Business & Technology Advisory

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NRECA America's Electric Cooperatives

Electric Vehicle Telematics Measurement and Verification Through a Pilot Program with Minnesota Valley Electric Co-op

Overview

- Minnesota Valley Electric Cooperative (MVEC) offers a 24-hour, Time-of-Use (TOU) Electric Vehicle (EV) charging program. Customers can charge their vehicles whenever needed, and electricity rates fluctuate by the time of day.
- Currently, EV usage is recorded through a dedicated electric submeter, which tracks charging usage separately from home electricity use.
- MVEC conducted a study to explore the feasibility of using EV telematics usage data as a proxy for EV submeter charging usage.
- EV telematics is the integrated data and communications associated with each EV manufacturer's transportation product.[1]
- This advisory reviews the research and findings.

Executive Summary

Minnesota Valley Electric Cooperative and other industry stakeholders, including NRECA, worked to evaluate the alignment between EV submetering data and telematics data to assess the feasibility of telematics as a billing method. The study found that billing customers through telematics usage at the sample level is an accurate proxy for dedicated submeter charging, showing 93.4% (± 1.9`%) accuracy over three months.

The analysis was conducted over three phases: Preliminary, Halftime, and Final Analysis. Initial findings during the Preliminary phase revealed a high mean usage ratio of 2.56 (EV: Submeter usage) due to the short data collection window. Improvements in data accuracy were seen during the Halftime period, with a reduced mean usage ratio of 1.89, although changes to Tesla's API introduced some inconsistencies. By the Final Analysis phase, mean usage ratios stabilized between 0.96 and 1.16 for all model vehicles, demonstrating substantial alignment between telematics and submetering data.

While the sample-level results were encouraging, customer-level complexities remain a challenge. Like all equipment, submeters are prone to inaccuracies or failure as they approach the end of their life cycle. Households with failing submeters, irregular charging behaviors, or multiple EVs often showed significant billing discrepancies. Approximately 26% of customers experienced billing changes to the EV portion greater than ±50% when transitioning to telematics, while 42% saw changes within ±10%, emphasizing the

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importance of enhanced anomaly detection and communication strategies for billing transparency. In some cases, customer billing increases are justified, as the usage data from the EV telematics dataset is more reflective of typical EV use than the submeter. In these cases, utilities should confirm the proper functionality of their submetering equipment before proceeding.

A key challenge lies in the variability of telematics data quality across automakers. EV-only manufacturers, such as Tesla and Rivian, consistently provided reliable data. Meanwhile, traditional auto manufacturers who build EVs exhibited significant gaps due to less advanced telematics systems. Additional complexities arose from estimating and updating battery capacity size assumptions and energy conversion inefficiencies.

This study concludes that telematics is a viable alternative to submetering for billing EV charging at the sample level. However, to ensure consistent and fair customer-level billing, collaboration with automakers to improve telematics data quality and developing more robust algorithms to address anomalies are critical next steps. These efforts will support the broader adoption of telematics billing, enabling more efficient and scalable EV charging infrastructure for utility customers.

Project Objectives

The following were the project objectives for the research:

- Determine how well EV telematics data represents the dedicated meters.
- Calculate impacts of major discrepancies in billed charges using actual rate structures for each meter.
- Identify and address potential risks and challenges with telematics data.

Project Team

This research effort brought together a number of key industry stakeholders to provide a comprehensive approach to the evaluation. MVEC lead the research with the advisory roles of NRECA and Great River Energy (GRE). Michaels Energy provided overall project management and analysis. Flex Charging managed and collected the telematics data, and also regularly manage the submetering usage data provided by MVEC. Accurant International is a technology consulting and capital investment firm, with emphasis on investing in technology companies in energy, power, and climate-tech, advising the participants of this study on the value of electric vehicle charge management for grid operations.

Team Members:

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Jennah Denney, Electric Vehicle Strategy & Solutions Manager

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GRE:
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Project Phases and Milestones

Figure 1 shows the project workflow for the comparative analysis between EV telematics and submeter consumption data. Each findings phase concluded with a presentation of results and a discussion of data quality. If the data quality did not meet the expectations of this study, new data was acquired to perform the analysis. Figure 2 shows the Project Milestones.

