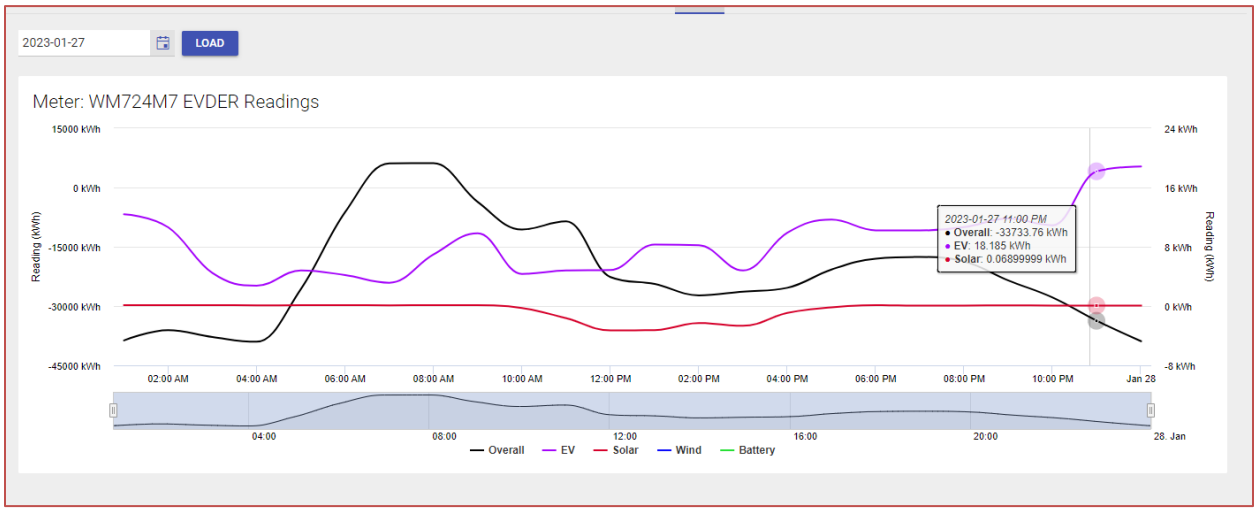


DER Peak: -8.516kWh

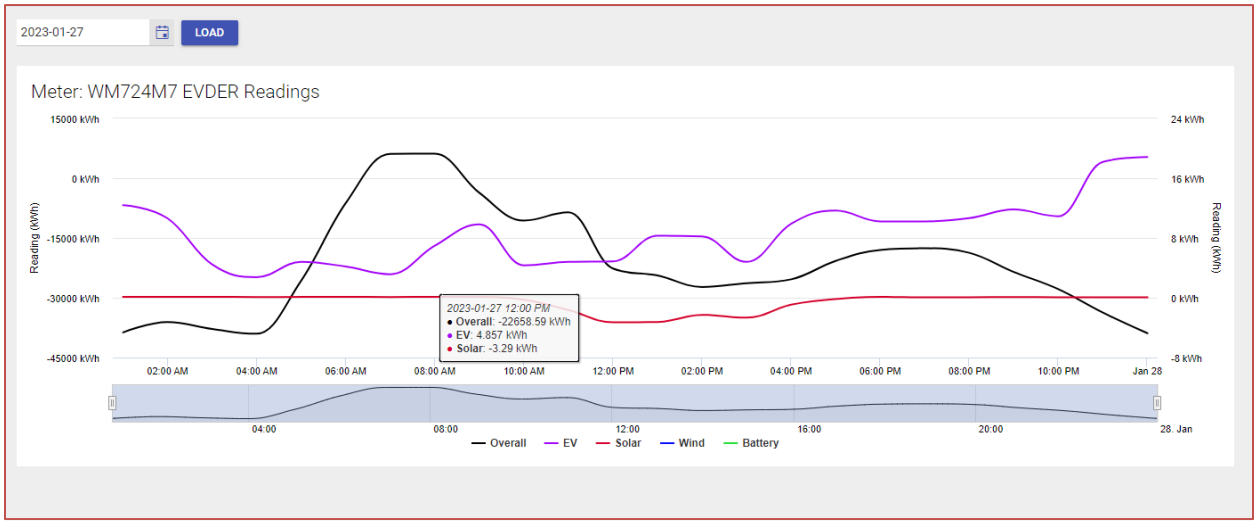
4.1.3 Amherstburg

24M7

EV Peak: 18.188 kWh



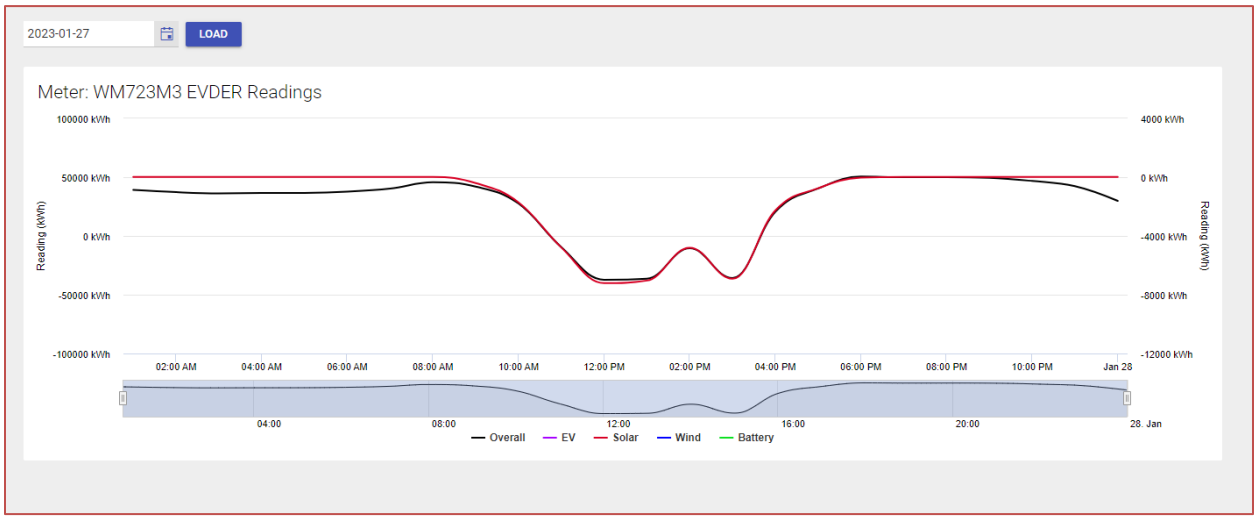
DER Peak: -3.29 kWh



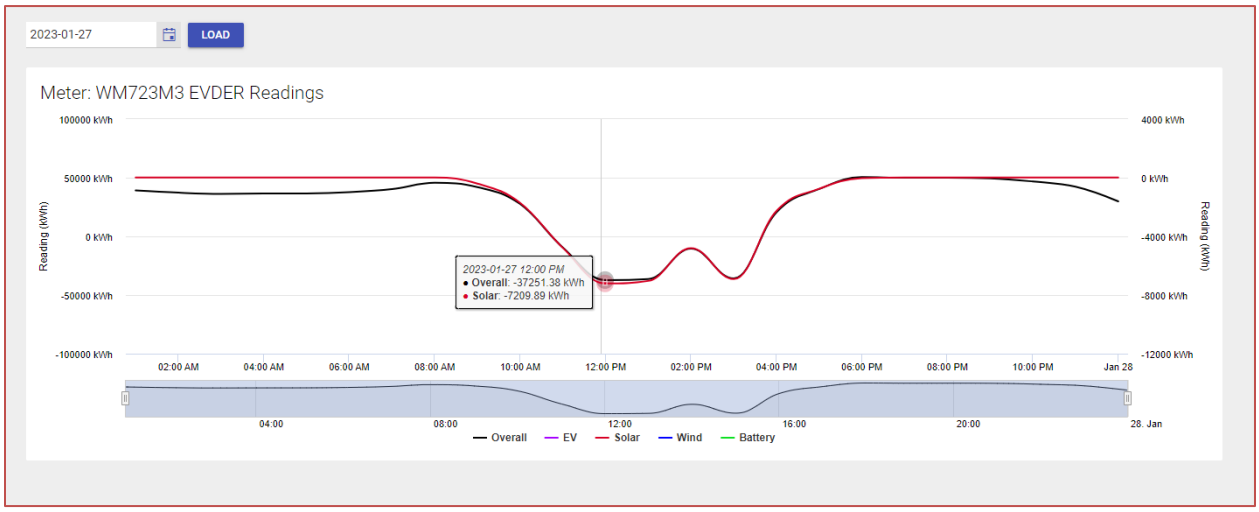
