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Enhancing network visibility: a smart metering data study

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Executive summary

In February 2025 Electricity North West completed a limited in scope study comparing aggregated smart meter data against data from monitoring devices at the heads of low voltage (LV) feeders at distribution substations

We created and tested the processes to:

Cleanse/process smart meter load profile data to manage data quality issue, and

Estimate time-series (i.e., half-hourly) load data to manage data availability issue

Study insights and results

The penetration of smart meters is relatively high at 61%, but data availability across customers with a smart meter is relatively low at 32%

Scaled up aggregated smart meter data did not match distribution substation devices data; kWh consumption (energy) differs from 4% up to 70% across the examined substations

Next steps

Continue to publicly encourage our customers to have smart meters fitted

Continue to develop robust automated cleansing and estimation processes so that in RIIO-ED2 we can deliver our commitment to provide 100% network visibility at all voltage levels

Background

In our RIIO-ED2 business plan we sought and received funding for distribution substation monitoring equipment, aiming to provide 100% customer coverage (95% from distribution monitoring equipment, and the remaining 5% supplemented with smart meter data – for sites where it was uneconomic to install monitoring equipment)

Smart meters have been installed in domestic properties since 2011

As at January 2025 smart meter penetration in our area is at 61%

Distribution monitoring has been installed at 6,408 substations in our license area, covering around 60% of our customers

In January 2025 in preparation for the spring 2025 flexibility services tender we downloaded the information from our monitoring equipment and customers' smart meters for 15 substations that required additional capacity to be released

This ad hoc study compares and shares the data and insights from both sources of monitoring data (measurements)

Network visibility strategy

Our business plan detailed our plans to deliver 100% network visibility coverage at all voltage levels in the price control period with new distribution monitoring equipment at 95% of sites and the remaining 5% supplemented with smart meter data

The data needed to provide a granular view of the operation of the network voltage levels will come from a combination of smart meters and new permanent distribution monitoring equipment (and where necessary third party-sources)

An accelerated installation of new distribution substation monitoring equipment recognised the state of the UK smart meter rollout and allowed us time to understand smart meter data before it is required for providing network visibility for the remaining 5% of customers

Study scope

For our spring 2025 flexibility services tender we considered distribution substations where data from monitoring equipment was available, and the forecasts showed that capacity needed to be released*

Fifteen distribution substations were identified:

Wigan, Salford, Bolton, Bury, Rochdale, Tameside, Chorley, South Ribble and Blackpool

These are urban distribution substations, supplying customer populations ranging from 192 to 688

A year's worth of monitoring data was obtained from January 2024 to December 2024

Aggregated smart meter data from the same 15 substations was obtained for comparison

All MPANs supplied by each substation were identified and aggregated smart meter data from the identified MPANs was identified using our DCC smart meter interface

Six months' worth of aggregated data* was obtained from January 2024 to May 2024, and July 2024

* For more information please check our DNOA Methodology document on LV flexibility services.

Data gathering process

The adapter provider that allowed us to gather the smart meter data for the study is Procode, an off-the-shelf product that recently replaced our previous adapter provider. For this study smart meter load data was gathered manually through the adapter as we are currently developing a process to automate access to smart meter data

To obtain the data:

Each substation was checked against our smart metering inventory and the active smart devices were collated into individual groups relating to the specific substation (manual process for this study)

Each group was uploaded to the Procode smart management portal, which is the user interface that sits over the adapter to allow us to monitor and perform any traffic in and out of our gateway

Consumption data was requested for each group for a sample of months in 2024 to avoid overloading the network with multiple requests by asking for a full year at once

Consumption data requests were returned to the Procode system which aggregated the data into a report that was manually downloaded for the analysis in this study

Smart meter data preparation for study

There were issues with data availability and data quality
Data availability varied significantly over the study period, e.g. missing data
Several data errors were identified, e.g. spikes, dips etc

We developed processes to:

Cleanse smart meter data to manage issues with data quality, and

Estimate half-hourly data to manage missing and/or poor quality smart meter data

To enable comparison, a simple percentage scaling adjustment was introduced to scale up the available aggregated smart meter half-hourly data, noting that this potentially introduces an error

The scaling adjustment introduces variable scaling factors per half-hour, taking into account the fact that the number of smart meters that data is pulled for varies with time

Study insights – focus on data availability

The availability of smart meters data varied significantly over the trial period

Sub	Jan 2024	Feb 2024	Mar 2024	Apr 2024	May 2024	Jul 2024	AVERAGE
211510	38%	17%	65%	17%	56%	65%	43%
212708	51%	20%	49%	36%	45%	41%	40%
216270	31%	28%	52%	37%	46%	52%	41%
216916	24%	3%	36%	3%	3%	6%	13%
216918	19%	11%	50%	11%	43%	5%	23%
217277	35%	30%	53%	29%	47%	2%	33%
231547	**83%**	50%	46%	50%	43%	44%	53%
231618	49%	12%	59%	16%	52%	64%	42%
232554	31%	35%	15%	31%	**0%**	19%	22%
315110	17%	41%	39%	41%	24%	41%	34%
323747	21%	8%	42%	4%	16%	40%	22%
414060	NA	13%	35%	10%	29%	31%	24%
414455	47%	24%	44%	20%	10%	24%	28%
414690	22%	18%	44%	12%	33%	29%	26%
423044	16%	20%	48%	17%	45%	45%	32%

The values in the table show the percentage of smart meters where load measurements could be retrieved over the total smart meter population connected below each substation (row)

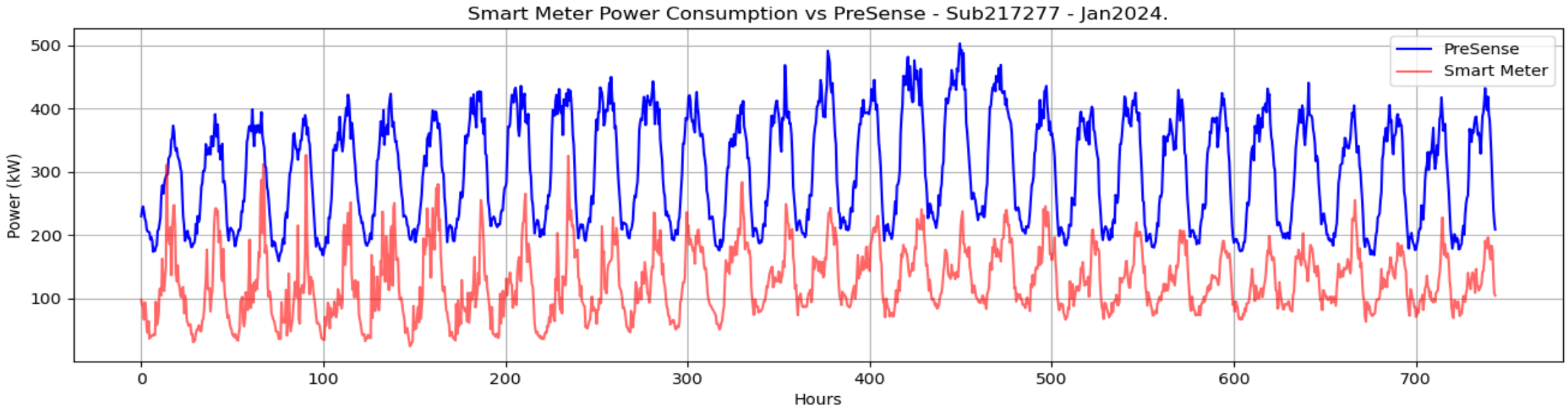
Considering the total population of customers supplied by each substation these percentages are even lower

Study insights (on the estimation process)

Limited smart meter data availability meant that to enable comparison, an adjustment was made to the aggregated HH smart data

We applied a simple percentage scaling adjustment to estimate the aggregated ‘real power’ for each half hour ie by scaling the available aggregated smart meter data using customer numbers

This simplified approach did not result in a quantum match although there was similarities observed in the profiles as shown in the graph below for a single substation



Study results

Ratio of energy consumption from smart meters estimate to substation device measurements

Sub	Jan 2024	Feb 2024	Mar 2024	Apr 2024	May 2024	Jul 2024	AVERAGE
211510	-13%	-8%	-7%	0%	-6%	-2%	-6%
212708	-21%	-12%	-21%	-14%	-14%	-14%	-16%
216270	-20%	-14%	-22%	+4%	-10%	-7%	-12%
216916	-1705%	-842%	-1287%	-1728%	-53%	-48%	-944%
216918	-64%	-32%	-49%	-56%	-53%	-64%	-53%
217277	-59%	-34%	-54%	-52%	-52%	**-70%**	-53%
231547	-40%	-33%	-44%	-45%	-52%	-51%	-44%
231618	-40%	-49%	-42%	-54%	-39%	-40%	-44%
232554	-39%	-38%	-44%	-40%	-55%	-37%	-42%
315110	-15%	-14%	-14%	-12%	-12%	-5%	-12%
323747	-26%	-40%	-21%	-52%	-22%	-22%	-30%
414060	NA	-33%	-32%	-30%	-36%	-40%	-34%
414455	-26%	-34%	-24%	-30%	-22%	-3%	-23%
414690	-32%	-16%	-27%	-20%	-24%	-40%	-26%
423044	+2%	-43%	-34%	-36%	-35%	-31%	-29%

Difficulties comparing substations with low smart meter data availability as scaling resulted in over/ under-estimating the kW values by half hour*

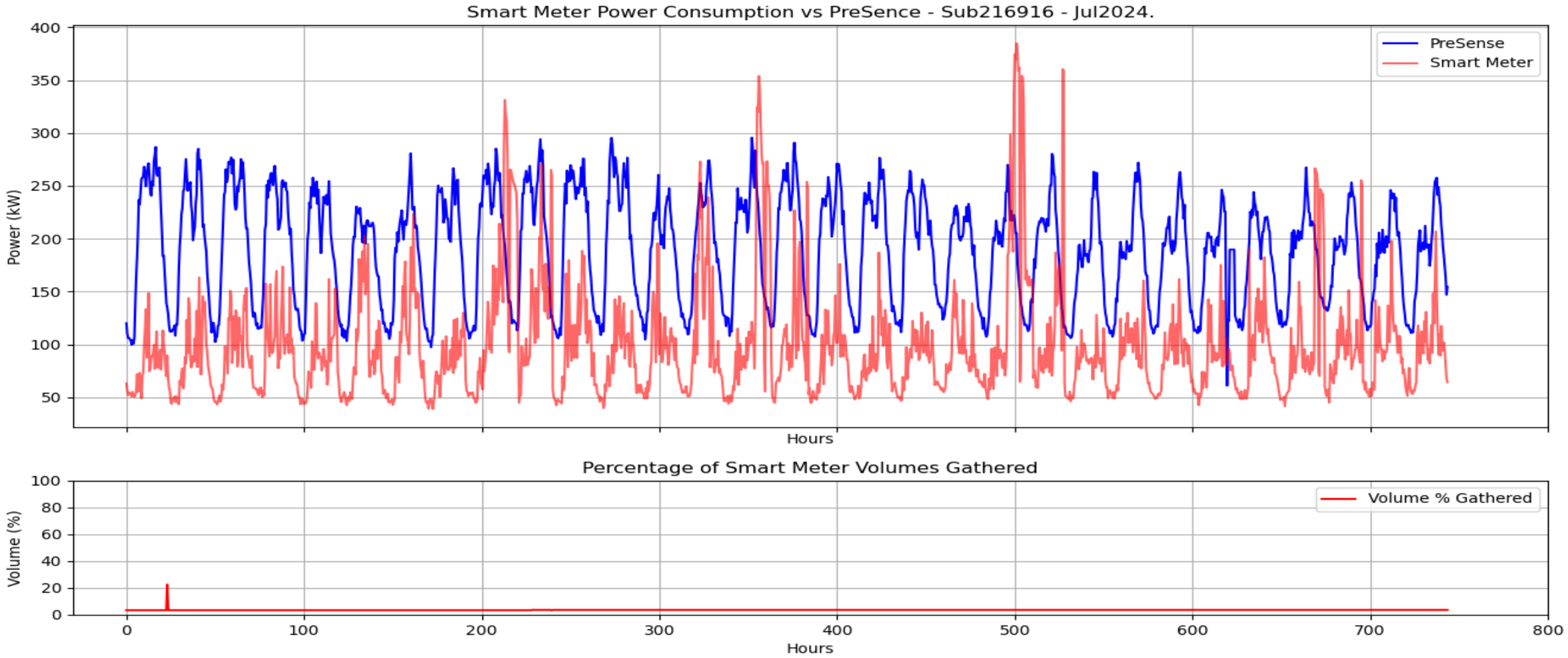
In some instances half-hourly kW profiles looked similar

In average estimates using smart meter data corresponded to monthly differences between a 4% overestimate and a 70% underestimate compared with measurements from substation devices

Extreme negative results corresponded to cases of substations with significant generation exports

Sample study result

Differences of smart meter estimates from PreSense readings (substation devices) representative of error using smart meter data for visibility. The bottom graph shows the percentage of smart meter volumes gathered as a percentage over all customers supplied by the same substation (all MPANs). Graphs for all substations examined in this study are shown in the appendices



Study conclusions

This limited study has helped us understand the challenges of processing aggregated smart meter data. Further work is needed to develop robust and automated processes – manual handling is time consuming and costly

Smart meter penetration and smart meter data availability are **NOT YET** at sufficient levels that aggregated smart meter data can be relied upon to provide network visibility in our license area

This endorses our approach of installing distribution monitoring equipment to drive high levels of network visibility in RIIO-ED2

We need to develop reliable automated estimating techniques to utilise smart meter data for planning and operational purposes

However, it is also critical for all DNOs to pull via DCC load measurements (kWh) across as many smart meter devices as possible every half-hour

Recommendations/next steps

Continue to publicly encourage our customers to have smart meters fitted

Continue to develop robust and automated processes so that in RIIO-ED2 we can deliver our commitment to provide 100% network visibility at all voltage levels:

Automate the processing of 'smart meter' data, collecting and aggregating half-hourly data from all import and export MPANs (metered customers)	Automate the cleansing / processing of smart meter data to manage poor quality data	Develop and automate a range of estimation techniques to manage missing data (contingent on the type and reason for the unavailability of data)	Agree an acceptable error for the difference between aggregated smart meter data and distribution network monitoring data

Re-do and extend the study in the next financial year (FY26)

Appendix 1: Distribution substation characteristics

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Appendix 1: Distribution substation characteristics

Study involved 15 distribution substations from:
Wigan, Salford, Bolton, Bury, Rochdale, Tameside, Chorley, South Ribble and Blackpool

These are ‘urban’ distribution substations, supplying mostly domestic customers:

Total number of customers is 5,025 (4782 domestic and 243 non-domestic)

Customer populations range from 192 to 688, average customer number per substation is 335

Transformer sizes range from 300 to 750kVA, with 300kVA being the mode

No. of LV ways range from 4 to 10, with 4 ways being the mode

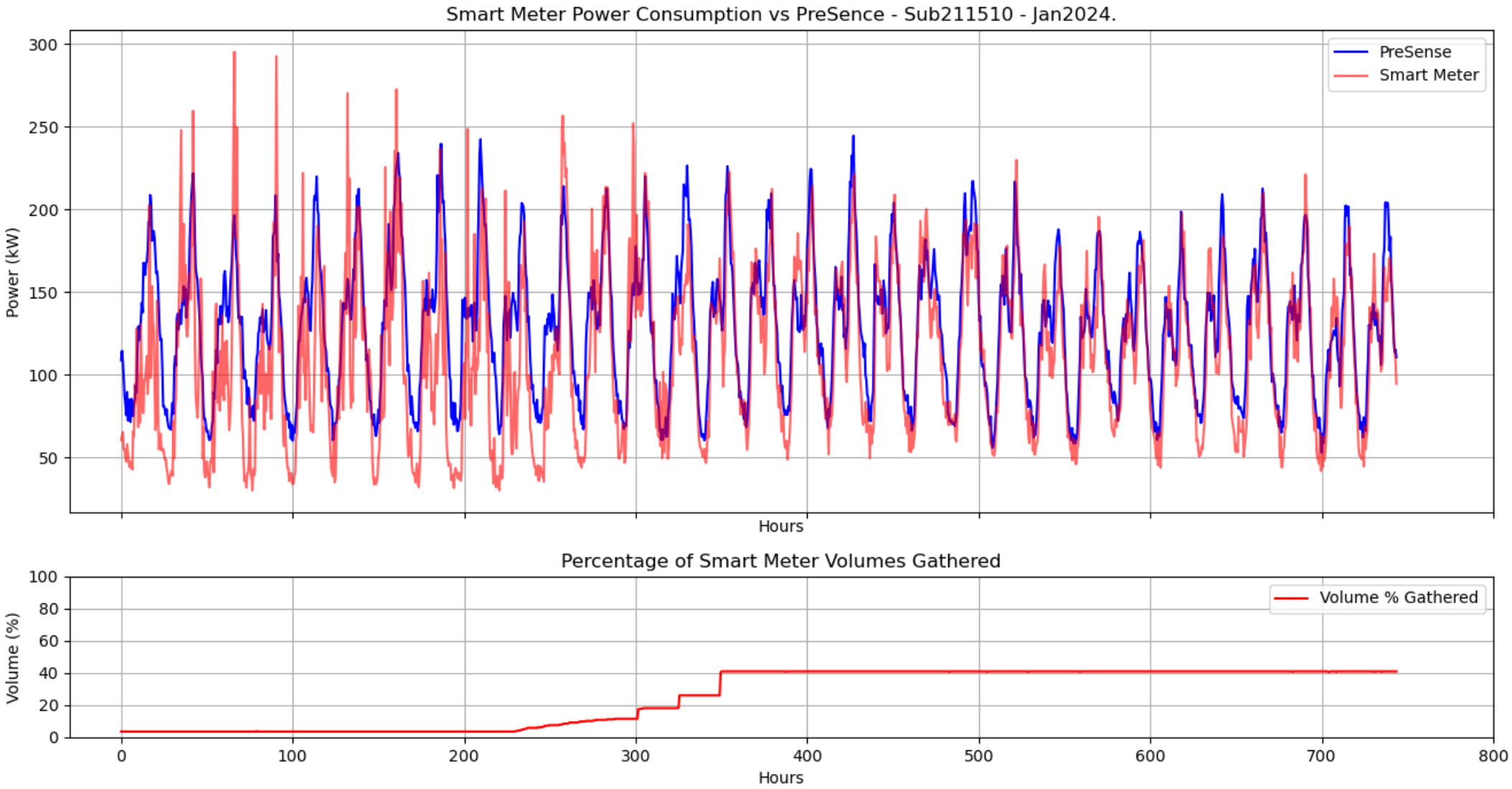
LV u/g mains cable lengths range from 1,994m to 6,525m, average length of 3,575m

LV service cable lengths range from 671m to 5,744m, average length of 3389m

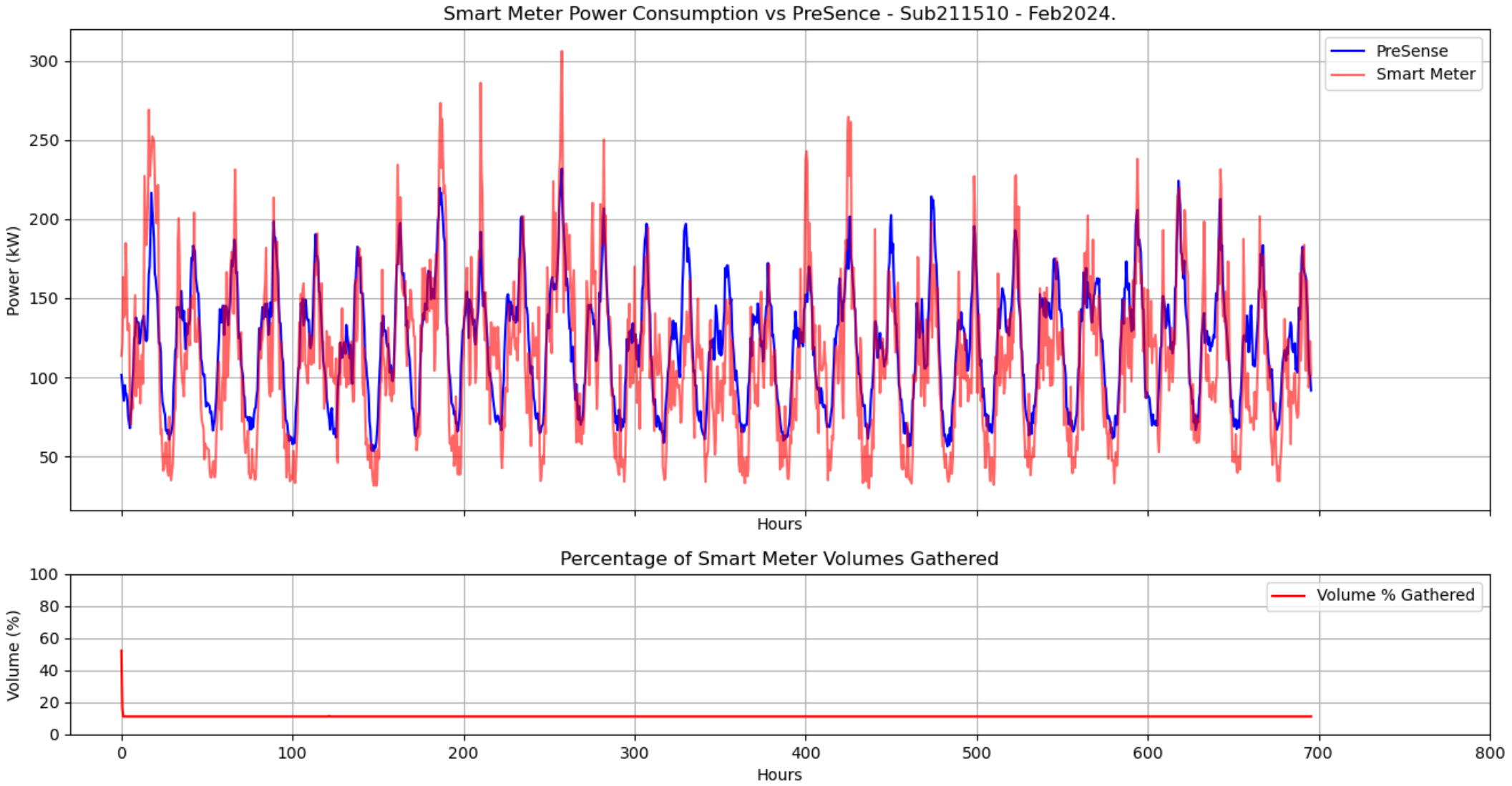
Relatively low level of low carbon technologies penetration with:
42 EV charging points, 124 SSEGs and 2 heat pumps