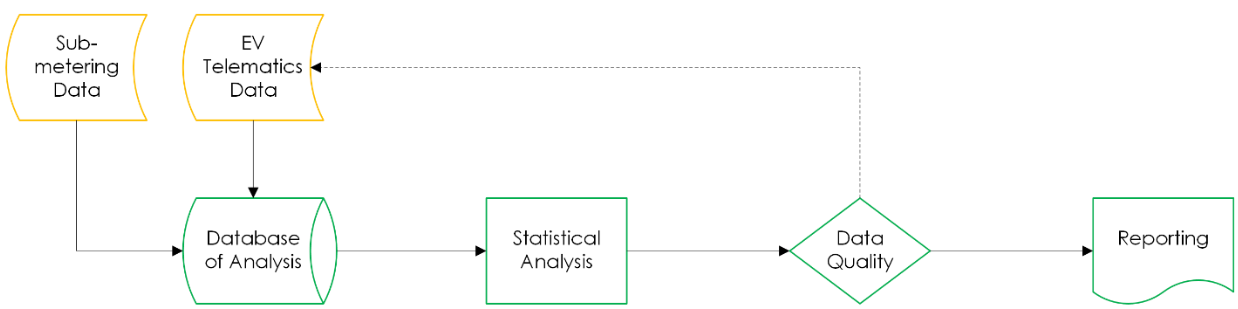

Figure 1: Project Workflow

Figure 2: Project Milestones

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Data, Methods, and Metrics

The study used linear regression to determine how well EV telematics data represents a dedicated EV charging submeter. Analysis steps included: establishing the acceptance criteria, performing the statistical analysis, outlier evaluation, quantifying the impact on customer billing, data quality management, risk mitigation, regular updates, and a final report and third-party telematics data validation.

Acceptance criteria were determined by merging the submetering and EV telematics consumption data based on their available date ranges. Only dates where consumption data is available in both datasets were used for analysis. A usage ratio was then calculated for each site for the analysis period (see Equation 1). Sites with a usage ratio greater than one standard deviation away from the mean were removed from the analysis dataset.

Equation 1: Usage Ratio

$$Usage\ Ratio = \frac{Sum\ of\ EV\ usage}{Sum\ of\ sub - meter\ usage}$$

The evaluation team utilized a linear regression model to analyze the accuracy of EV Telematics data compared to submeter data. In this linear regression, the submeter data was shown as a dependent variable on the x-axis, and the EV Telematics data was the independent variable on the y-axis (see Figure 3).

Under an ideal EV telematics to submeter comparison model, the slope is 1 with an intercept of 0. However, a small amount of power draw occurs due to the EV charger, such as an LED display or internet connection capabilities. As such, even ENERGY STAR chargers have an estimated efficiency of 99.2%.[1] Additionally, an anticipated difference in the readings of the comparative datasets is energy loss due to charging cables. The longer the charging cable is, the more energy loss is due to thermal conversion. The expected energy loss due to all Electric Vehicle Supply Equipment (EVSE) can be up to 1.48%.[2] The expectation is that more participants will show higher submeter consumption than EV Telematics consumption due to energy loss.

Lastly, the actual hourly consumption readings for both comparative datasets are uncertain. For the EV telematics dataset, the uncertainty is unknown and unregulated. The lack of accurate battery capacities for each make and model of EVs adds another layer of uncertainty and complexity to the EV telematics dataset. Alternatively, for the submeter dataset, this study assumes the submeters currently used to bill customers are within ± 2% per ANSI Standard C12.1-2022. This study aims to determine the accuracy of EV telematics data through current technology and practices, not necessarily to achieve the standard of ± 2%.

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[1] Arkansas Public Service Commission. (2023). *Arkansas Technical Reference Manual* (Version 9.2 Vol. 2), Table 486

[2] Apostolaki-Iosifidou, Elpiniki, Paul Codani, and Willett Kempton. "Measurement of power loss during electric vehicle charging and discharging." Energy 127 (2017): 730-742.