4.1.4 Lasalle

23M3

EV Peak: 0kWh

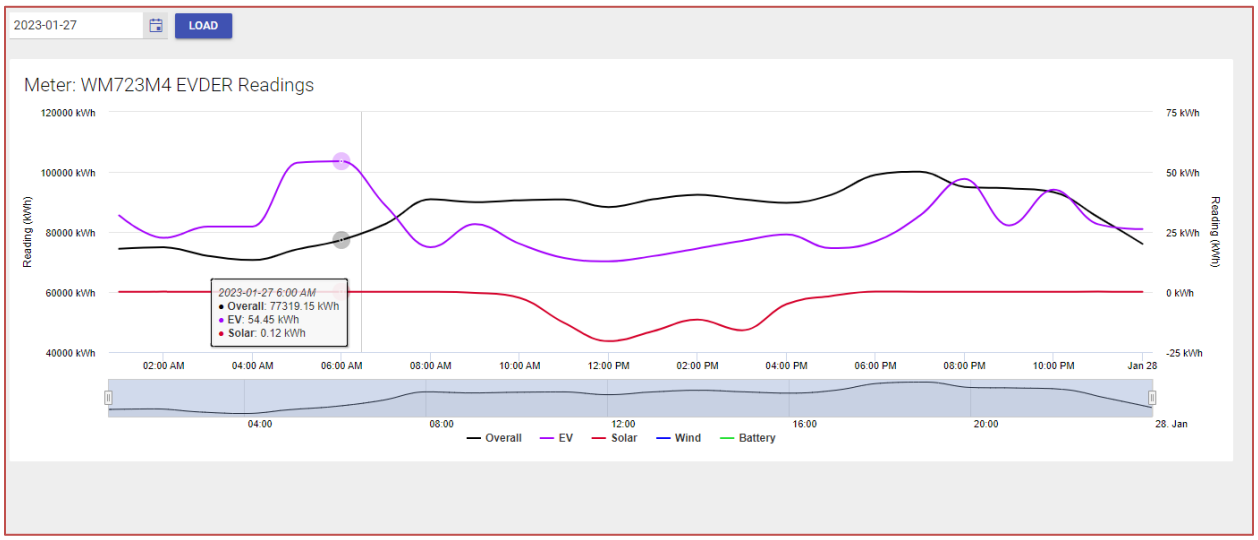


DER Peak: -7,209.89kWh

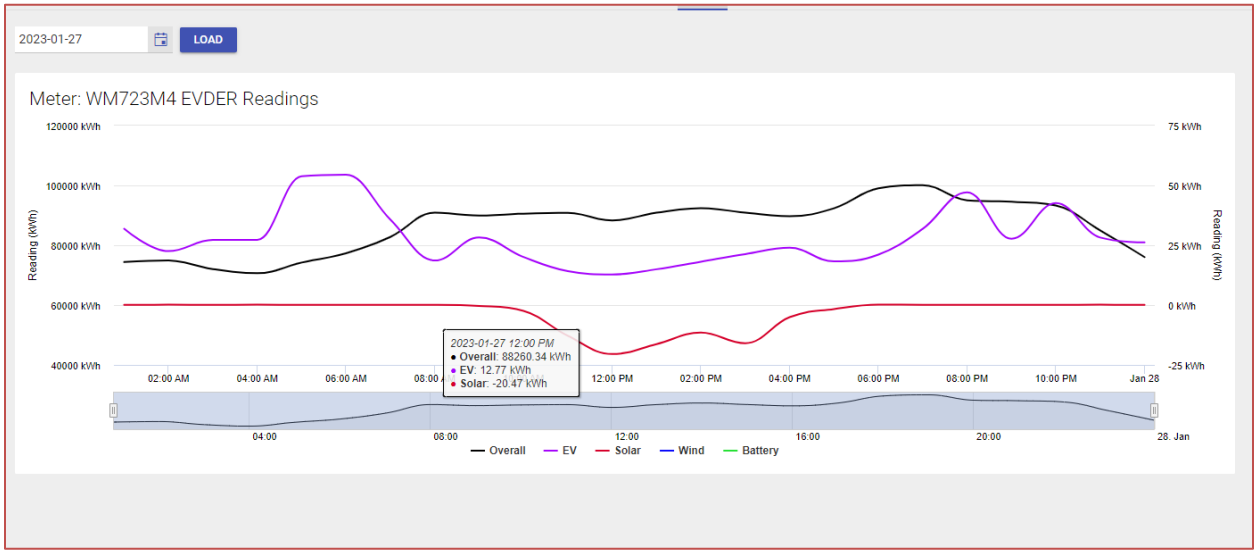


23M4

EV Peak: 54.45kWh

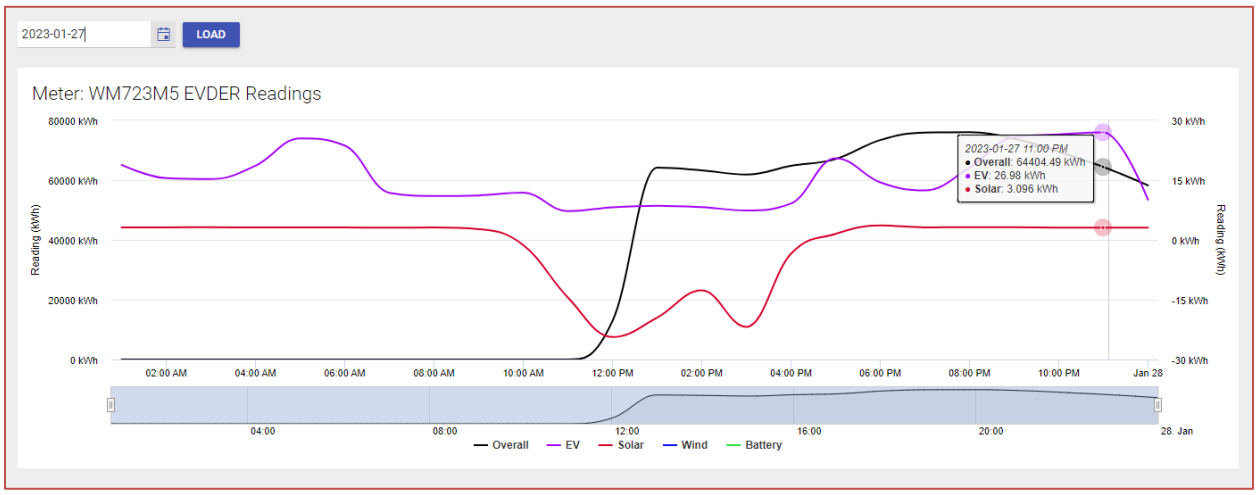


DER Peak: -20.47kWh

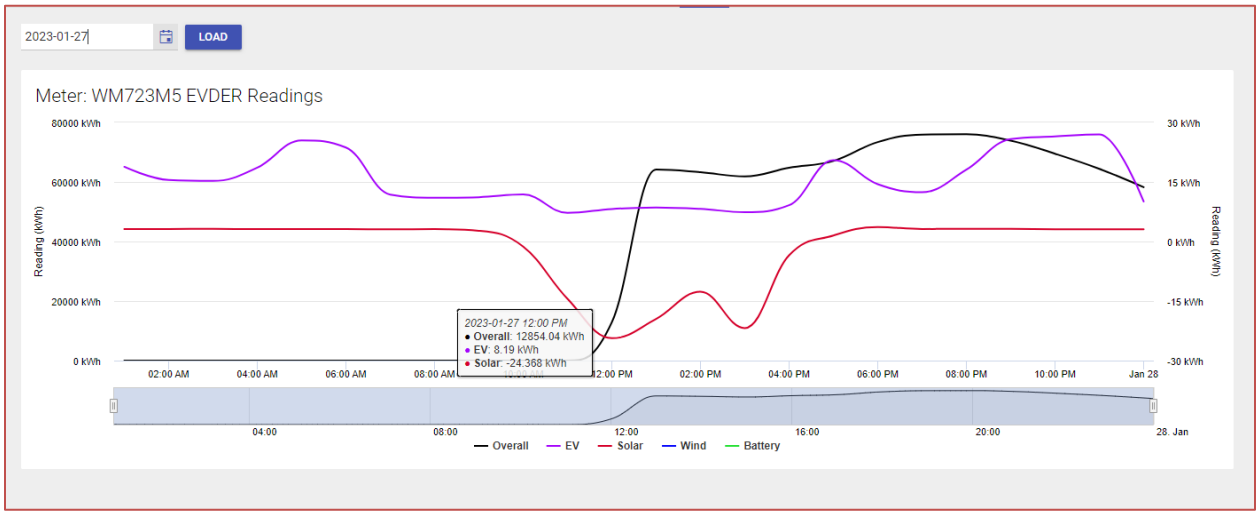