Appendix 2.1: Study results for substation 211510

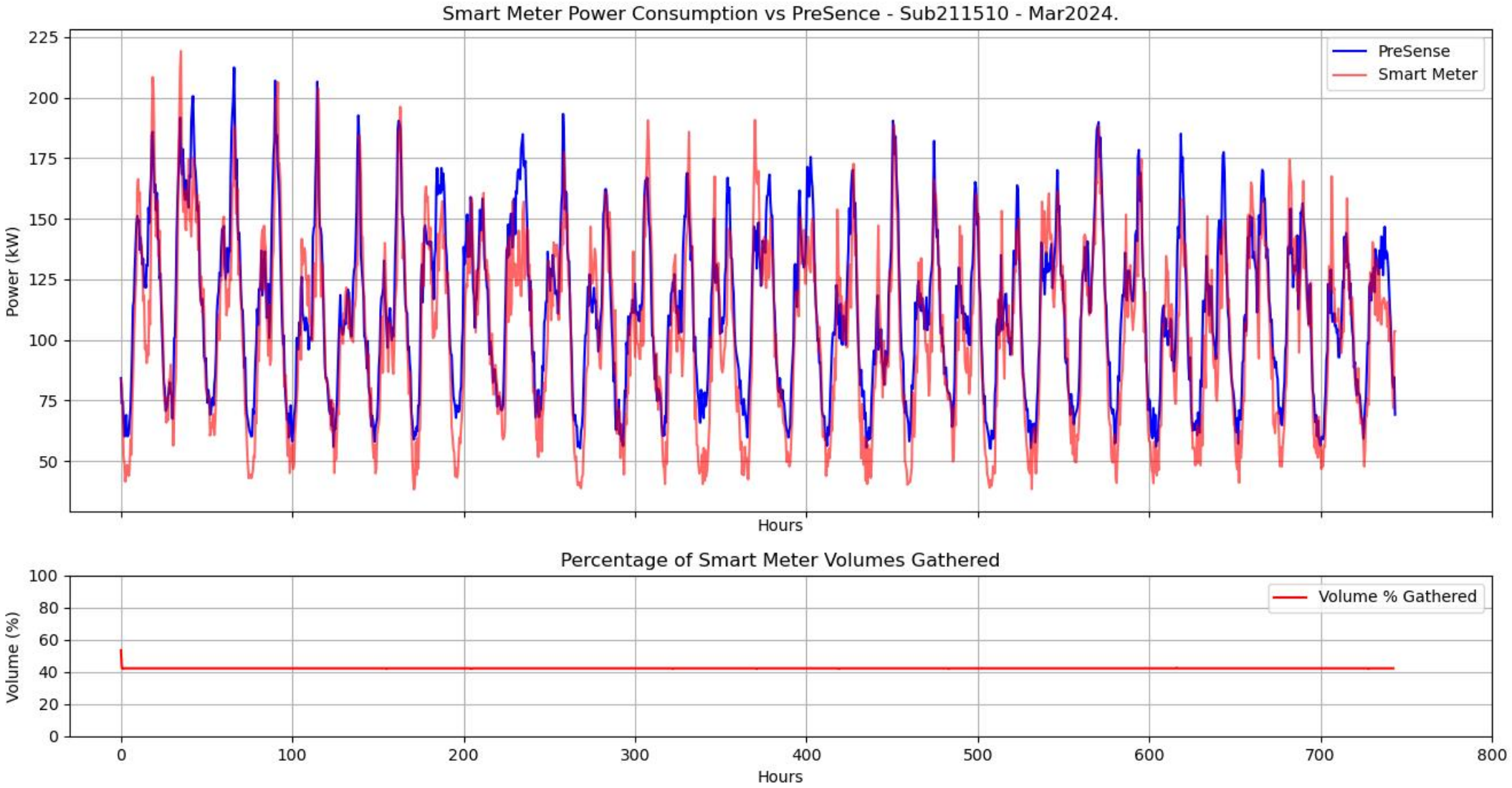
Substation 211510 – January 2024



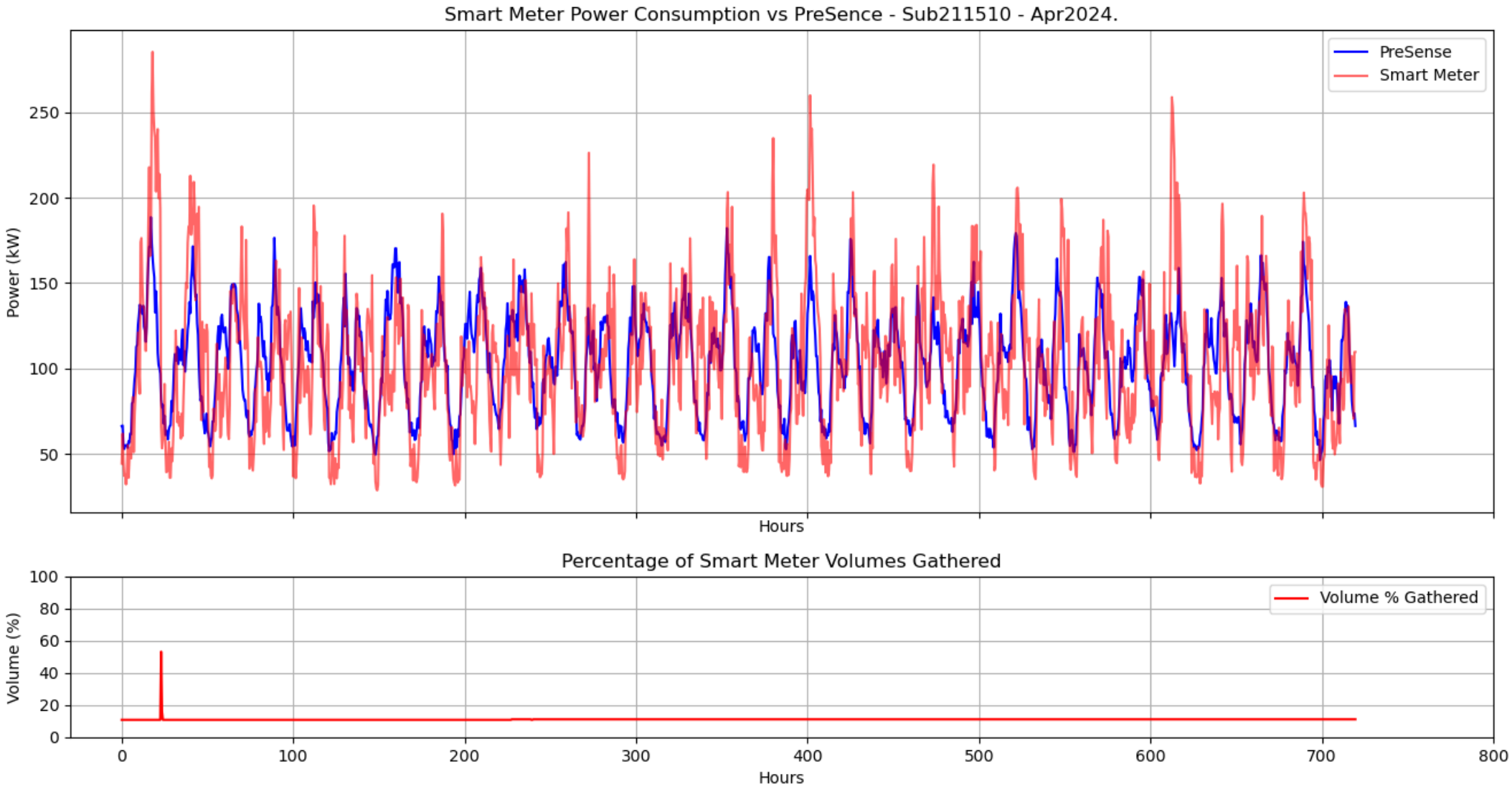
Substation 211510 – February 2024



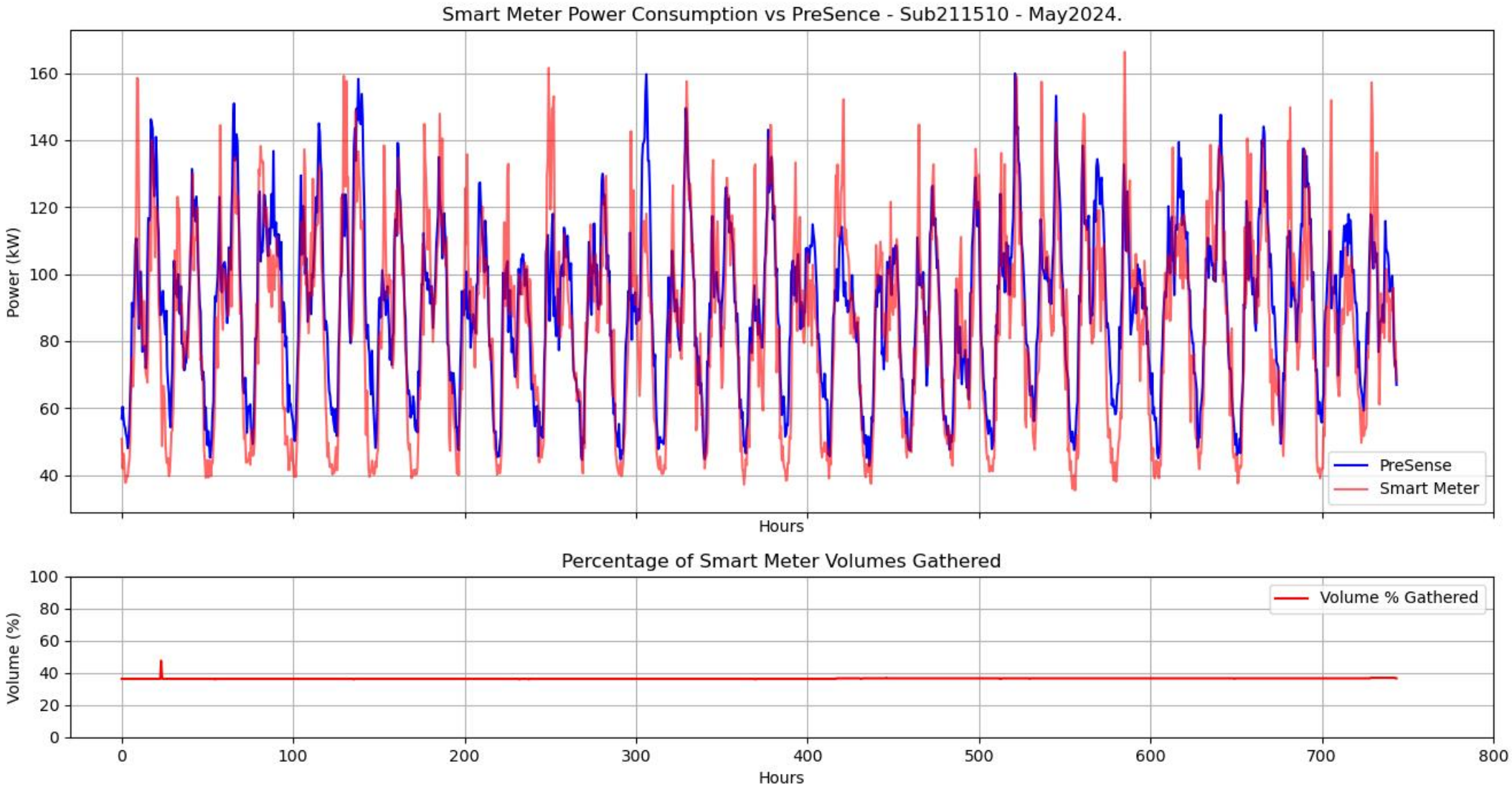
Substation 211510 – March 2024



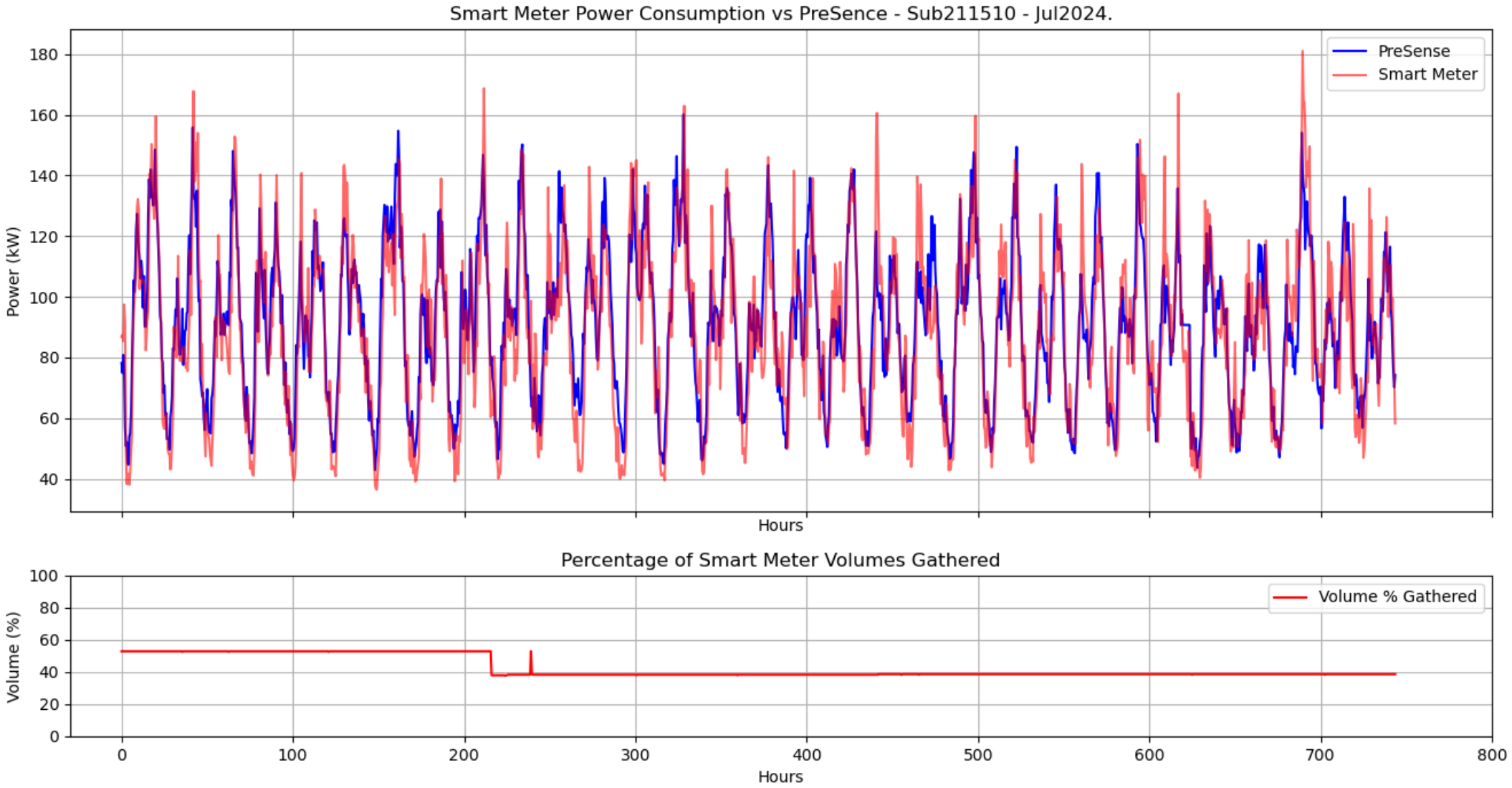
Substation 211510 – April 2024



Substation 211510 – May 2024



Substation 211510 – July 2024



Appendix 2.2: Study results for substation 212708

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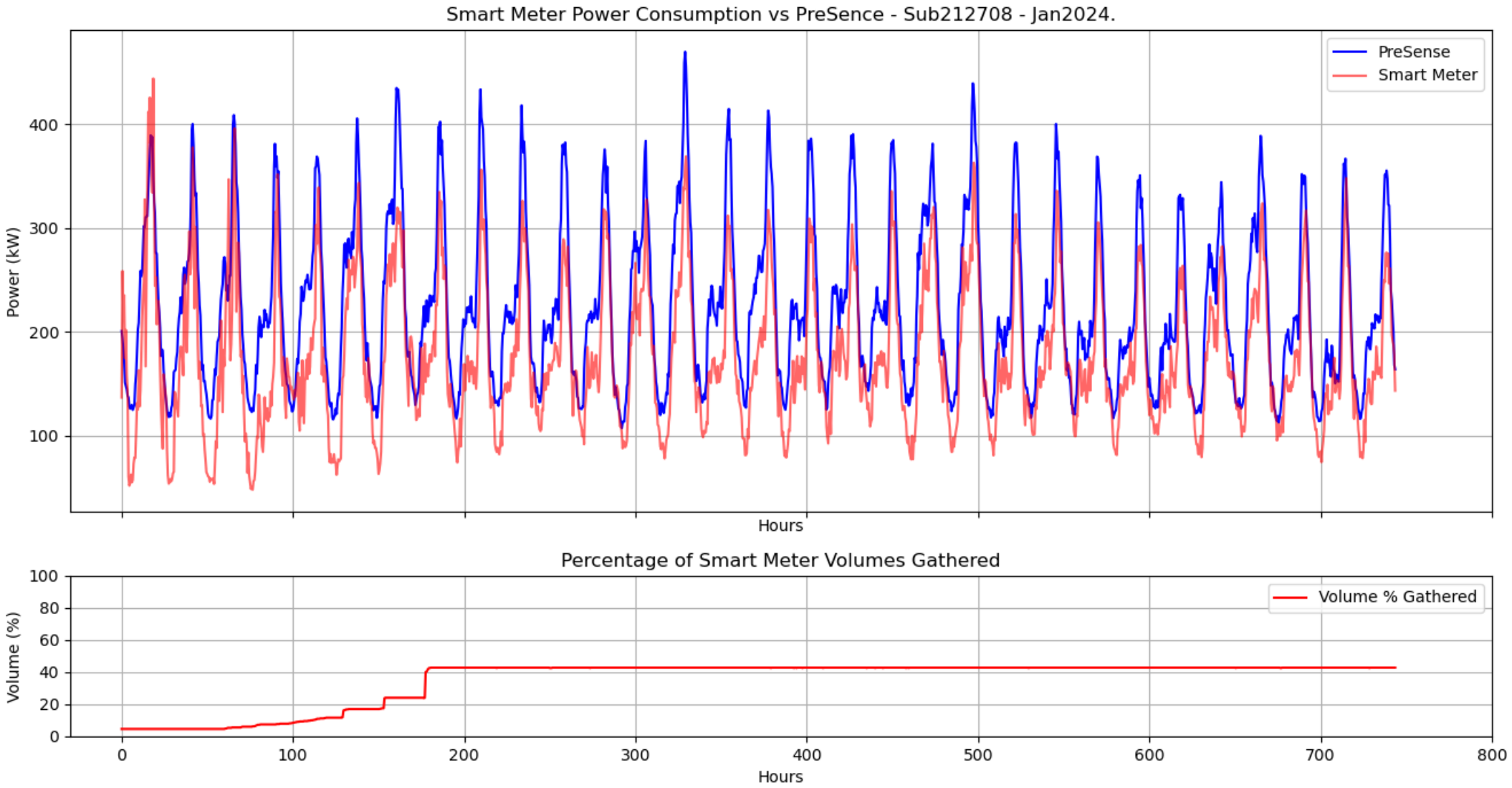
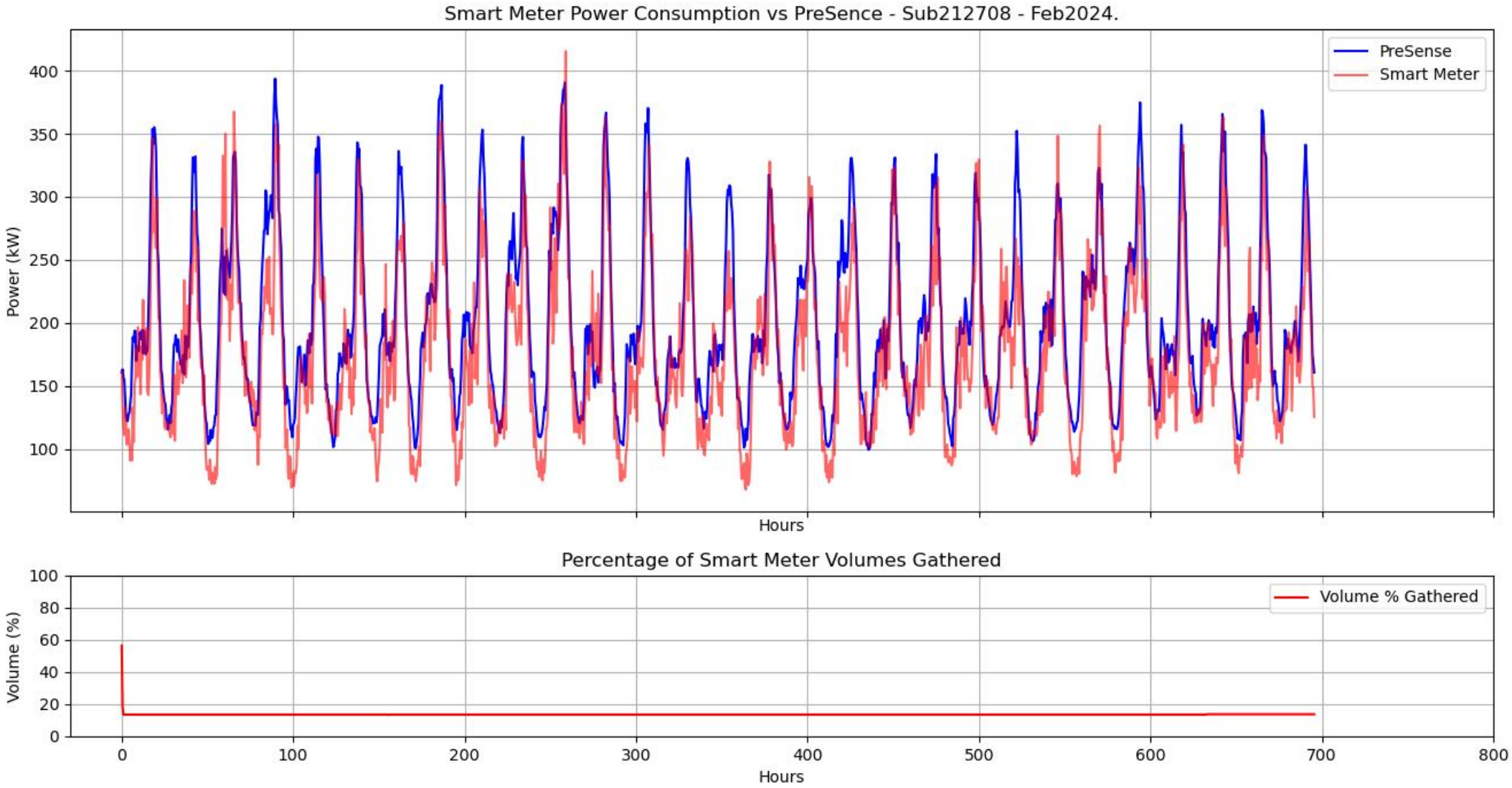
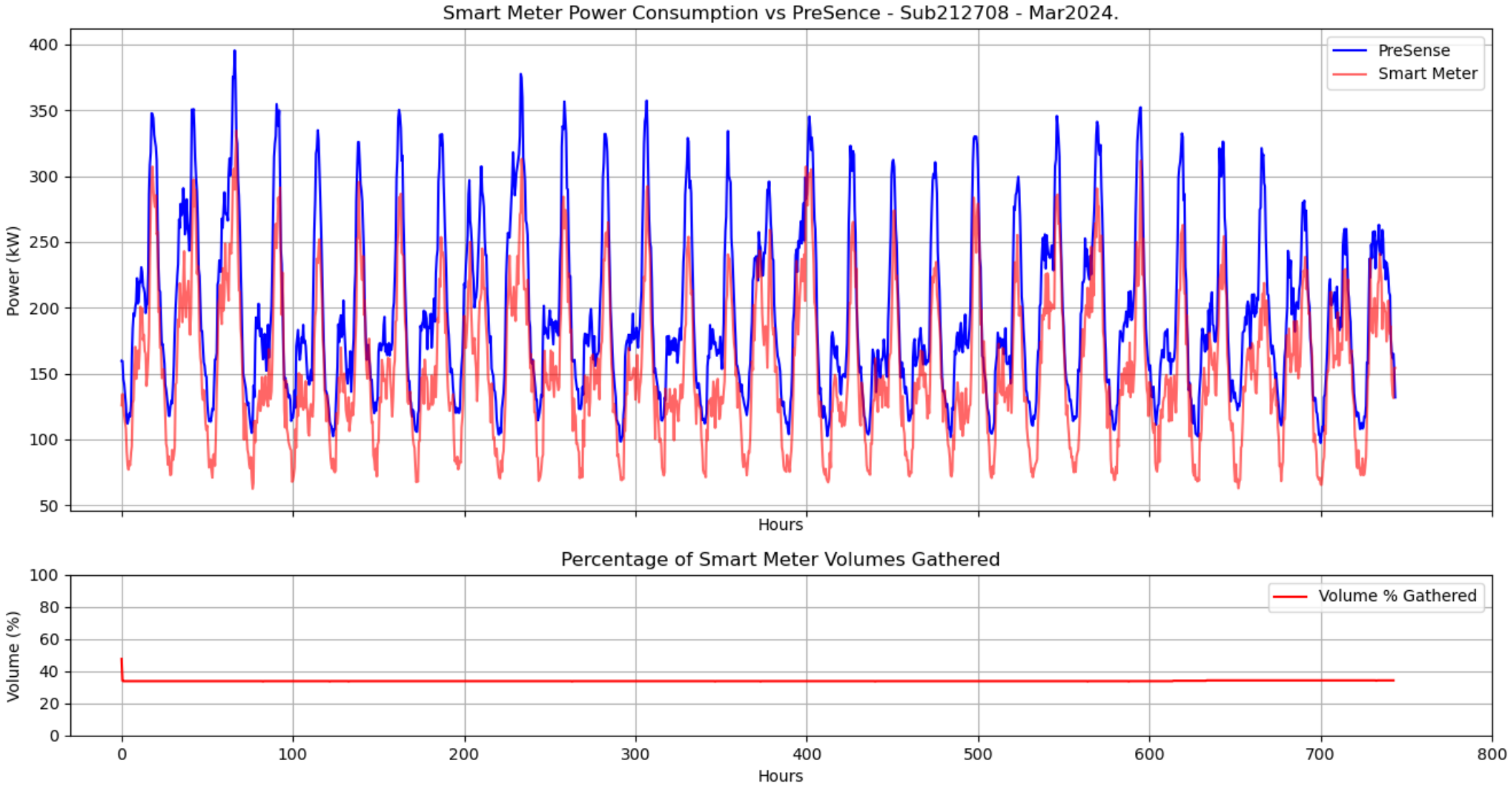
Substation 212708 – January 2024