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Figure 3: Electric Consumption by Source for the Final Analysis Period

Note: Each point on the charts above represents the sum of usage for each participant over each month for each data source.

Results

Electric vehicle telematics data showed a strong correlation with dedicated submetering data, achieving an accuracy of over 93%, see Table 1. The telematics accuracy for individual months ranged from 83% in April 2024 to 95% the following month.

Table 1: Telematics Data Measurements

Period	Telematics Accuracy (Regression Coefficient)	R-Squared	Standard Error	p-value
April	83.2 %	0.87	± 3.1 %	<0.001
May	95.4 %	0.88	± 3.5 %	<0.001
June	91.7 %	0.89	± 3.3 %	<0.001
July	92.9 %	0.88	± 3.3 %	<0.001
Total	**90.6 %**	**0.88**	**± 1.7 %**	**<0.001**

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Table 2 summarizes the evolution of data accuracy across three distinct analysis periods in the pilot project, highlighting the progressive refinement of telematics as a billing proxy for submetering. During the Preliminary Period (November 2023), a short data collection window with only 71 sites produced a high mean usage ratio of 2.56, indicating that a more extended analysis period is required to achieve a satisfactory confidence level in the results.

Table 2: Study Overview Statistics

Analysis Period	Period	Count of Sites	Mean Usage Ratio
Preliminary	11/2/2023 - 11/9/2023	71	2.56
Halftime	10/1/2023 - 3/30/2024	188	1.89
Final Analysis	Apr-24	118	0.96
Final Analysis	May-24	114	1.16
Final Analysis	Jun-24	111	1.03
Final Analysis	Jul-24	106	1.05

The Halftime Period (October 2023 to March 2024) included 188 sites and reflected improvements with a reduced mean usage ratio of 1.89, though this period was impacted by a Tesla API shift that disrupted data reliability.[3] Finally, the Final Analysis (April to July 2024) demonstrated considerable alignment between the two data sources, with mean usage ratios stabilizing between 0.96 and 1.16 across 106 to 118 sites per month. The convergence of the mean usage ratios towards 1.0 does not reflect an increasing accuracy of telematics data over time, but reflects methodological improvements as the details about data collection and customer behavior were better understood by researchers.

Time-of-Use Comparison

The comparison between telematics and submeter data through a billing perspective demonstrates the alignment between the two data sources. In this comparison, the electrical usage of each participant is assigned a rate code for each hour of the day throughout both datasets, with EV-Wise being the off-peak period. The billing discrepancies range from 0.5% during peak rate hours (EV-Critical) to 1.3% during the general billing period (EV-General, Table 3, Figure 4). The minimal percentage differences across categories demonstrate telematics' capability to replicate submetering accuracy on an aggregate level. Such results validate telematics as a replacement for submeters in real-world billing applications. Additionally, the consistency across categories indicates that EV telematics can handle varying usage profiles, from standard to critical peak charging, with minimal error.

Table 3: Time of Use Rates

Rate Code	Cost per kWh	Start Time	End Time
EV-WISE	$0.06	0:00	4:59
EV-WISE	$0.06	22:00	23:59
EV-GENERAL	$0.09	5:00	16:59
EV-CRITICAL	$0.25	17:00	21:59
GENERAL	$0.13		

[3] In March 2024, Tesla changed its API platform, making telematics data from these vehicles unavailable during that period. In April 2024, participants were required to re-register their vehicles for this study. Although data from April is available, it is incomplete and does not accurately reflect sample-level usage.