23M5

EV Peak: 26.98 kWh

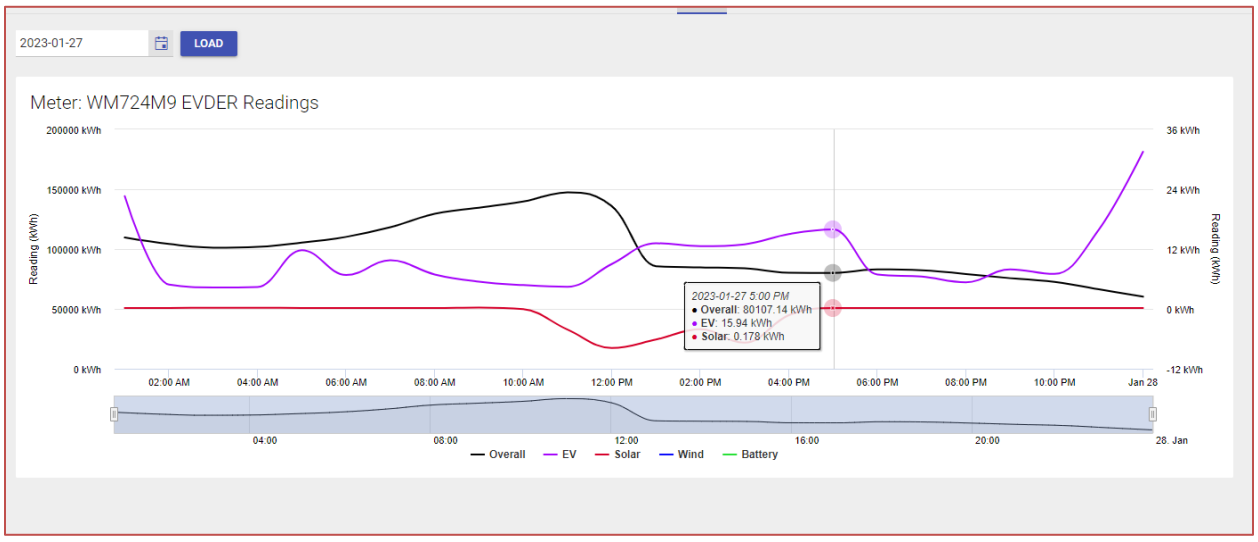


DER Peak: -24.368 kWh

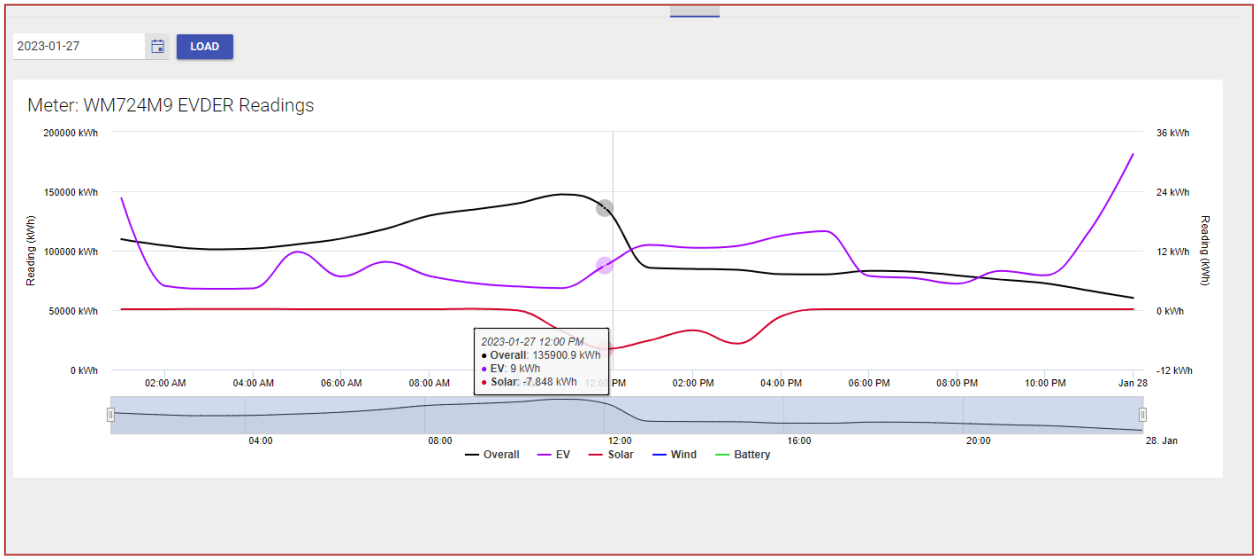


24M9

EV Peak: 15.94 kWh

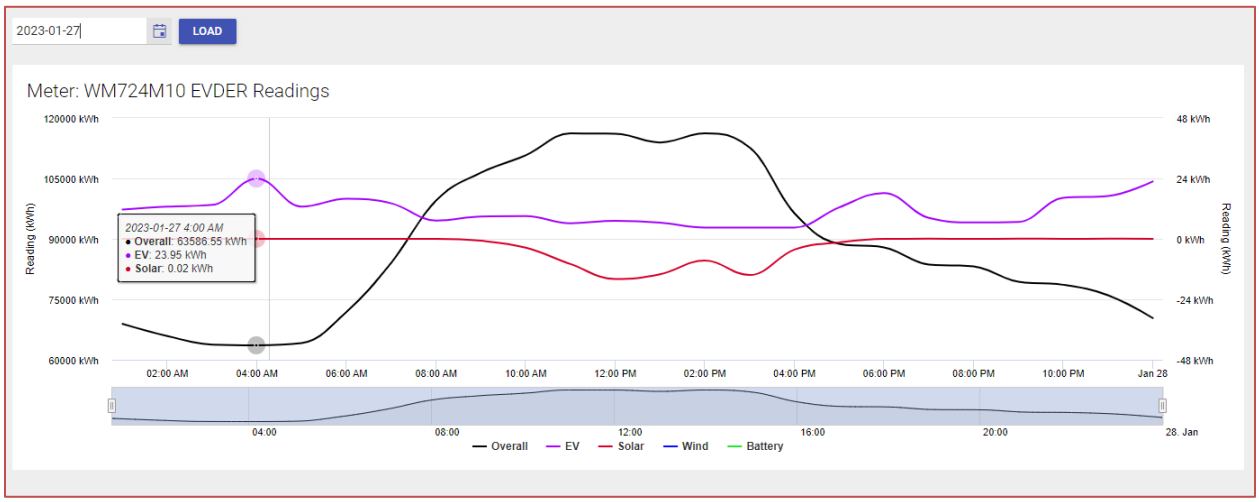


DER Peak: -7.848 kWh

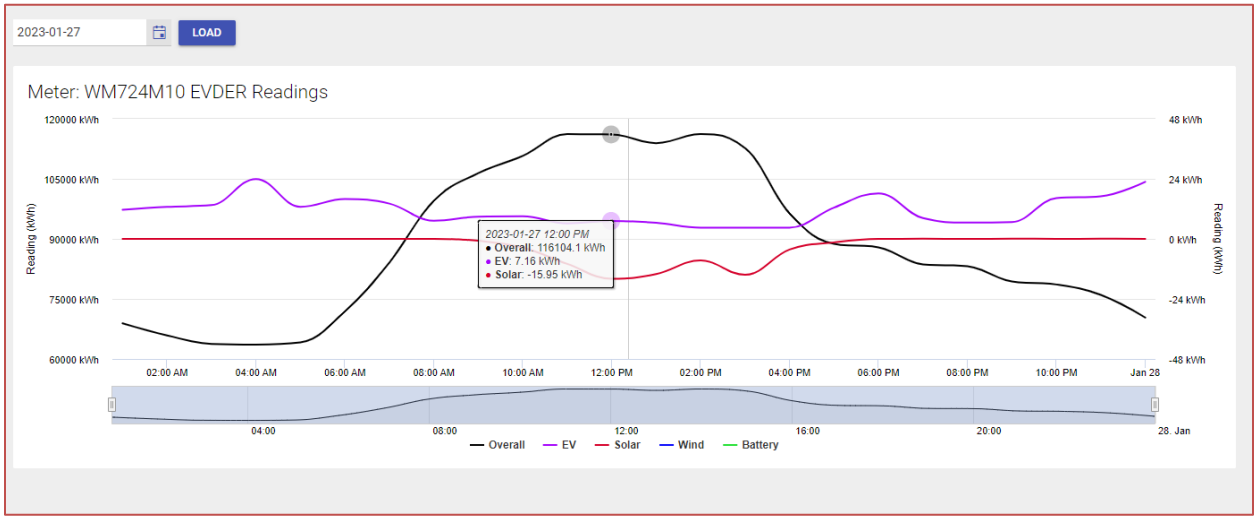