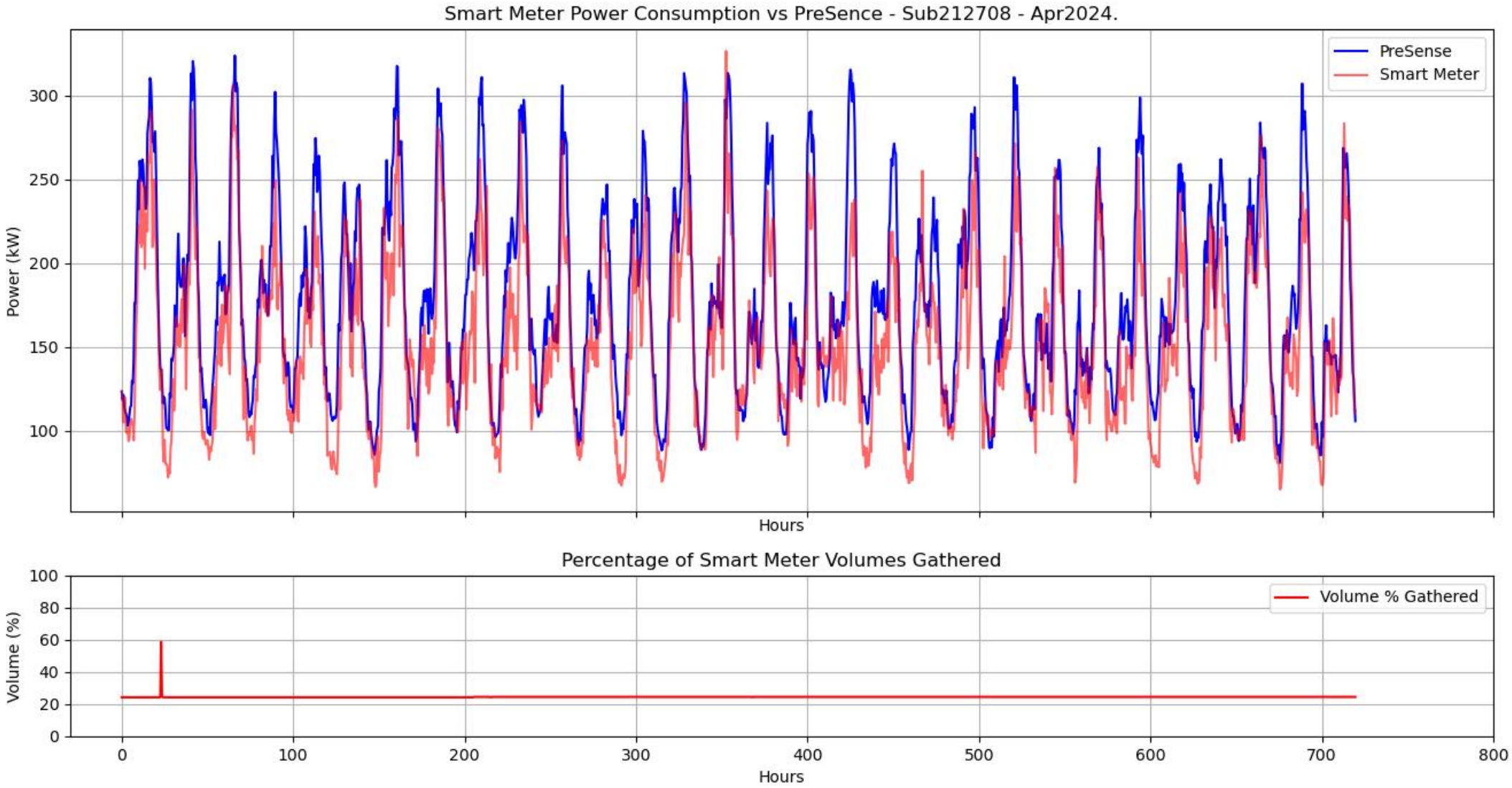
Substation 212708 – February 2024



Substation 212708 – March 2024



Substation 212708 – April 2024



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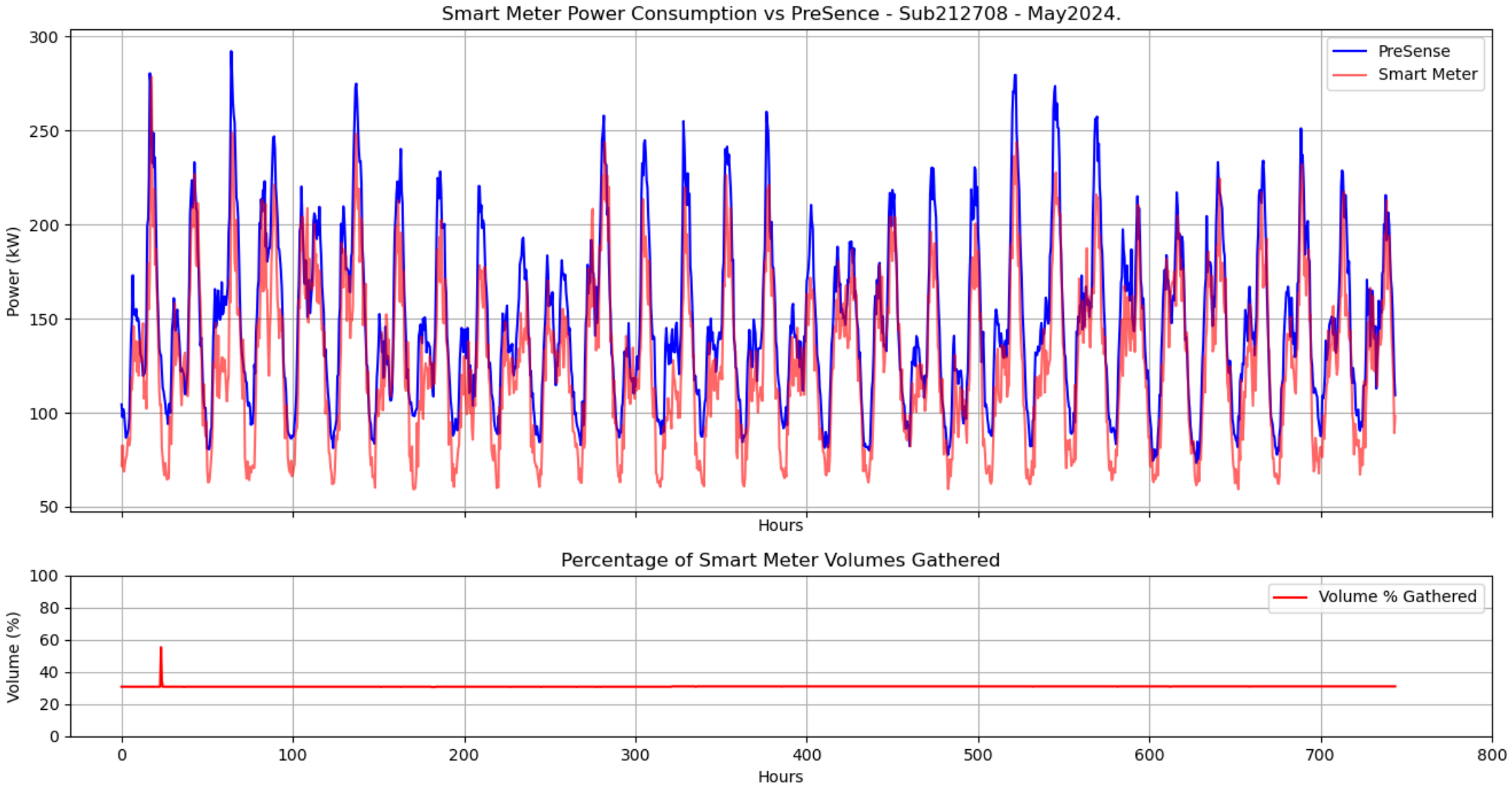
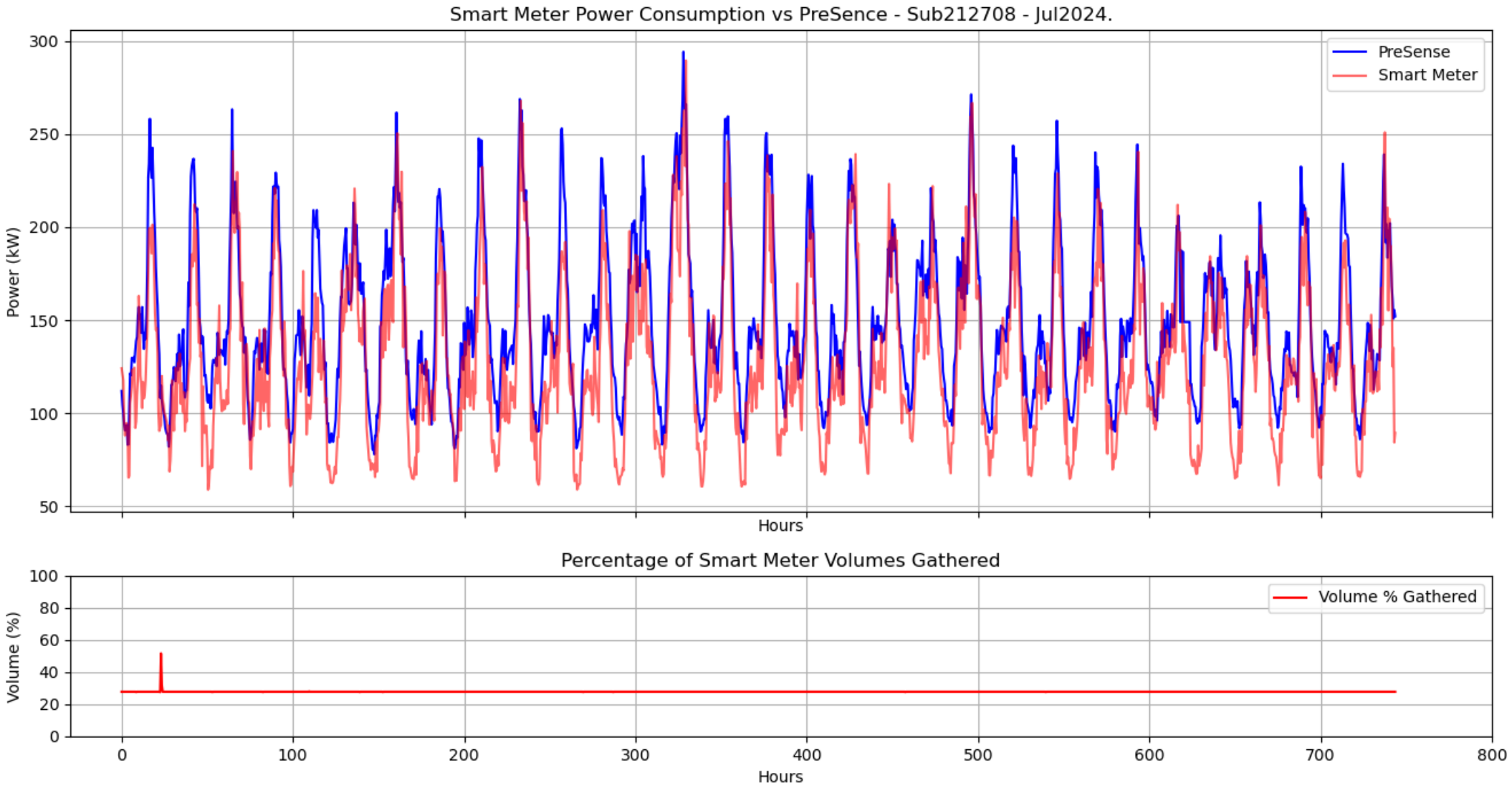
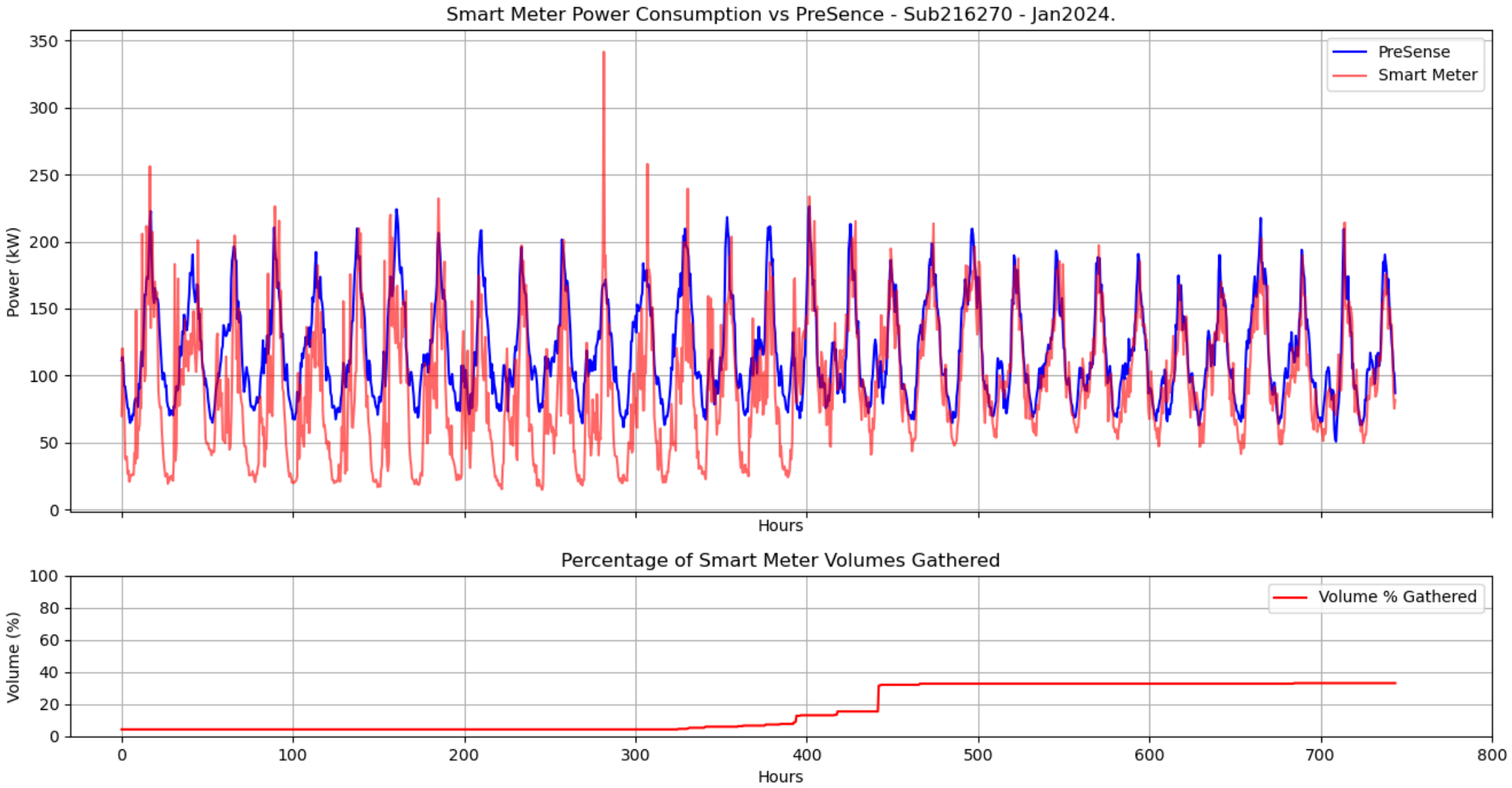