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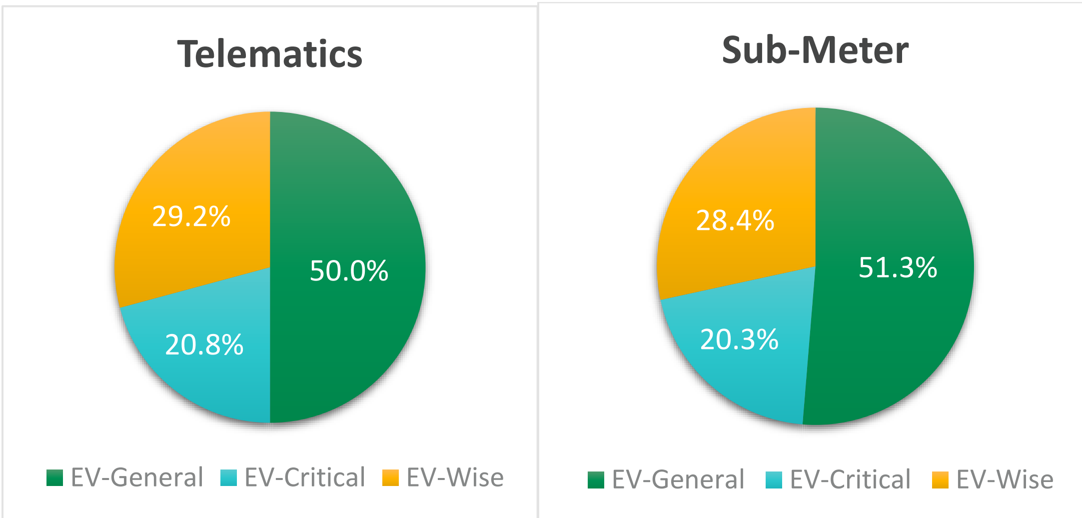
Figure 4: Time of Use Comparison



Customer-Level Impacts

Despite achieving over 93% accuracy at the sample level, significant complexities arose at the individual customer level, presenting hurdles to fair and consistent billing. These challenges underscore the nuanced realities of transitioning to telematics data for real-world applications.

Under current data collection practices, 26% of customers will realize EV-charging billing changes greater than ± 50% in a shift from submeter to telematics billing. Larger discrepancies are likely the result of multiple factors, such as faulty submeters or behavioral changes, like charging activity from outlets outside the monitored circuit or the purchase of a new vehicle without program registration. Additional discrepancies can be attributed to households owning multiple electric vehicles.

The future of customer billing sources from telematics is promising, as over 42% of customers will realize Ev-charging billing changes within ± 10% of switching from submeter to telematics billing. This study highlights the need for enhanced algorithms to identify and manage usage anomalies, such as outliers or behavioral changes, particularly for multi-EV households and households with inconsistent charging patterns. Achieving high precision through telematics billing will require close collaboration with automakers to address the current variability in telematics data quality.

Automaker-Specific Data Quality

Nine automakers were examined in the study, including Audi, BMW, Cadillac, Chevrolet, Ford, Kia, Rivian, Tesla, and Volkswagen. As shown in Figure 5, the quality of telematics data varied significantly between automakers:

- **High Accuracy**

  Tesla and Rivian consistently provided accurate and reliable telematics data, aligning usage ratios with submeter readings. These manufacturers have well-established telematics systems facilitating precise data collection and tracking usage.