24M10

EV Peak: 23.95 kWh



DER Peak: -23.95 kWh



4.2 Feeder Capacity

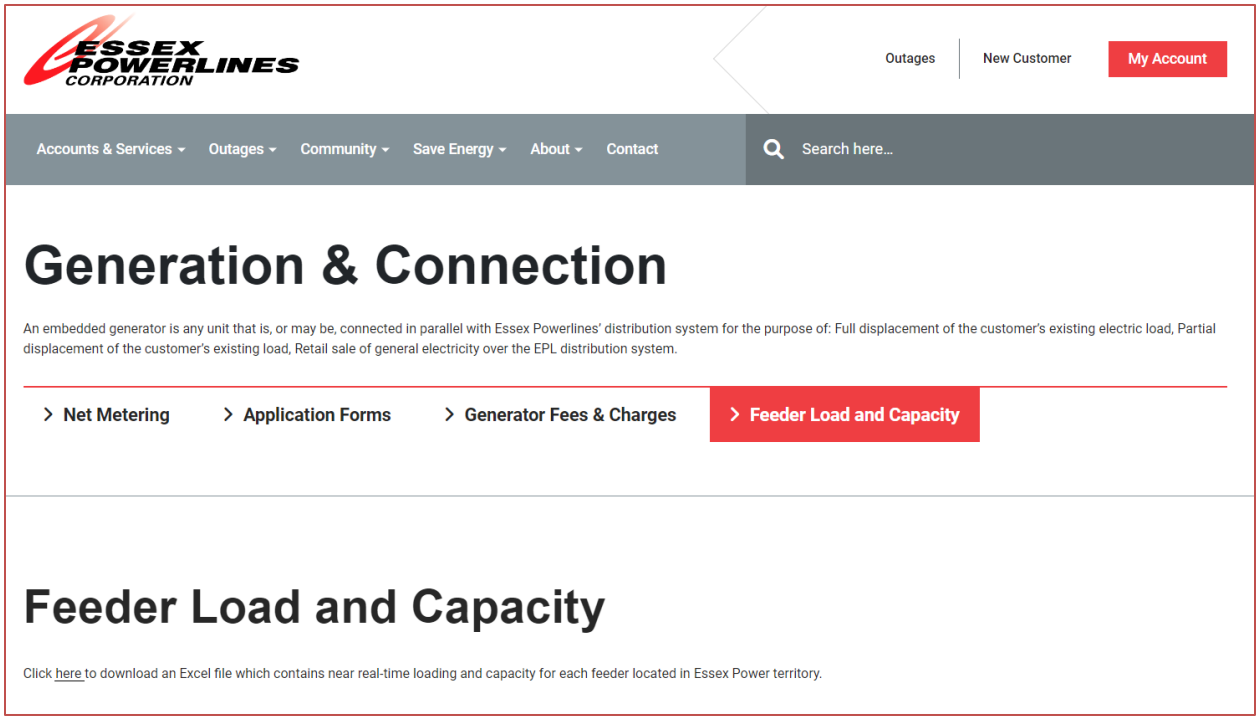
Feeder capacity and near real-time loading is now available on the Essex Powerlines website. This file is updated every hour and includes the latest load reading and the capacity of each of the feeders within EPL's territory.

Please note that Essex Powerlines do not own the stations and that the feeder capacity values are provided by Hydro One

4.2.1 Website Updates

A new page was created on the Essex Powerlines website and can be found in the menu under Save Energy > Generation & Connection > Feeder Load and Capacity or with the following URL:

https://essexpowerlines.ca/save-energy/connection/feeder-load-and-capacity/



4.2.2 Sample Output

Below is a sample of the file that is accessible from the Essex Powerlines website. This file is updated every hour as load readings for a feeder change throughout the day. Capacity values are static for the most part but may be updated seasonally at the direction of Hydro One.