Substation 212708 – July 2024

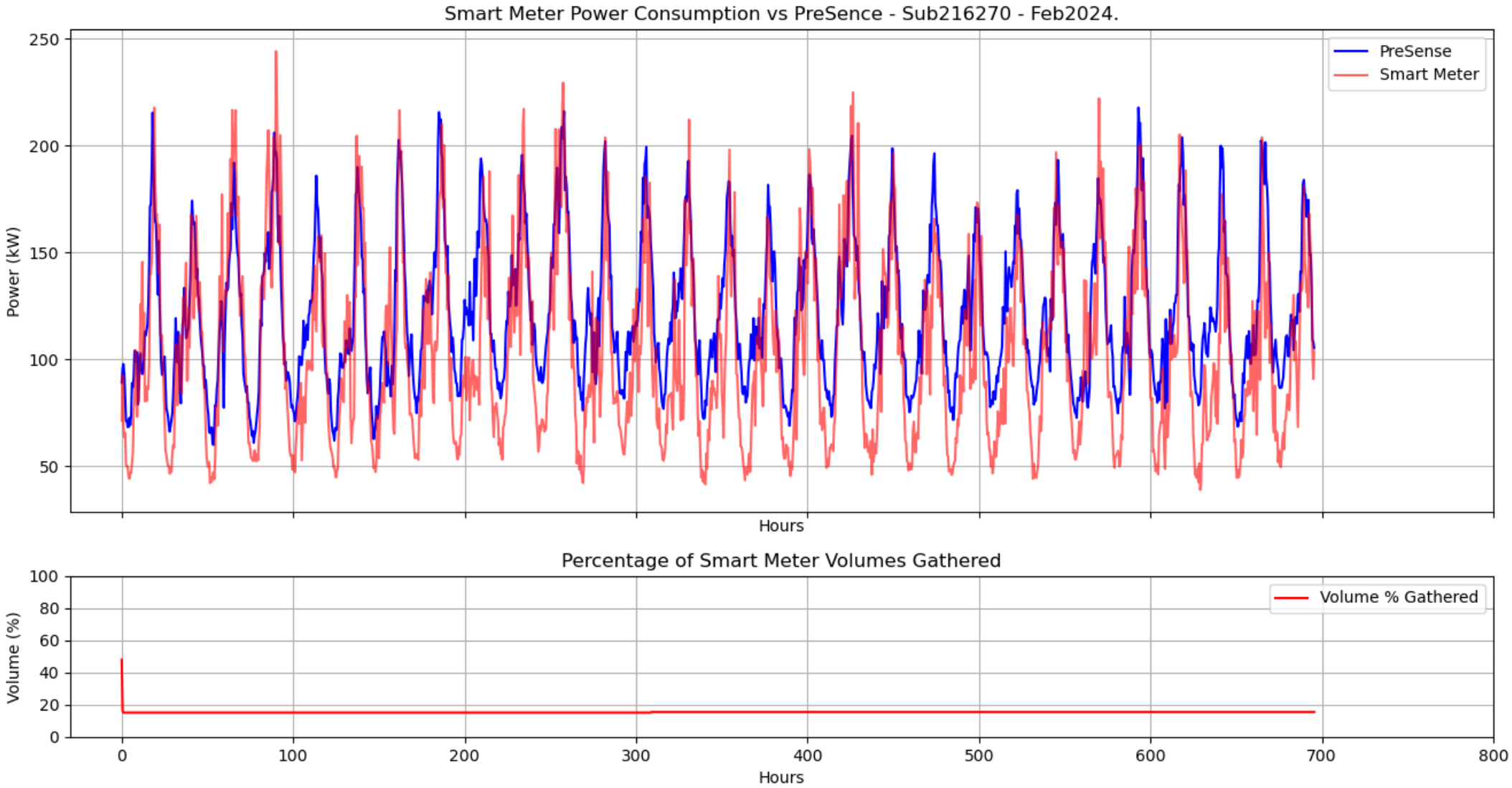


Appendix 2.3: Study results for substation 216270

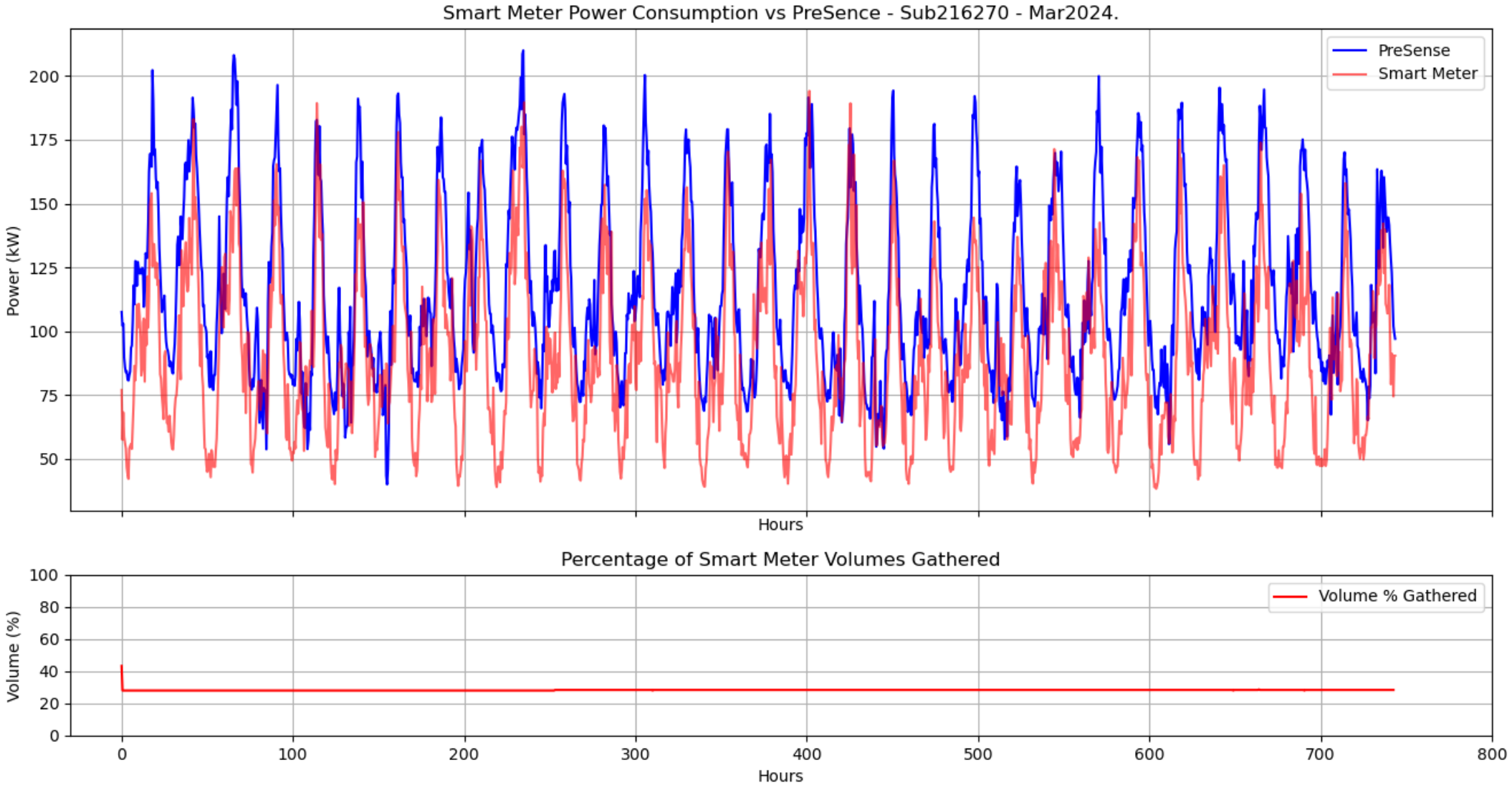
Substation 216270, January 2024



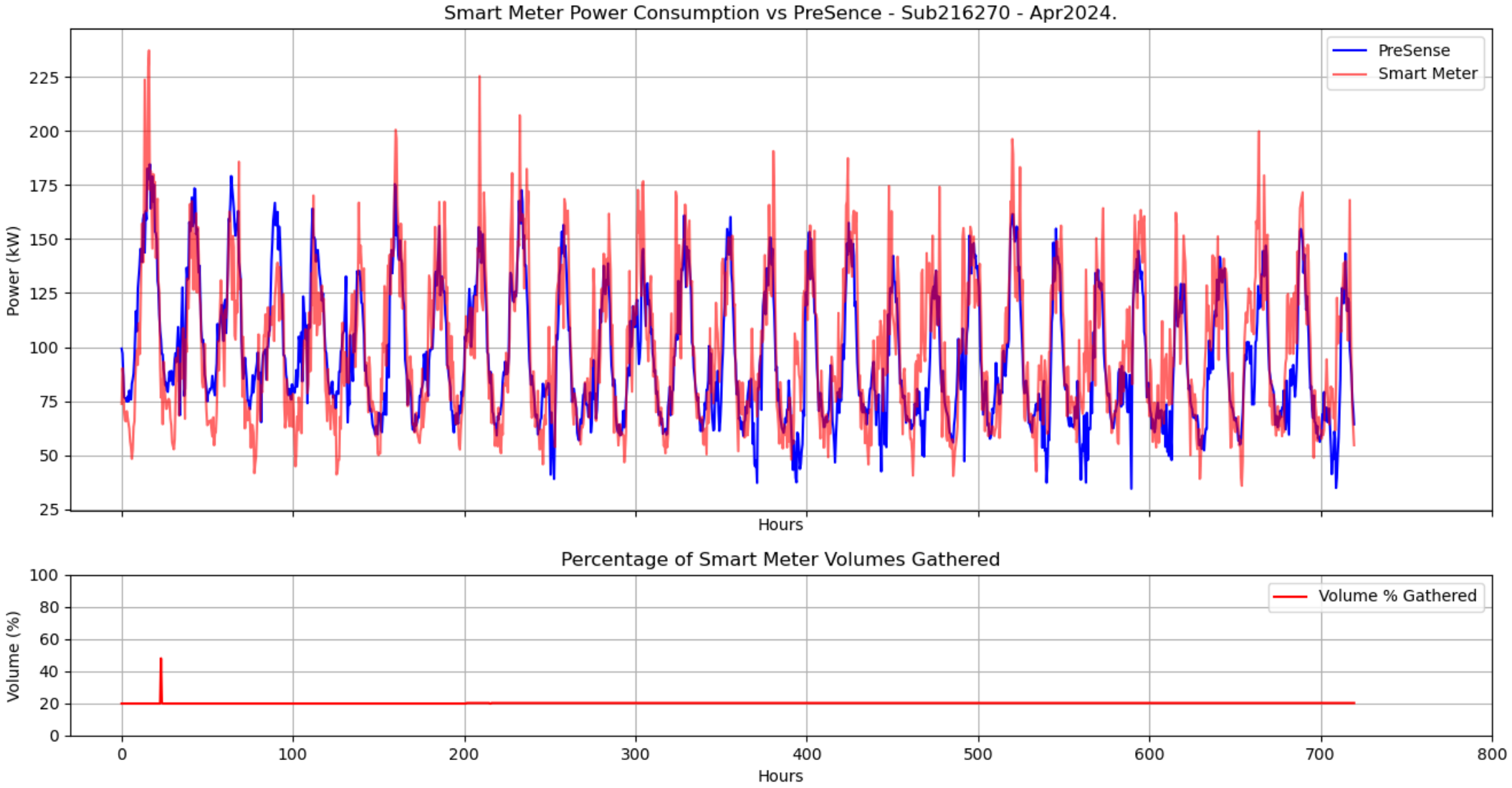
Substation 216270 – February 2024



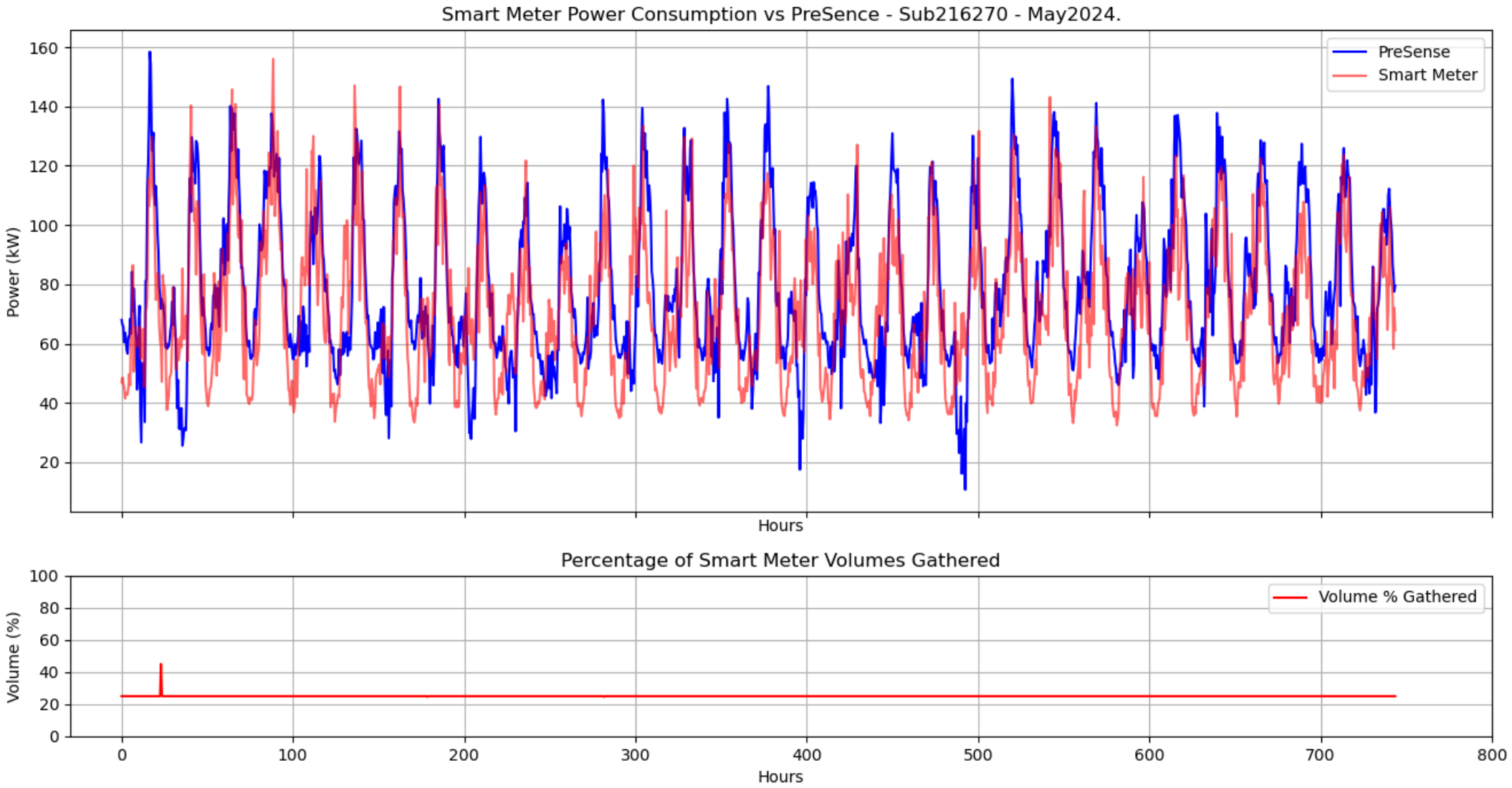
Substation 216270 – March 2024



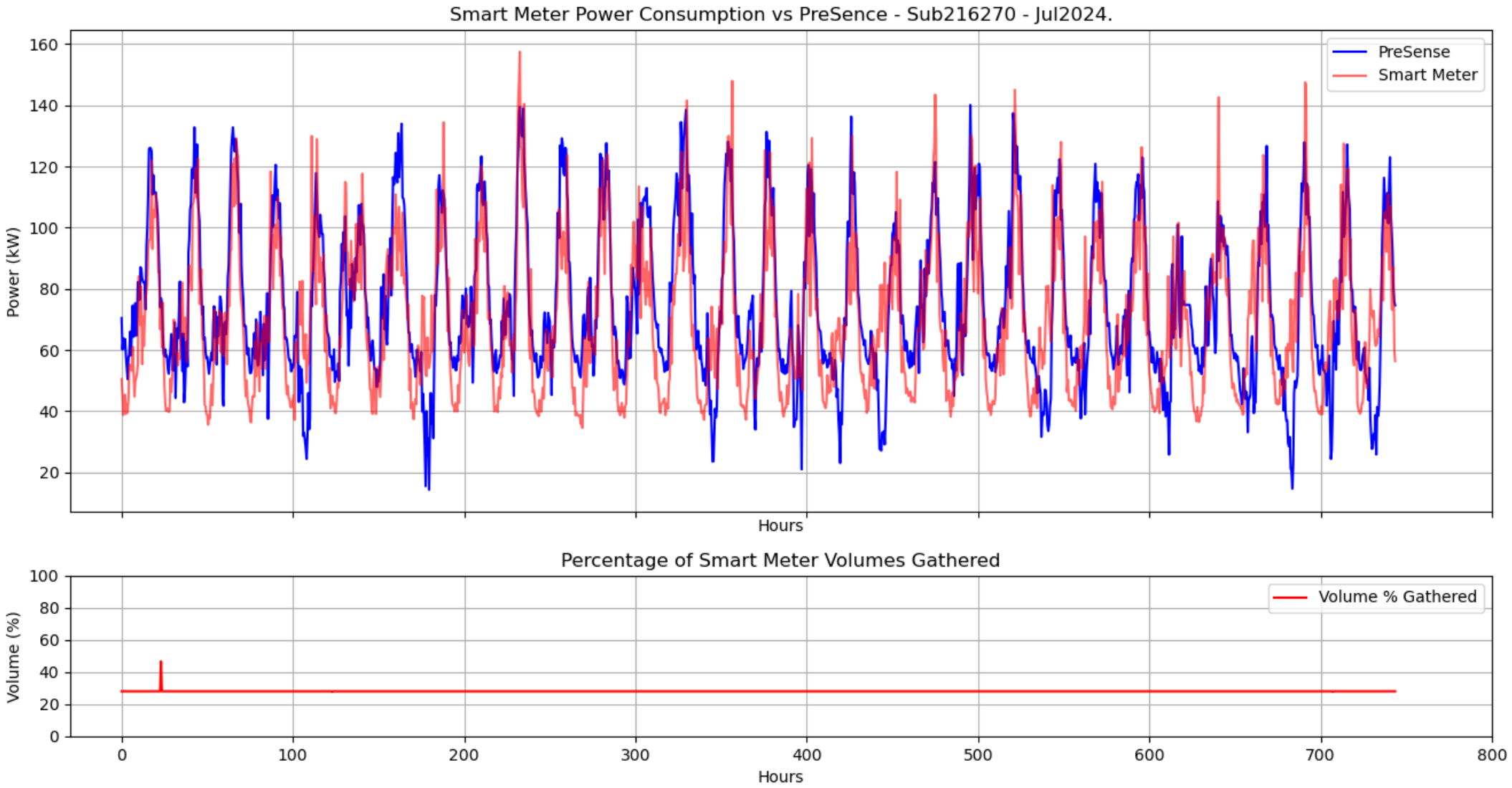
Substation 216270 – April 2024



Substation 216270 – May 2024



Substation 216270 – July 2024



Appendix 2.4: Study results for substation 216916

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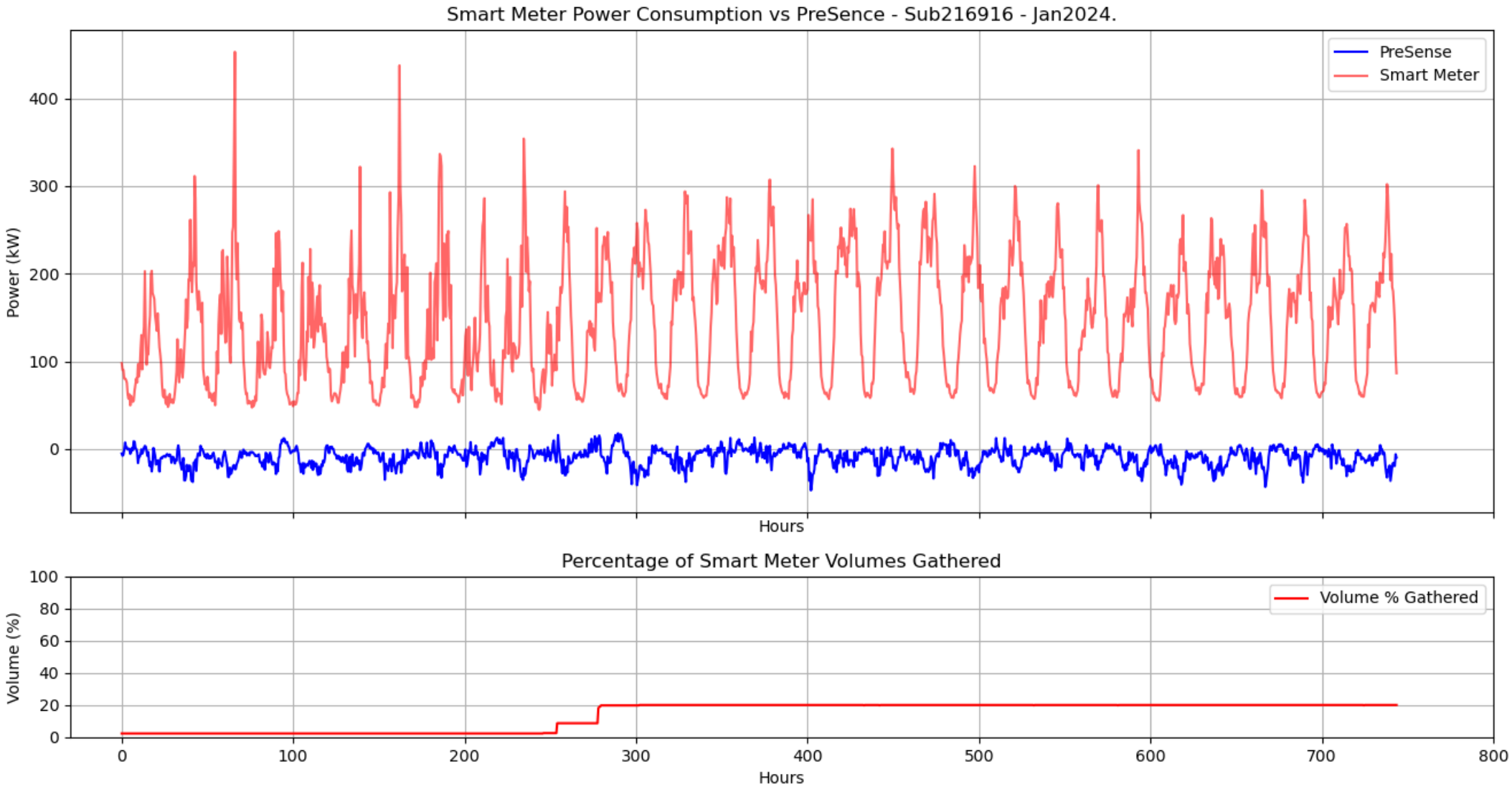
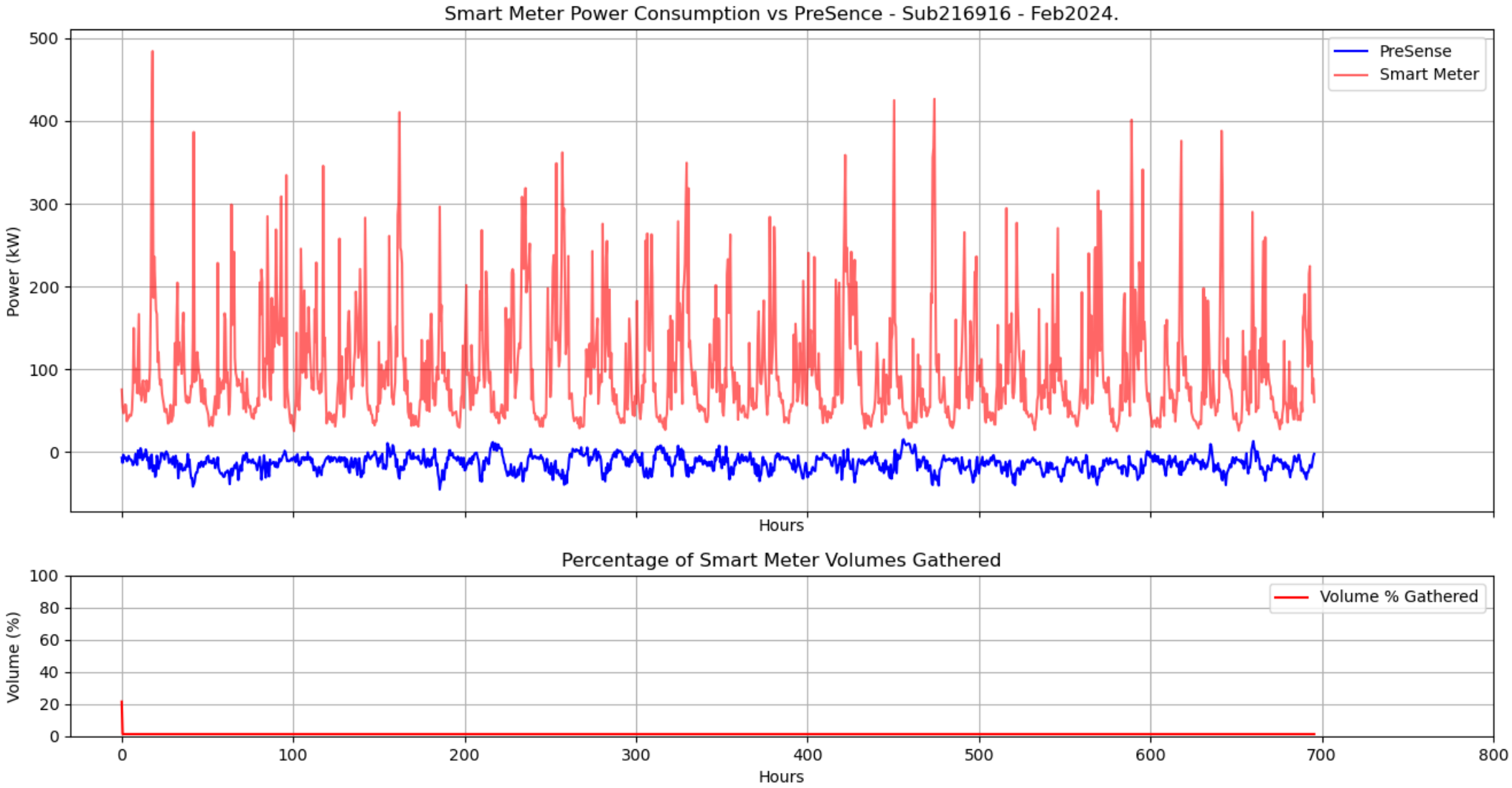
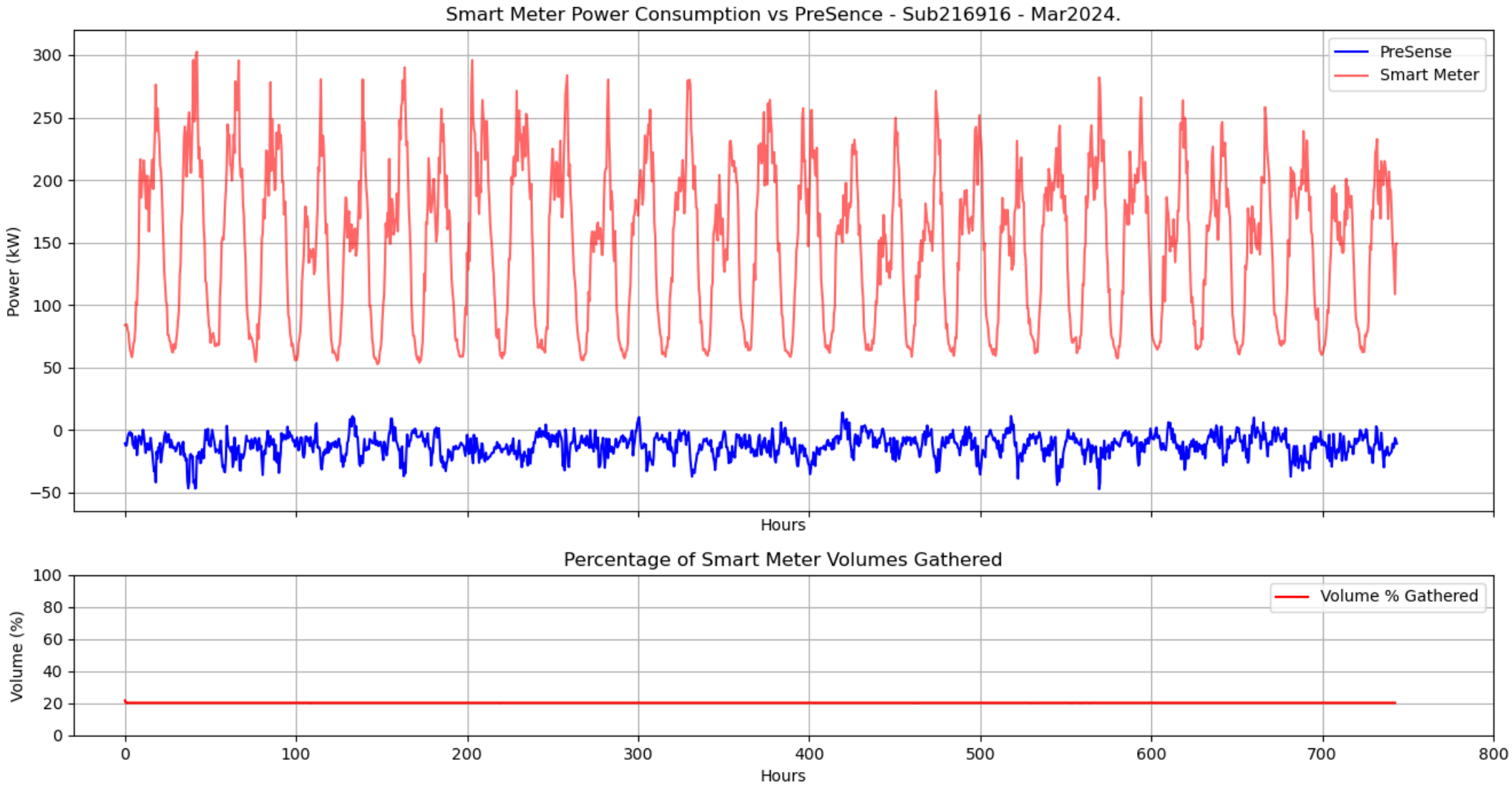
Substation 216916 – January 2024