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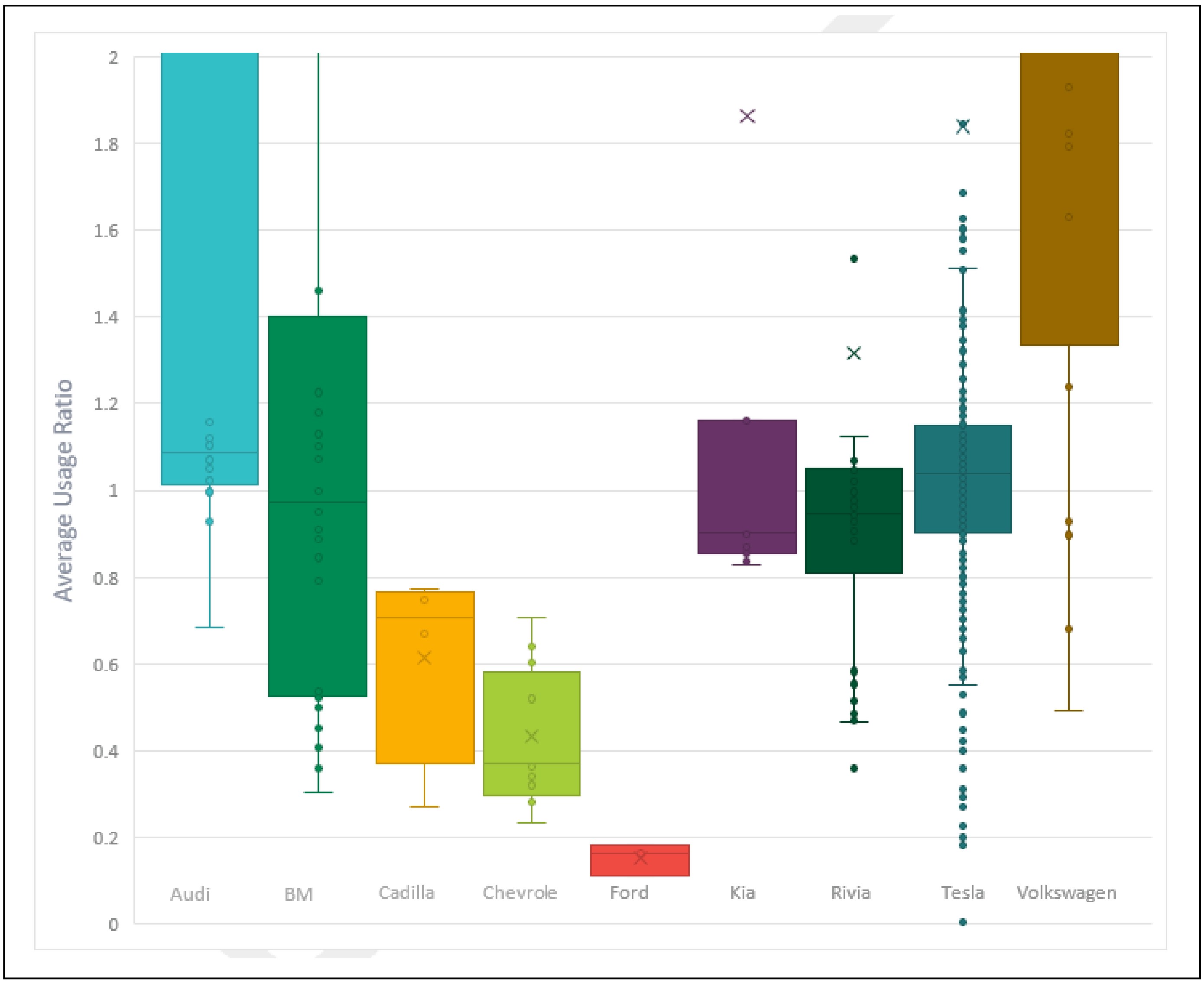
- **Moderate Accuracy**
  Brands like Audi and Volkswagen performed reasonably well but still showed gaps in telematics reliability due to occasional data inconsistencies.
- **Low or Uncertain Accuracy**

  Automakers such as Cadillac, Chevrolet, and Ford exhibited significant gaps and inefficiencies, likely due to less-developed telematics systems. During this period, Ford encouraged EV owners to work with ChargeScape instead of accessing data through Smartcar or other data aggregators.

Additionally, technical factors such as AC/DC conversion efficiency losses contributed to discrepancies. For example, certain brands demonstrated an 8% efficiency loss between wall power and battery state of charge, requiring manual corrections for more accurate billing.

Figure 5: Usage Ratios by Manufacturer



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Conclusion

The Minnesota Valley Electric Cooperative telematics pilot project demonstrates the promising potential of telematics data as a replacement for submetering in tracking and billing electric vehicle charging usage. The project achieved 93.4% (± 1.9%) accuracy at the sample level, with telematics data aligning closely with submeter readings. Despite these promising results, the study highlighted several challenges, most notably the data collection and integration quality. Key hurdles include addressing faulty submeters, managing behavioral anomalies like inconsistent charging habits, and accurately identifying multi-EV households.

However, the most significant remaining obstacle lies in resolving automaker-specific data quality issues. The variability in telematics data across manufacturers, compounded by assumptions about battery capacity sizes and efficiency losses, presents significant challenges. Addressing these challenges will require closer collaboration with automakers to standardize and improve telematics systems, ensuring the feasibility of telematics billing on a broader scale.

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