FEEDER	AREADESCRIPTION	READING_TS	LOAD_READING	LOADCAPACITY	CTRATIO	PTRATIO	VOLTSMULTIPLIER	LATITUDE	LONGITUDE	VOLTAGE
56M25	A1-TEC	23-MAR-23 08.00.00.000000000 AM	3.56	7.54	80	140	1	42.308865	-82.846518	27600
56M4	A1-TEC	23-MAR-23 08.00.00.000000000 AM	2.03	6.97	80	140	1	42.309831	-82.869164	27600
56M26	A1-TEC	23-MAR-23 08.00.00.000000000 AM	5.28	12.4	120	140	1	42.307603	-82.885176	27600
393M27	A3-LEA	23-MAR-23 08.00.00.000000000 AM	2.22	13.7	60	140	1	42.047205	-82.619531	27600
393M24	A3-LEA	23-MAR-23 08.00.00.000000000 AM	7.69	14	120	140	1	42.06303392	-82.5985897	27600
24M7	A7-LAS	23-MAR-23 08.00.00.000000000 AM	2.22	7.61	120	140	1	42.25465403	-83.05761807	27600
24M9	A7-LAS	23-MAR-23 08.00.00.000000000 AM	5.48	14.1	120	140	1	42.254649	-83.057702	27600
24M10	A7-LAS	23-MAR-23 08.00.00.000000000 AM	7.54	13.5	120	140	1	42.254395	-83.056678	27600
23M5	A7-LAS	23-MAR-23 08.00.00.000000000 AM	4.82	11	120	140	1	42.25538265	-83.08794442	27600
23M3	A7-LAS	23-MAR-23 08.00.00.000000000 AM	3.38	8.18	120	140	1	42.249984	-83.091431	27600
23M4	A7-LAS	23-MAR-23 08.00.00.000000000 AM	6.89	15.63	120	140	1	42.249984	-83.091431	27600

Section 5.0 - Communication

5.1 Knowledge Transfer

Knowledge transfer with Essex Powerlines stakeholders occurred at various points throughout the project as their feedback was critical to the success. A detailed demonstration of the tool was also presented to several representatives from the IESO on October 3, 2022, at the Essex Powerlines facility. Additionally, the Ontario Energy Board has reached out for a similar demonstration, but a date has not yet been confirmed.

5.2 Stakeholder Feedback

"The EV identification tool developed within the SmartMap platform is something that we look at on a weekly basis. EPL looks to see the growth of EV penetration and where these EV's are located within the

service territory. This tool is very helpful in supporting why transformer loading is increasing in specified areas of the network. EPL can also see the overall impact of these EV's on the loading of the feeder. Currently these identified EV's are not impacting the network significantly as the load increase is being seen in the overnight hours. It will be interesting to monitor how this impact will change with the seasons.

EPL will be using this information to plan, where necessary, for future infrastructure upgrades. This will also flow into our next and future Cost of Service (COS) applications for infrastructure upgrades as needed."

Anthony Clavet, Director of Engineering and Assets at Essex Powerlines Corporation.

5.3 Electrification Study

Additionally, Essex Powerlines will be conducting a study to explore the impacts of future electrification on their service territory utilizing the new EV/DER functionality in the SmartMAP application. This study proposes to be one of many foundational steps required in preparing EPL for future electrification and covers the following scope:

- Model EPL system impacts at the feeder and sub-feeder levels considering the following variables:
  - Current / Future Electric Vehicle ("EV") adoption
  - Future electrification of heating/cooling/common appliances
  - Load growth due to urbanization / economic development
  - Other DER current and future adoption
- The study will identify technical areas of concern in the distribution system that result from the above elements of electrification.
- Consideration will be given to three assumptions regarding the level of electrification:
  - Low or modest adoption rates of electrification (EV, heating, appliances, economic development)
  - Medium adoption rates of electrification (EV, heating, appliances, economic development)
  - Accelerated adoption rates of electrification (EV, heating, appliances, economic development)
- Electrification adoption will be considered for all EPL's rate classes.
- All four of EPL's non-contiguous service areas will be considered.

The study is intended to serve as a detailed resource that can contribute to EPL's Cost of Service (COS) and Distribution System Plan (DSP) – a plan that considers both Wires and Non-Wires alternatives based on EPL's ability to manage the various scenarios presented and their respective timing.

Section 6.0 - References

6.1 Public Forums

Knowledge learned in public forums was gained from attending industry trade shows in Canada and the United States. Speaking with vendors and attending relevant sessions provided valuable insight into the EV/DER market. Shows included:

- EDIST 2018 – Markham, ON
- DistribuTech 2018 – San Antonio, TX
- EDIST 2019 – Markham, ON

- DistribuTech 2019 – New Orleans, LA
- EDIST 2020 – Markham, ON
- EDIST 2022 – Markham, ON

6.2 Project Contributors

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