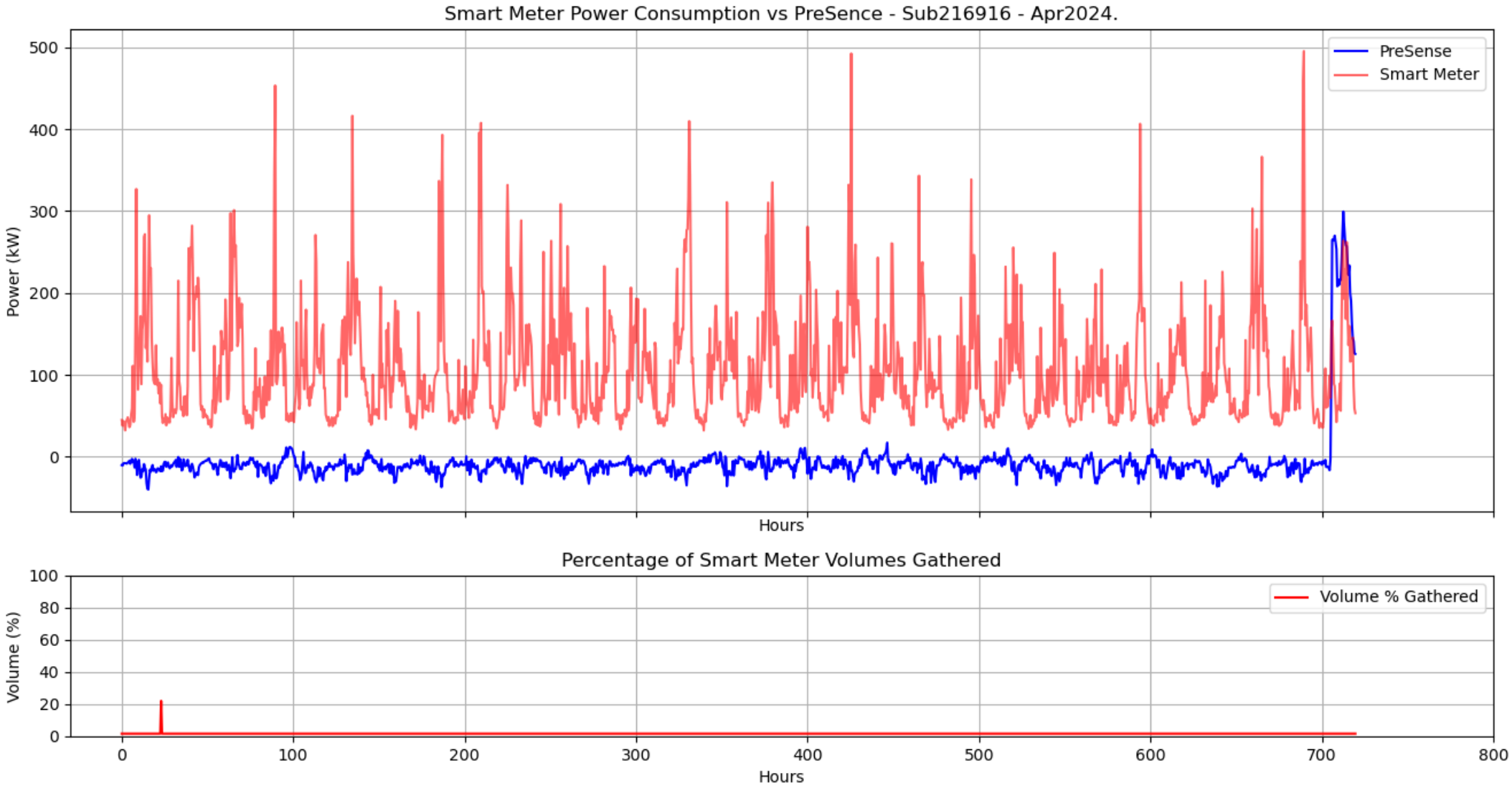
Substation 216916 – February 2024



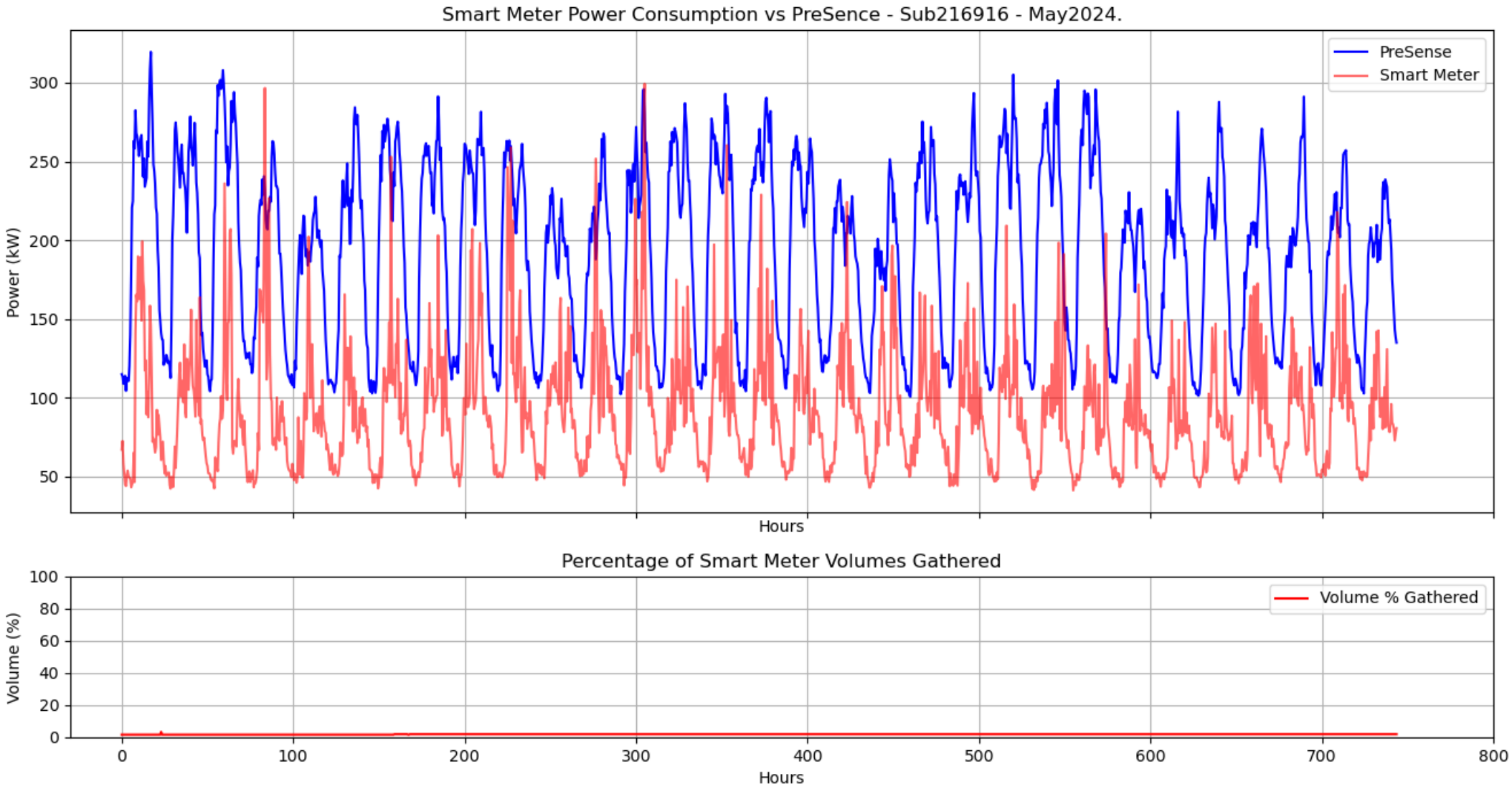
Substation 216916 – March 2024



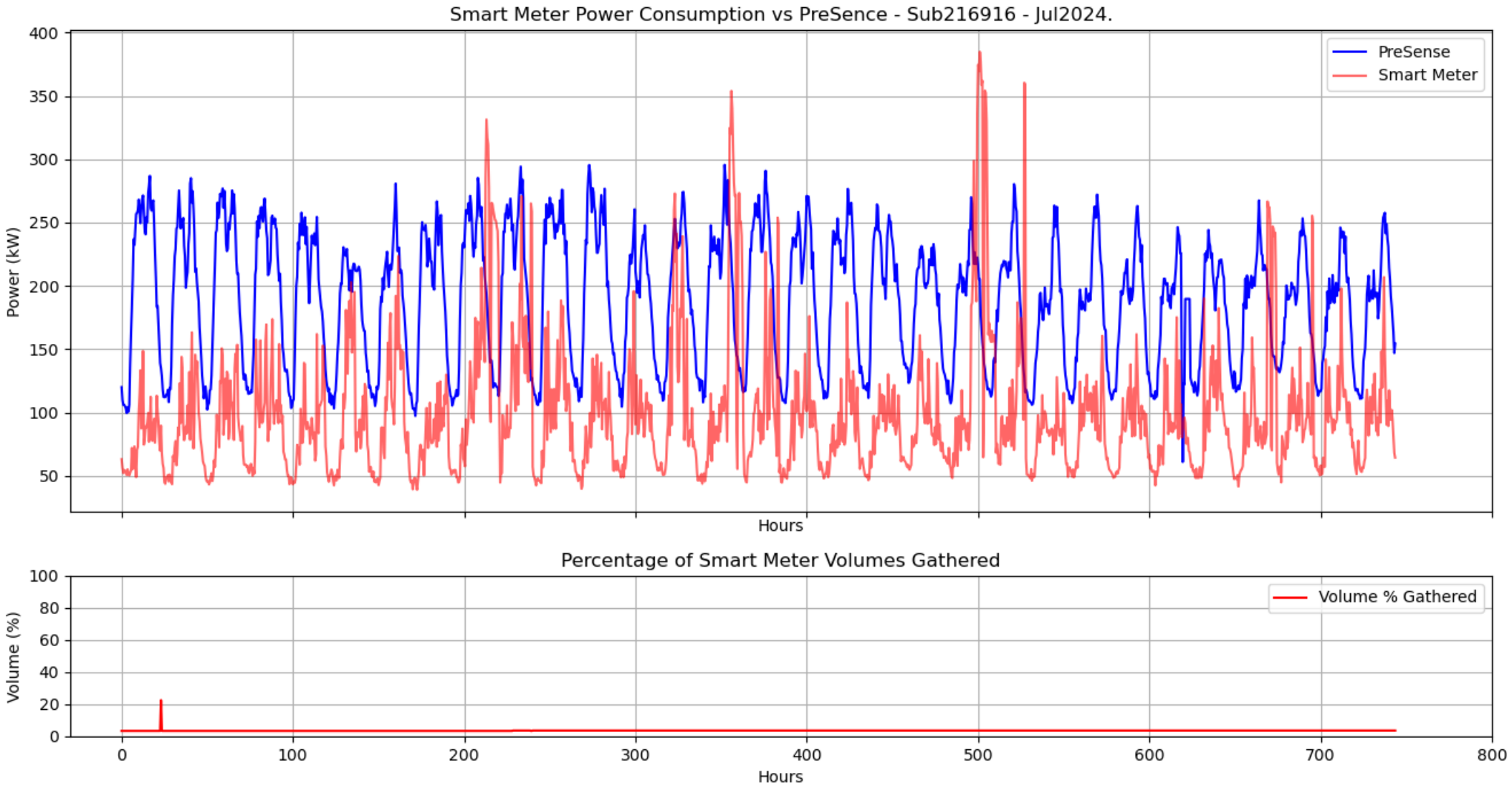
Substation 216916 – April 2024



Substation 216916 – May 2024



Substation 216916 – July 2024



Appendix 2.5: Study results for substation 216918

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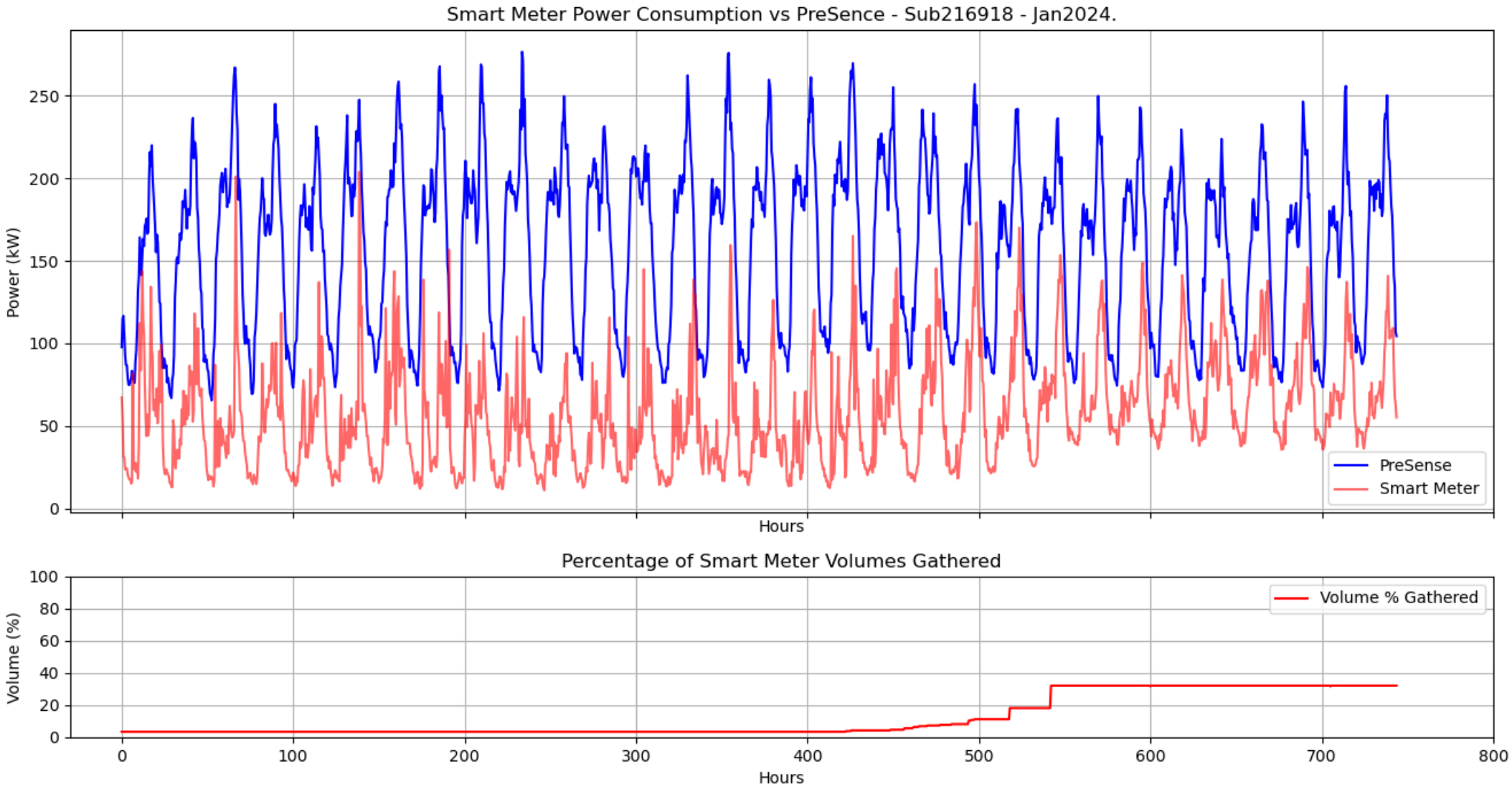
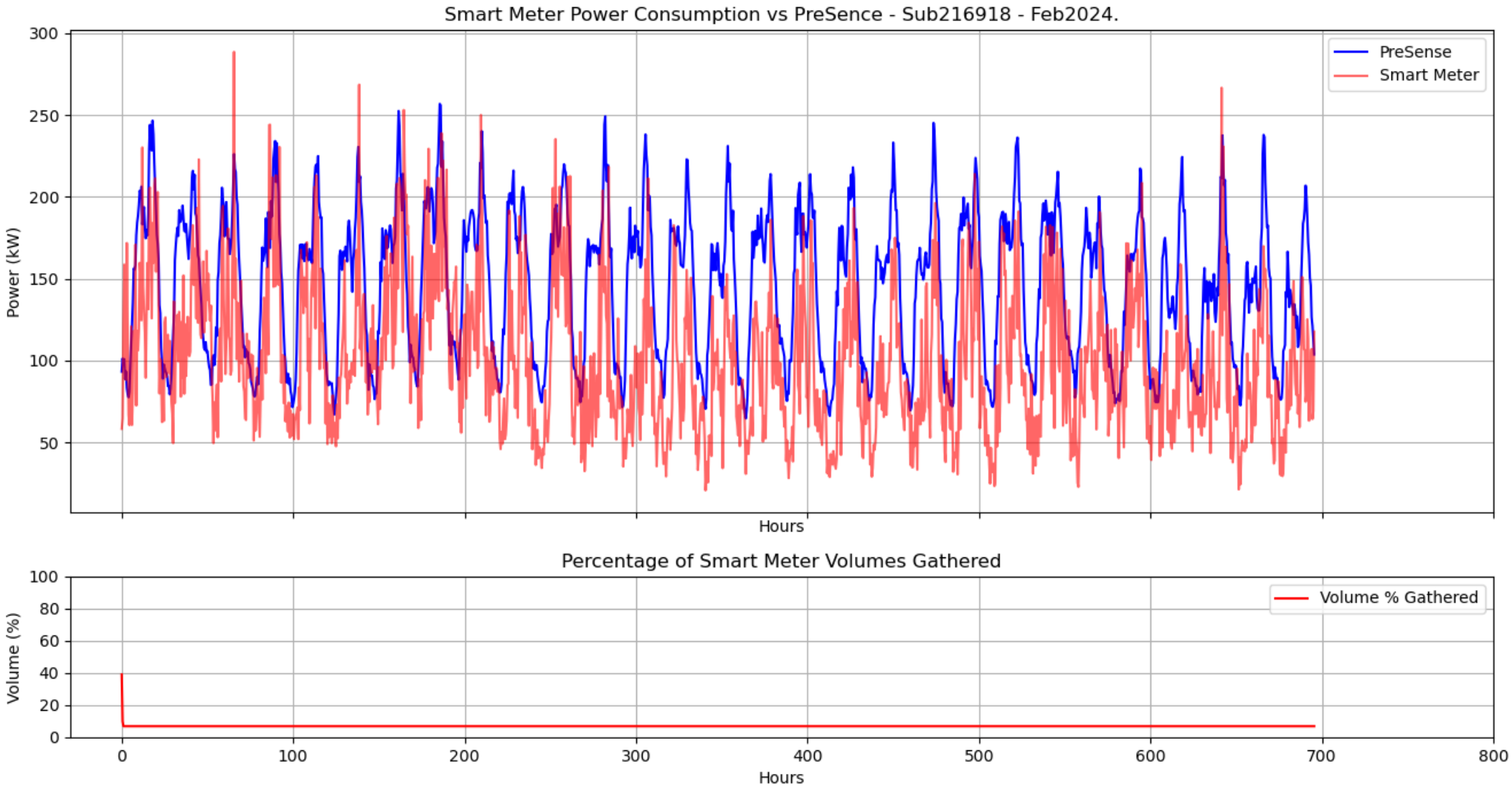
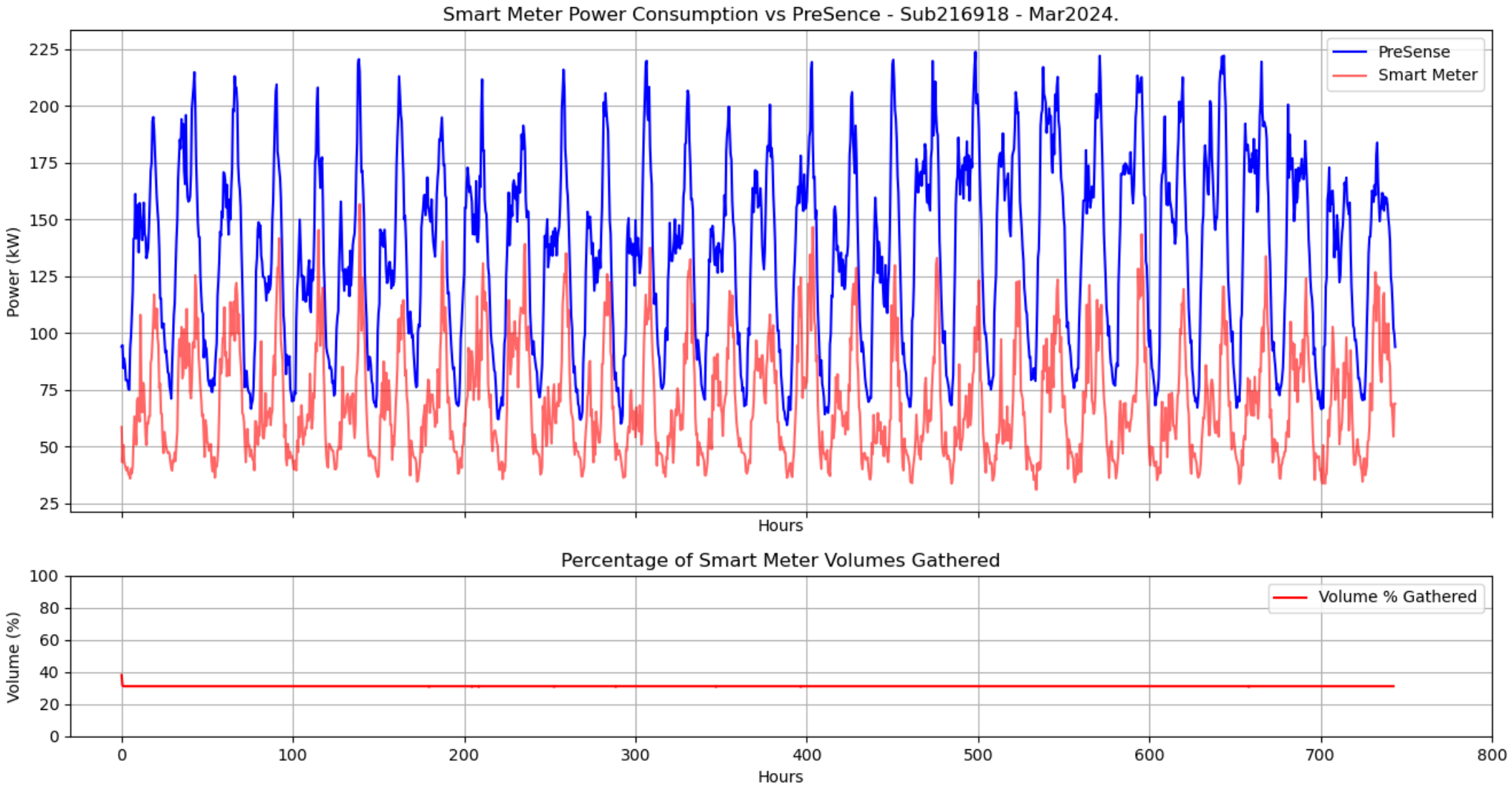
Substation 216918 – January 2024



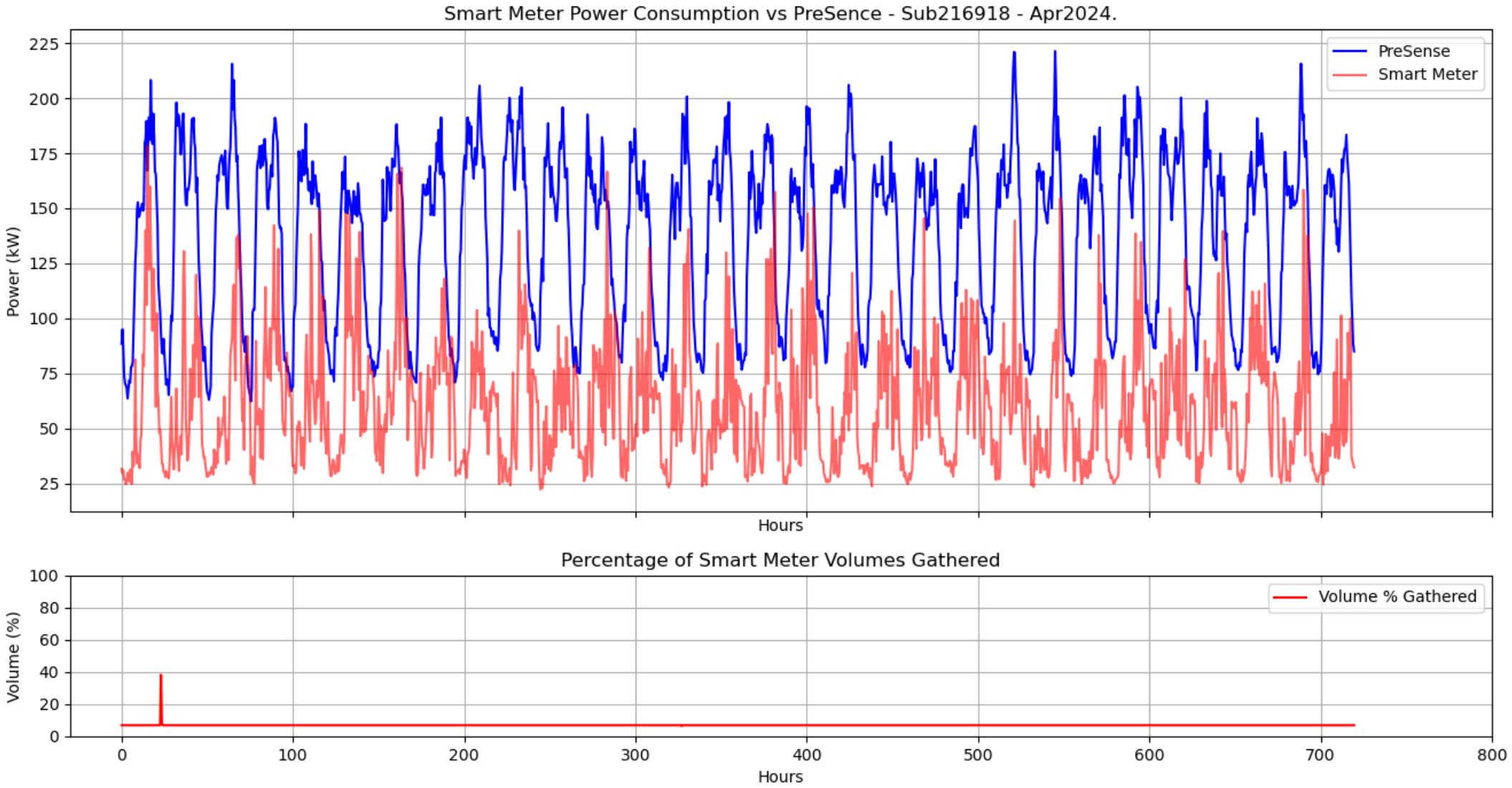
Substation 216918 – February 2024



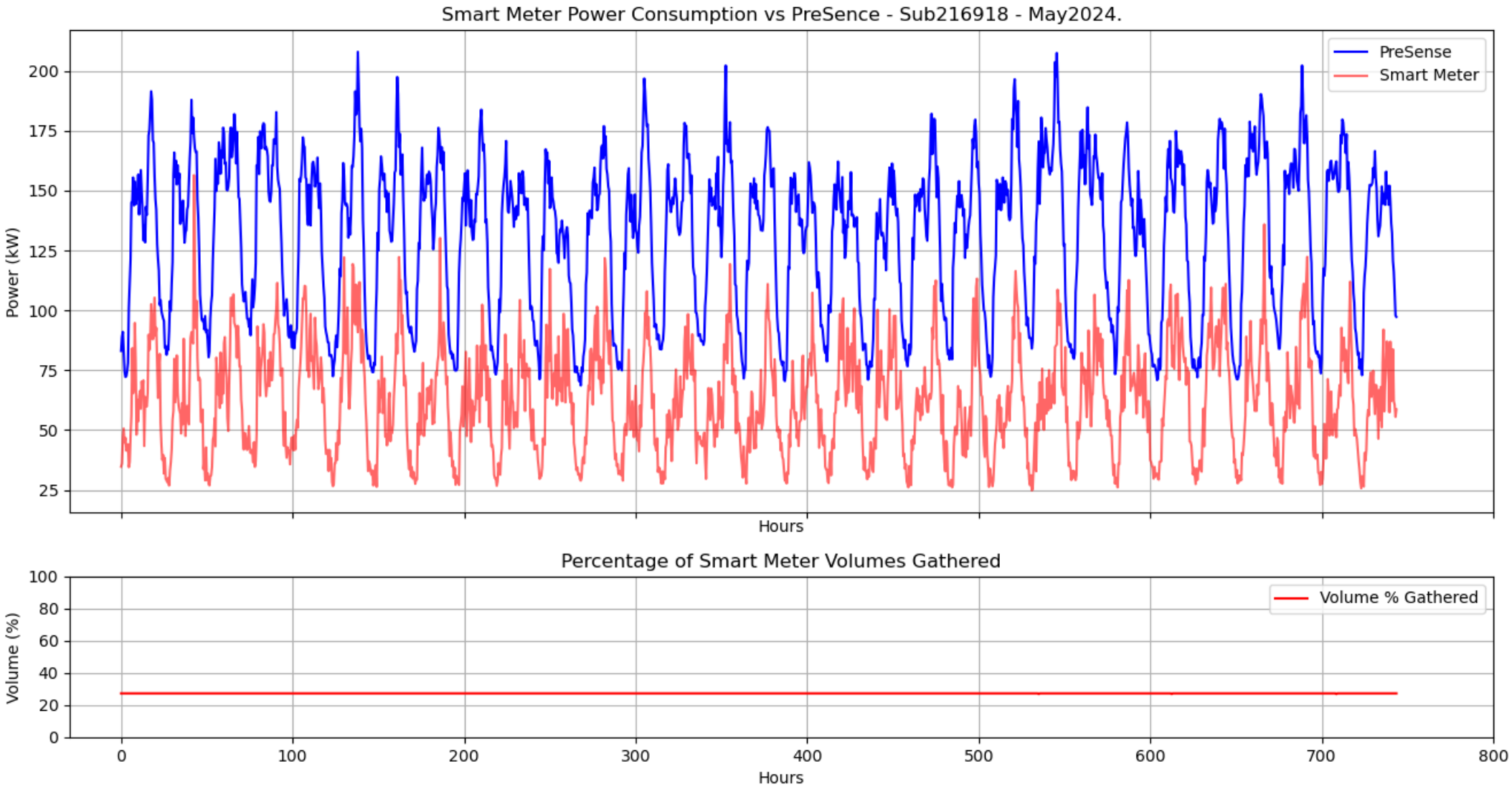
Substation 216918 – March 2024



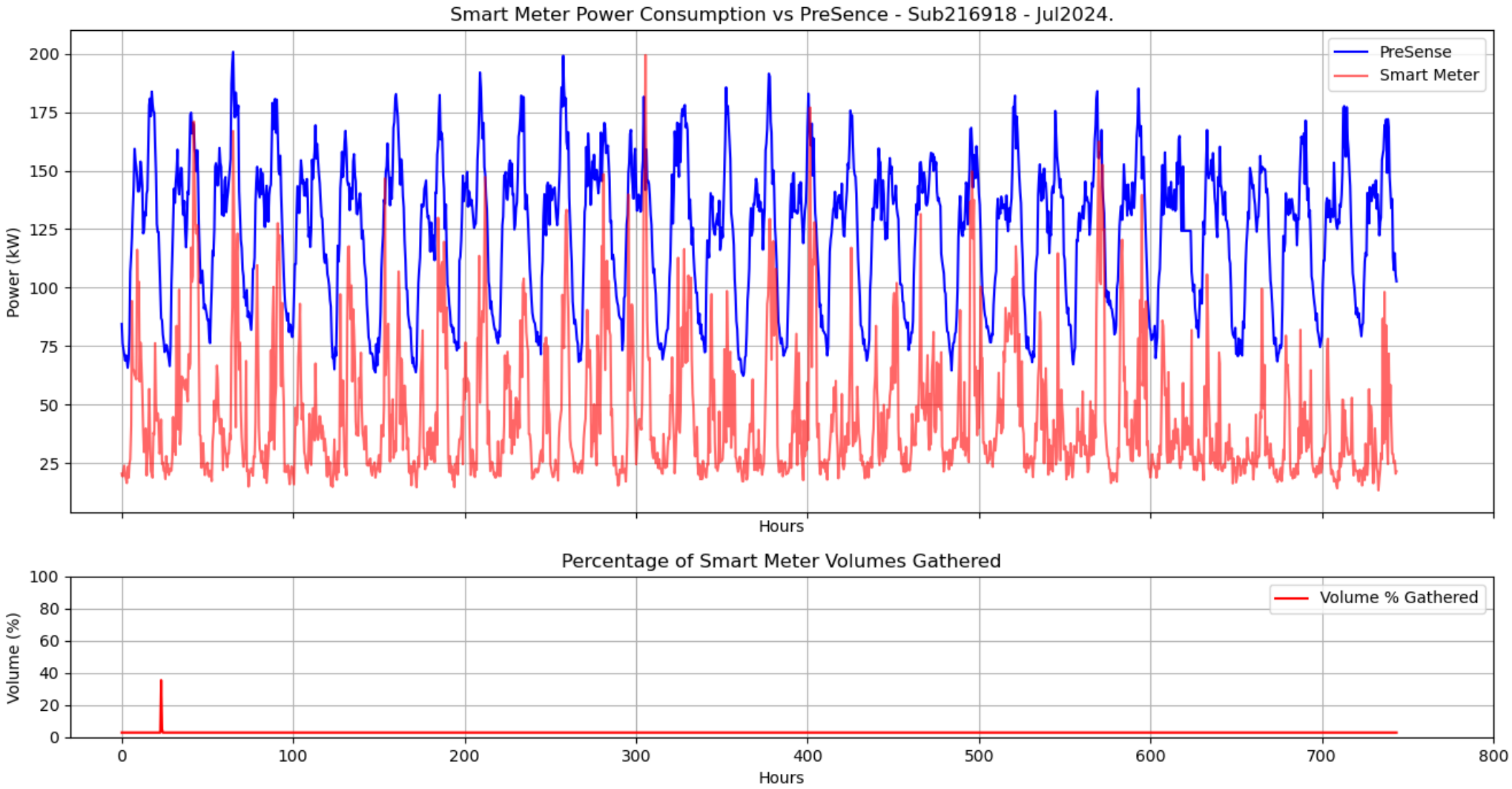
Substation 216918 – April 2024



Substation 216918 – May 2024



Substation 216918 – July 2024



Appendix 2.6: Study results for substation 217277

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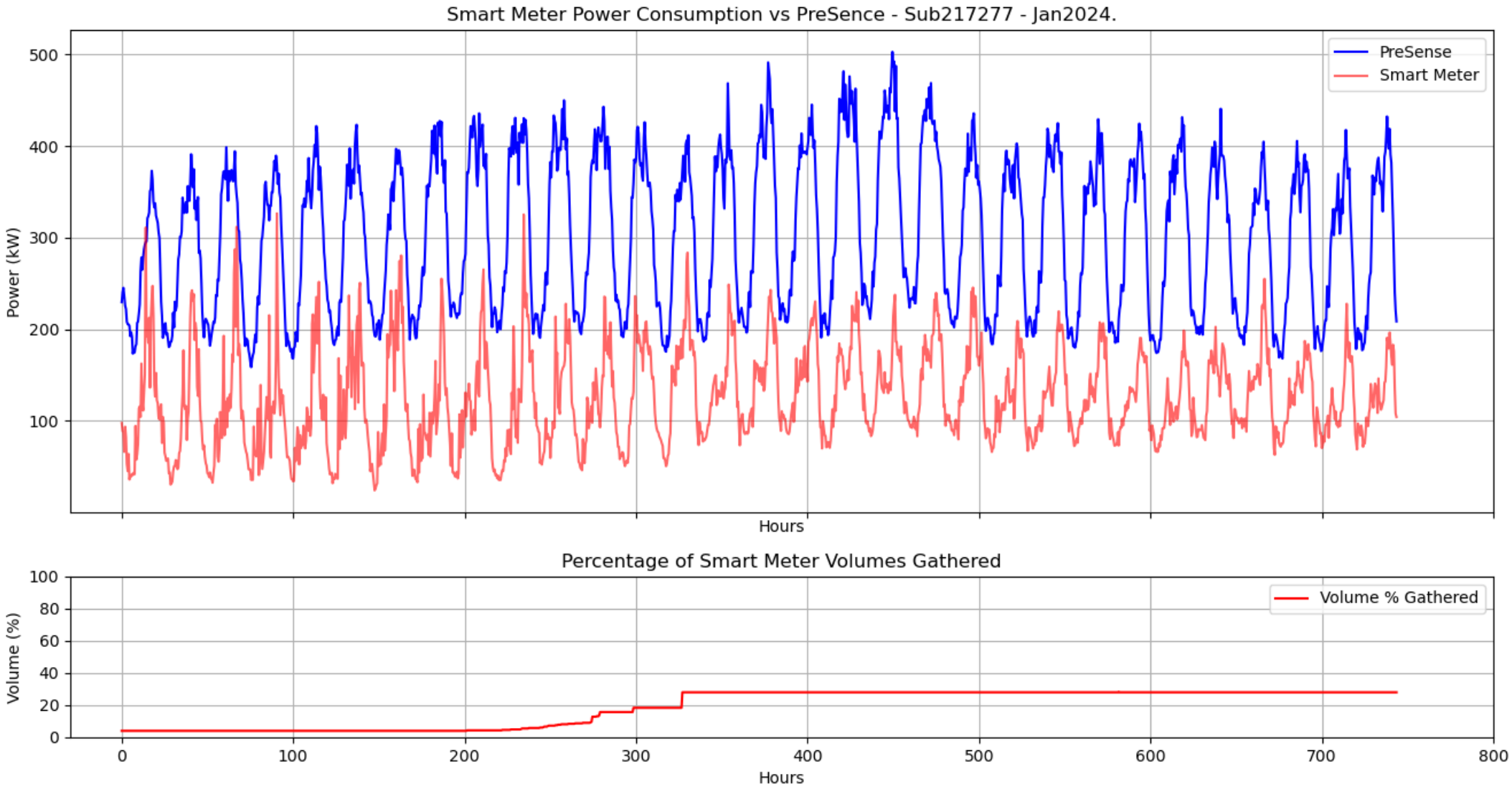
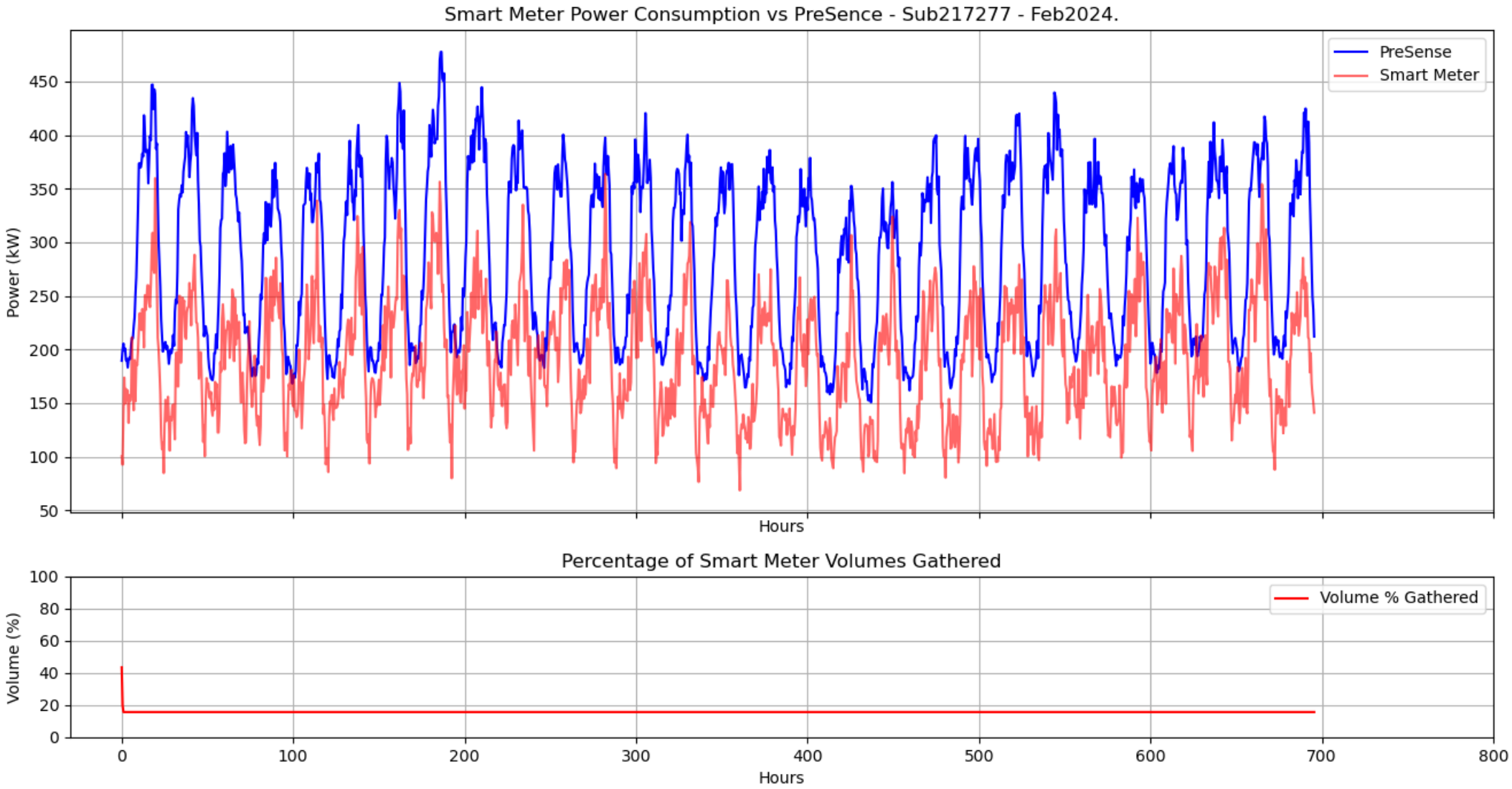
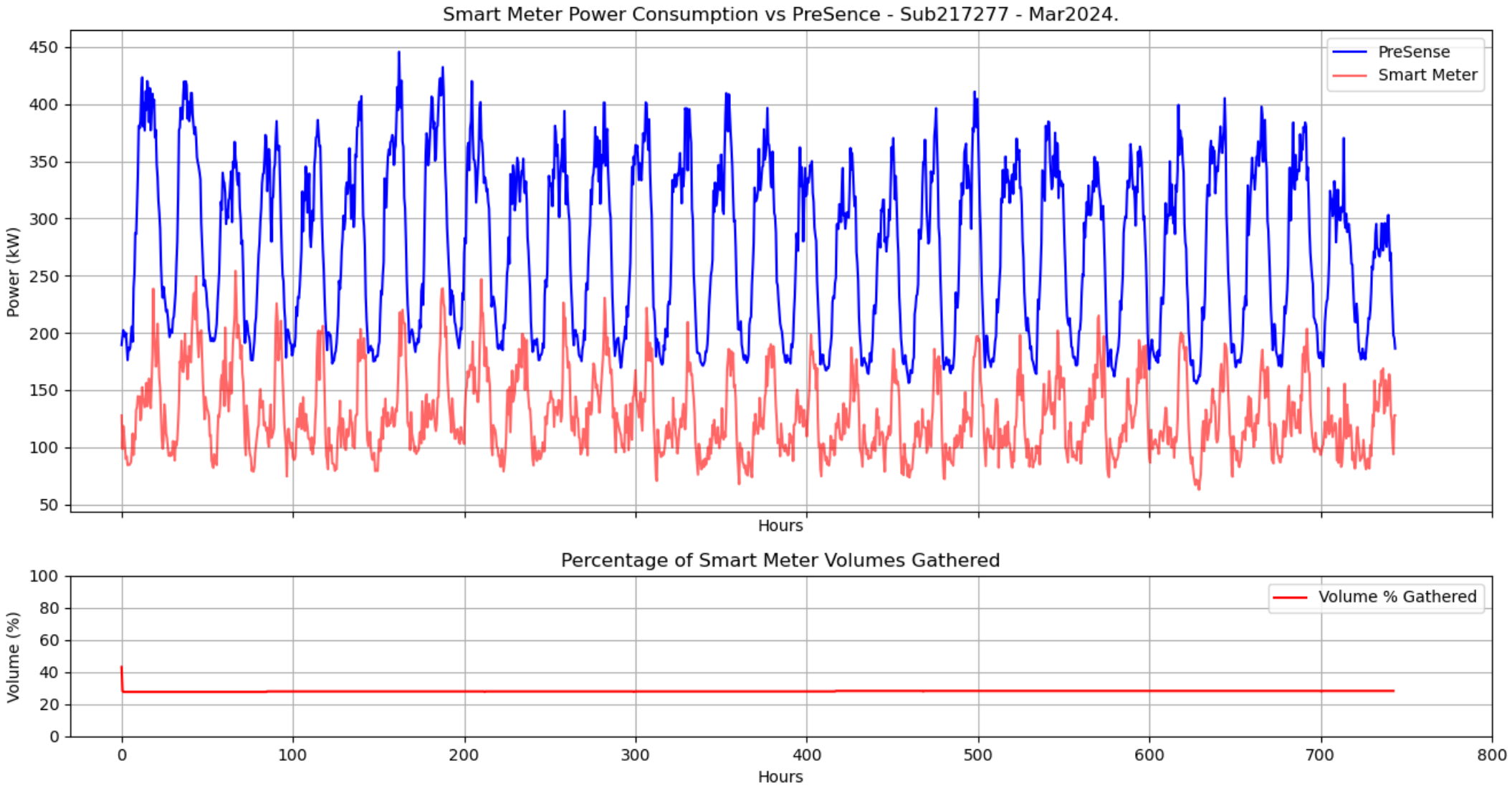
Substation 217277 – January 2024



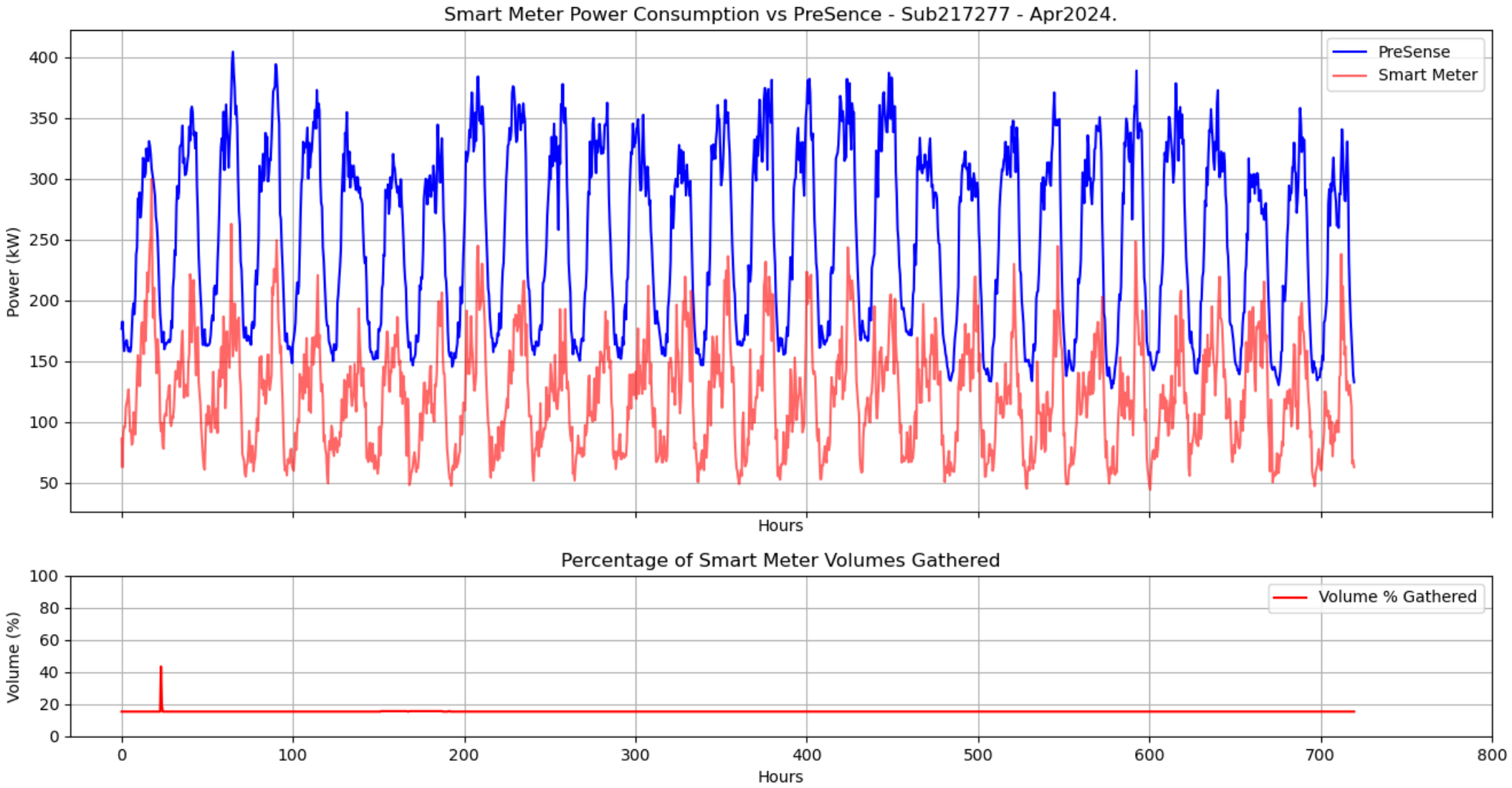
Substation 217277 – February 2024



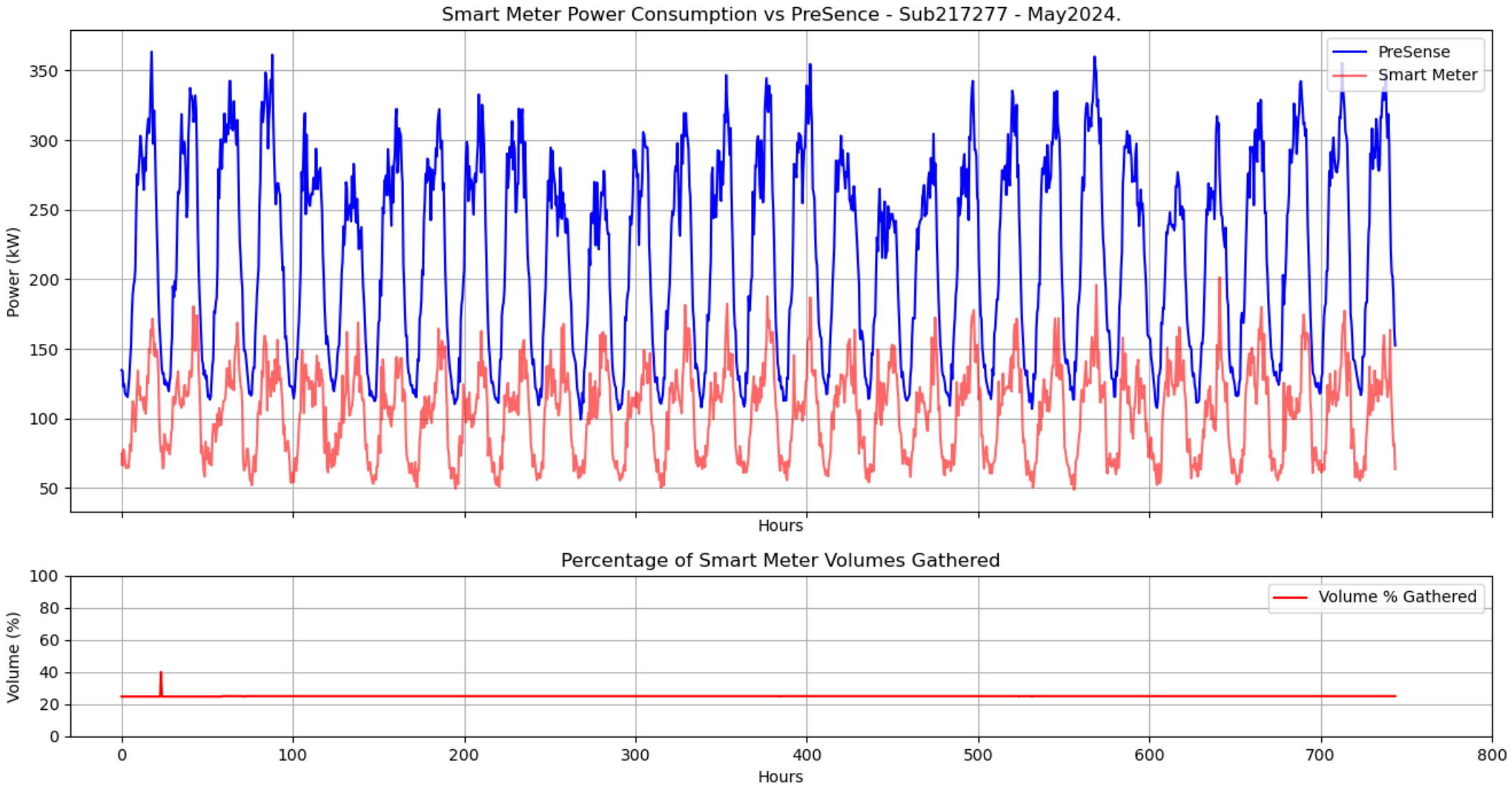
Substation 217277 – March 2024



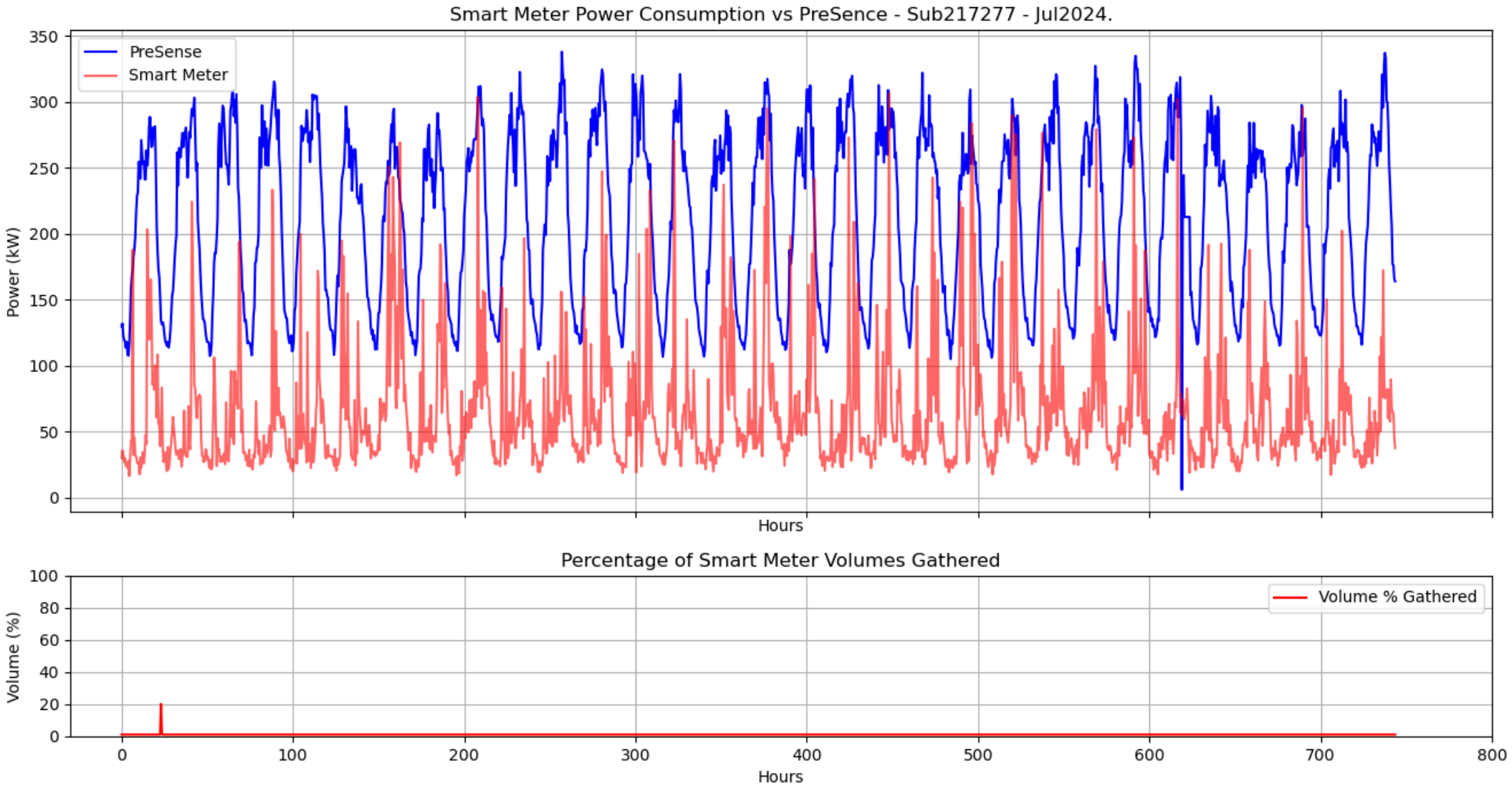
Substation 217277 – April 2024



Substation 217277 – May 2024



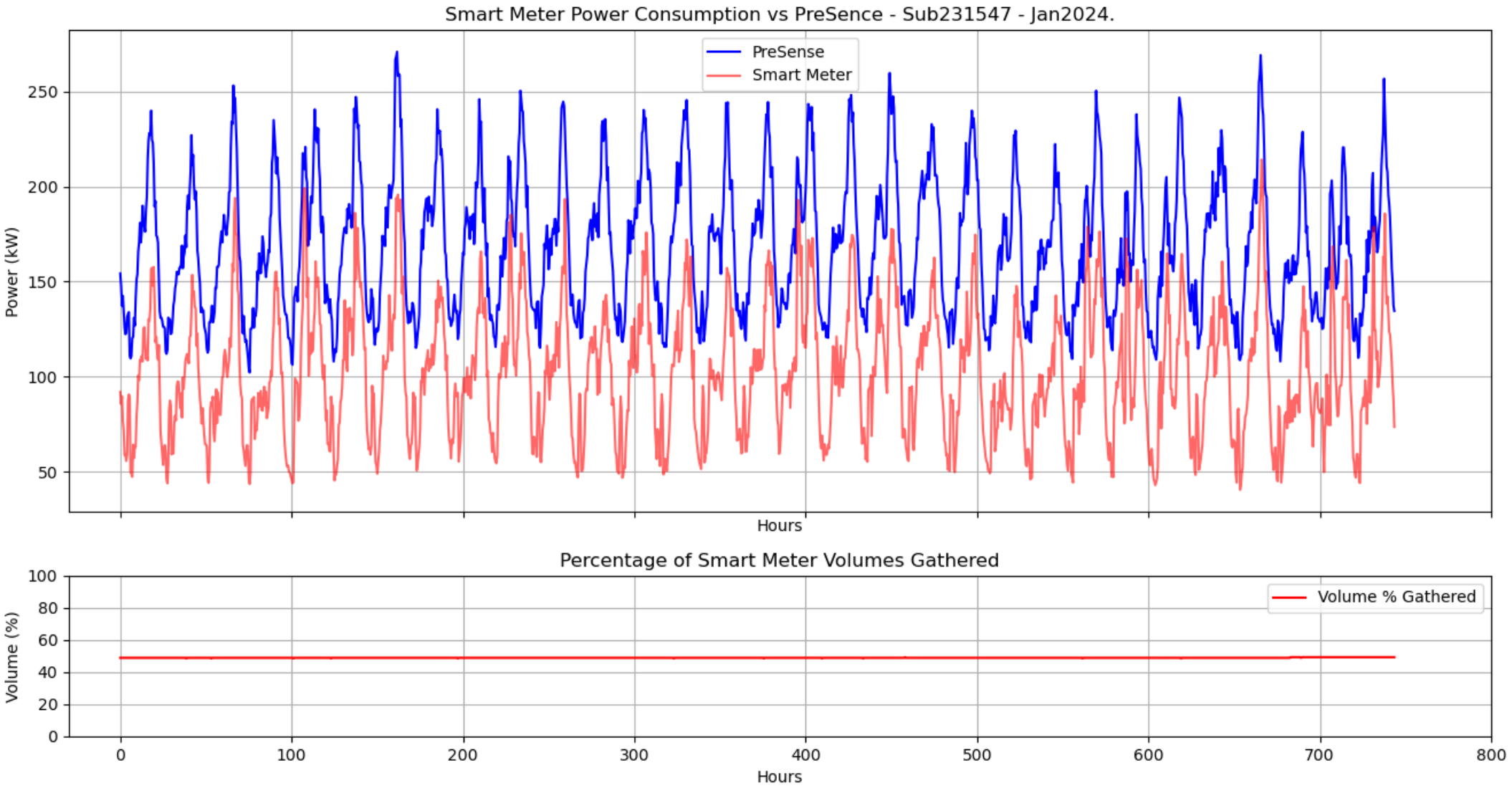
Substation 217277 – July 2024



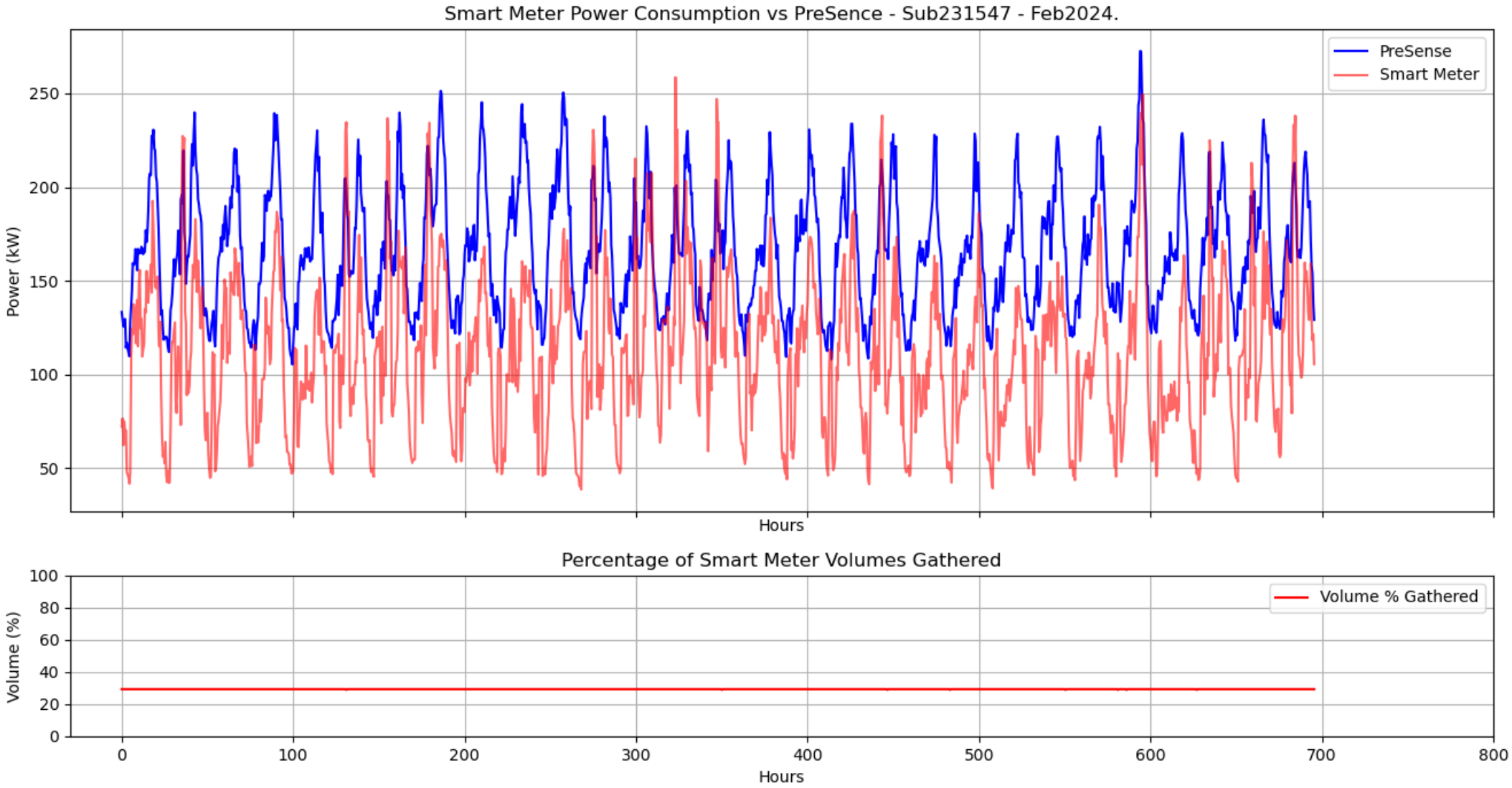
Appendix 2.7: Study results for substation 231547

electricity north west
Bringing energy to your door

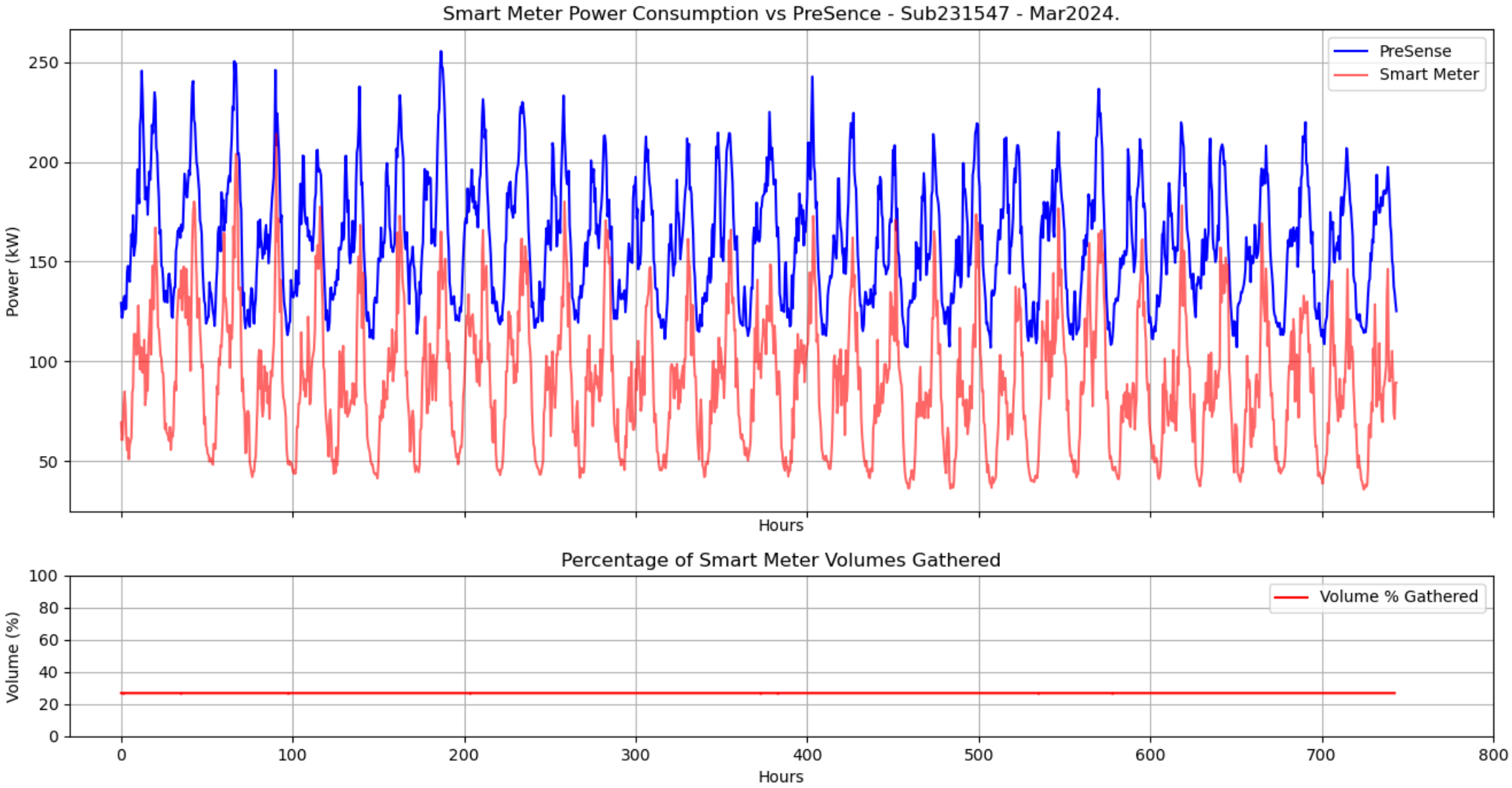
Substation 231547 – January 2024



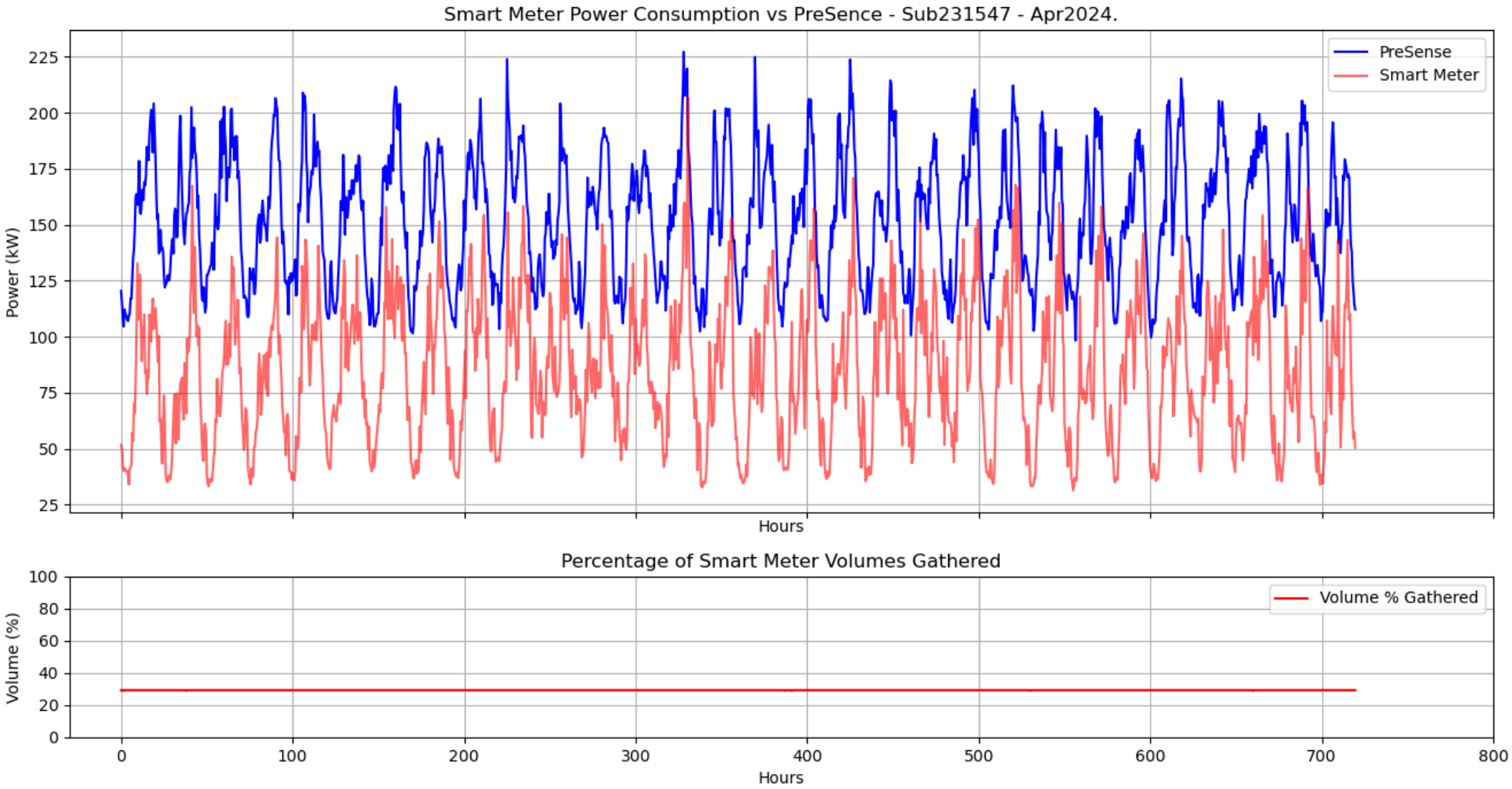
Substation 231547 – February 2024



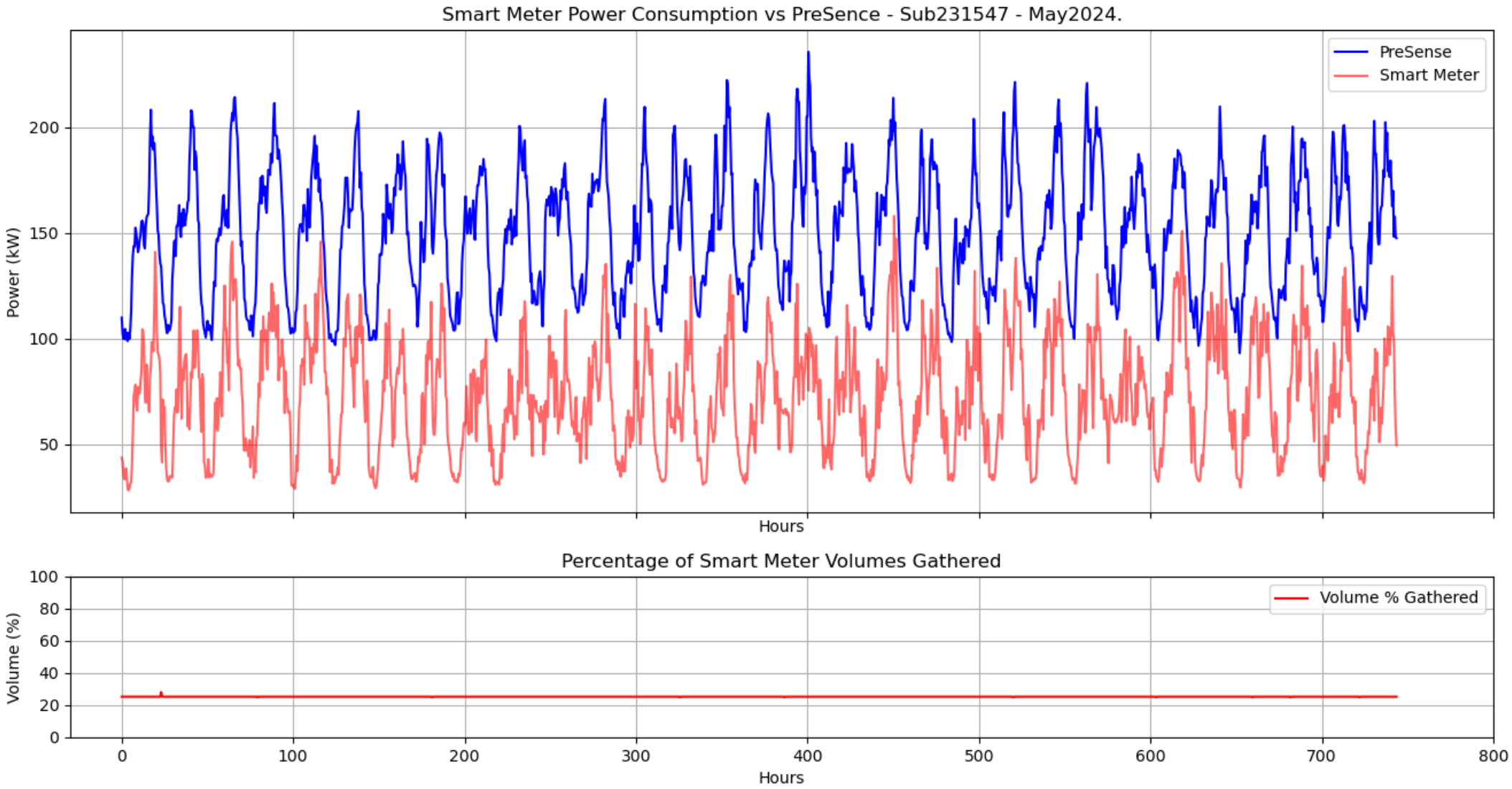
Substation 231547 – March 2024



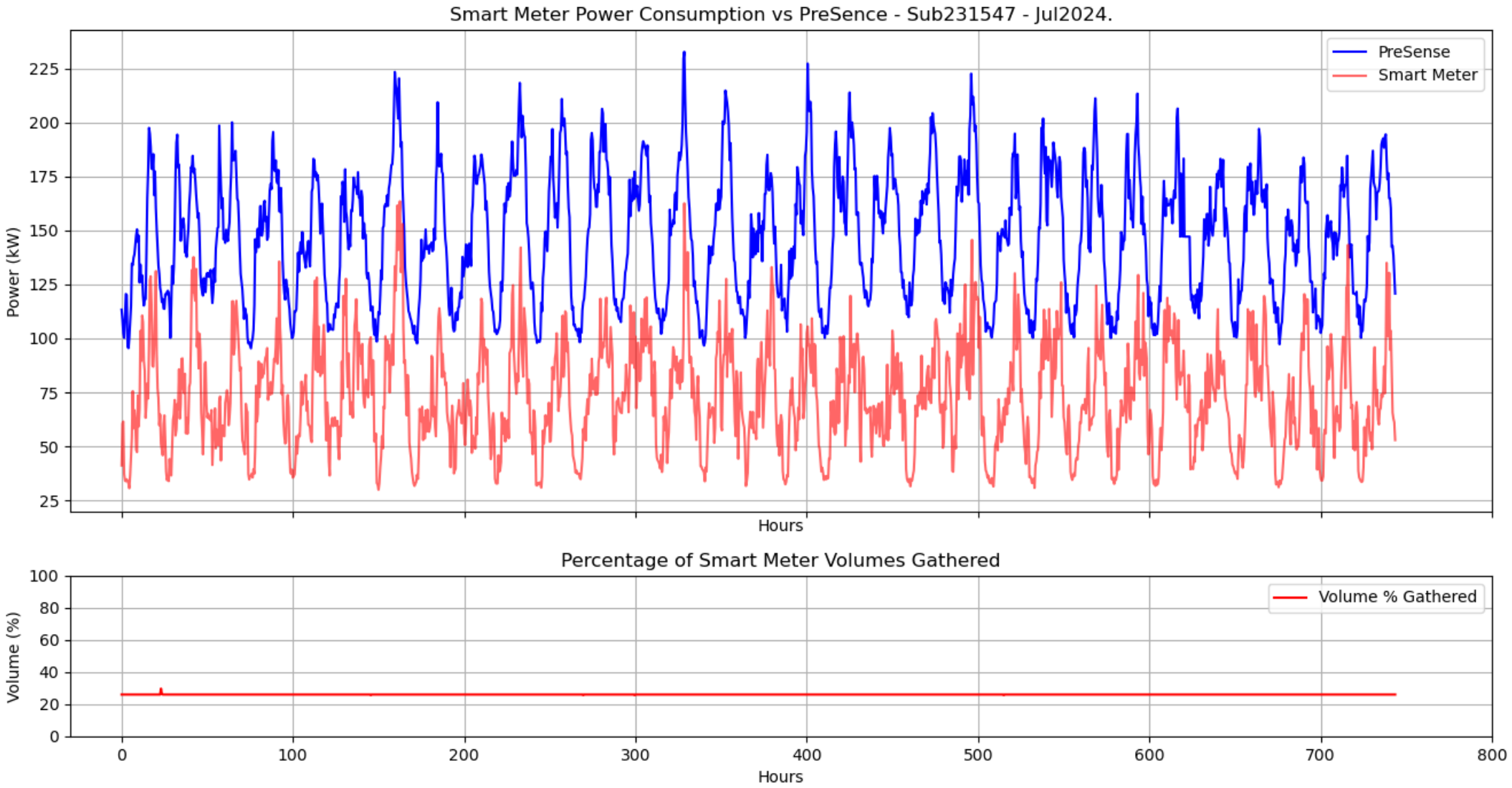
Substation 231547 – April 2024



Substation 231547 – May 2024

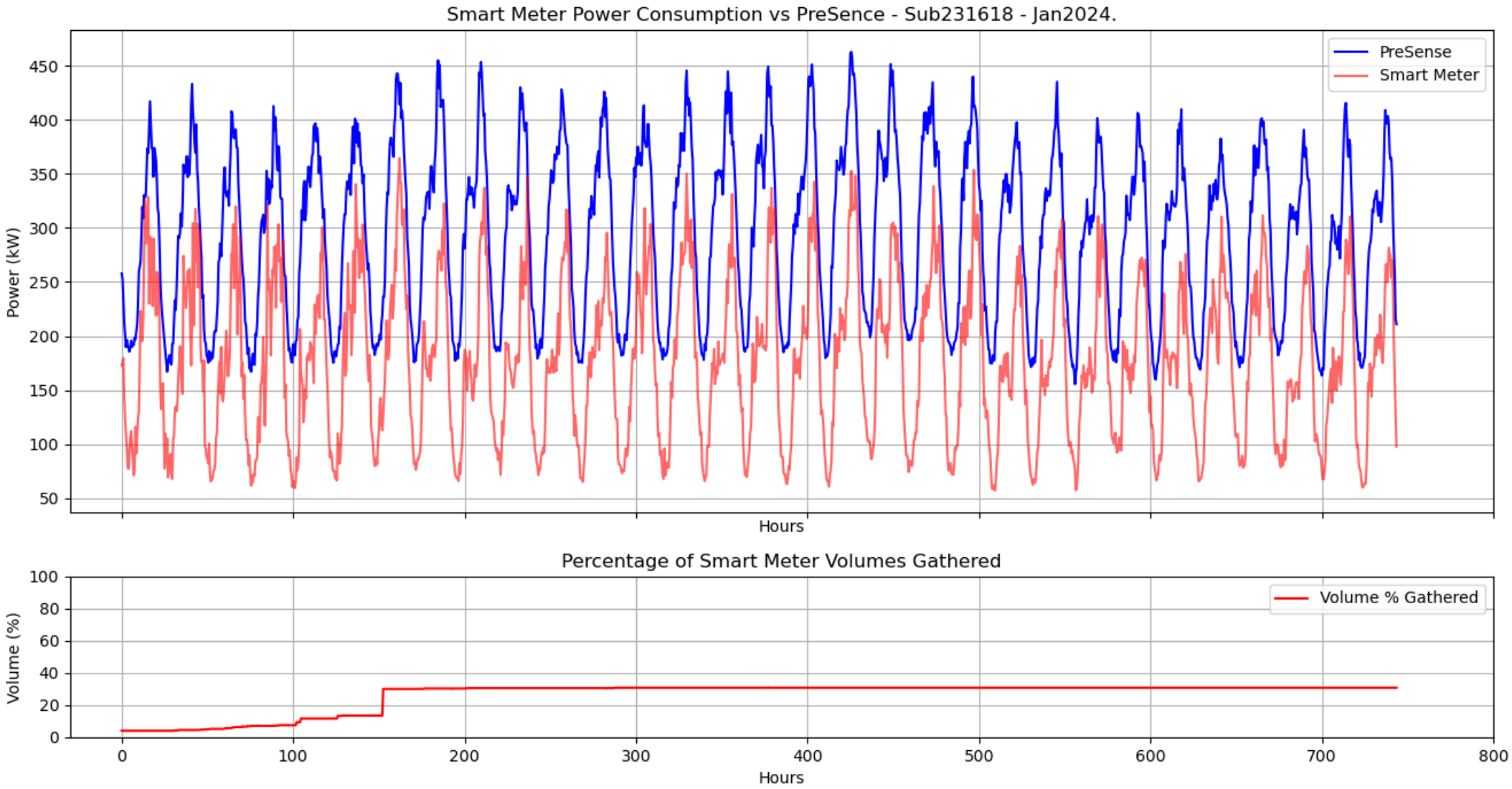


Substation 231547 – July 2024

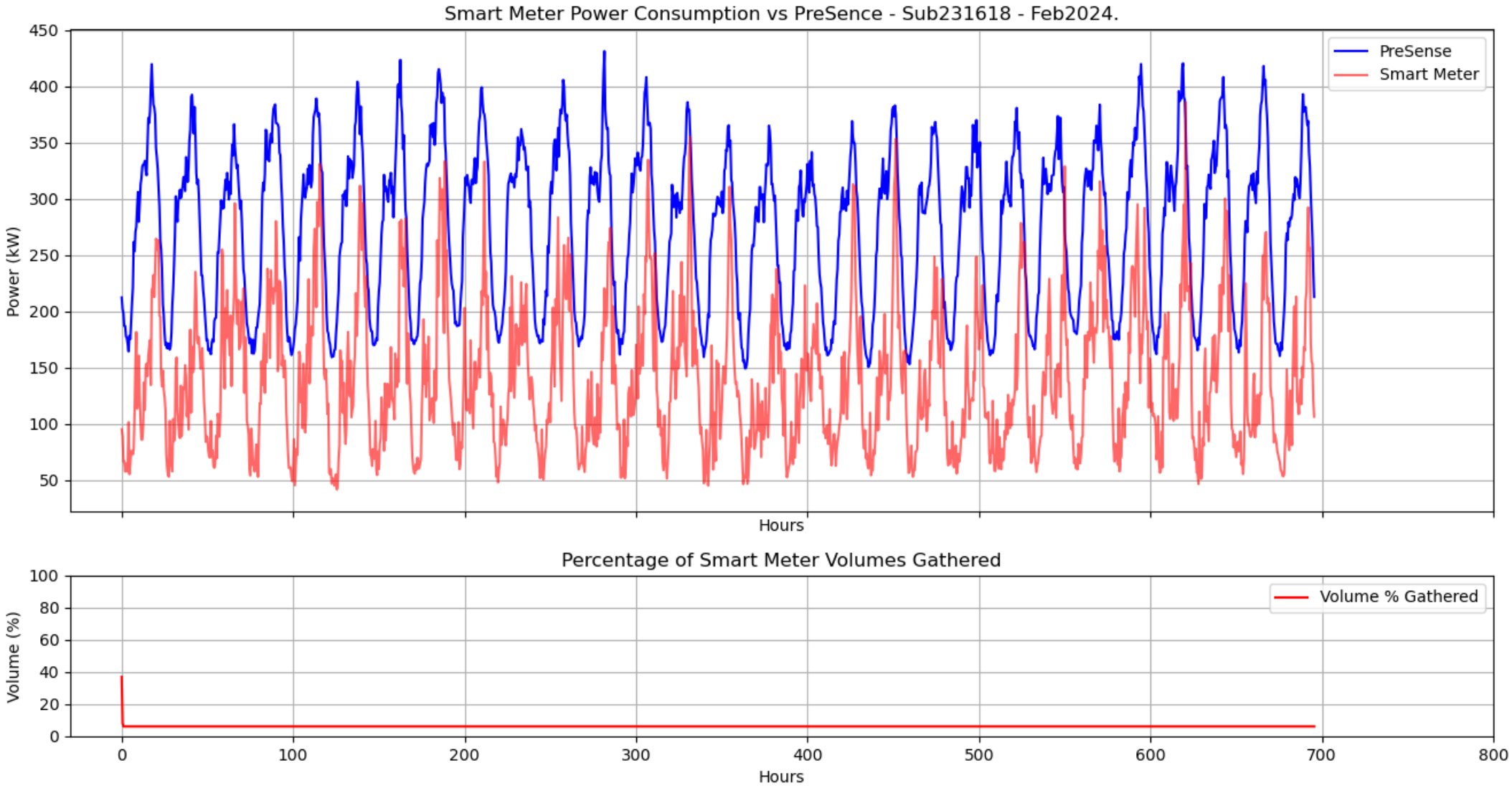


Appendix 2.8: Study results for substation 231618

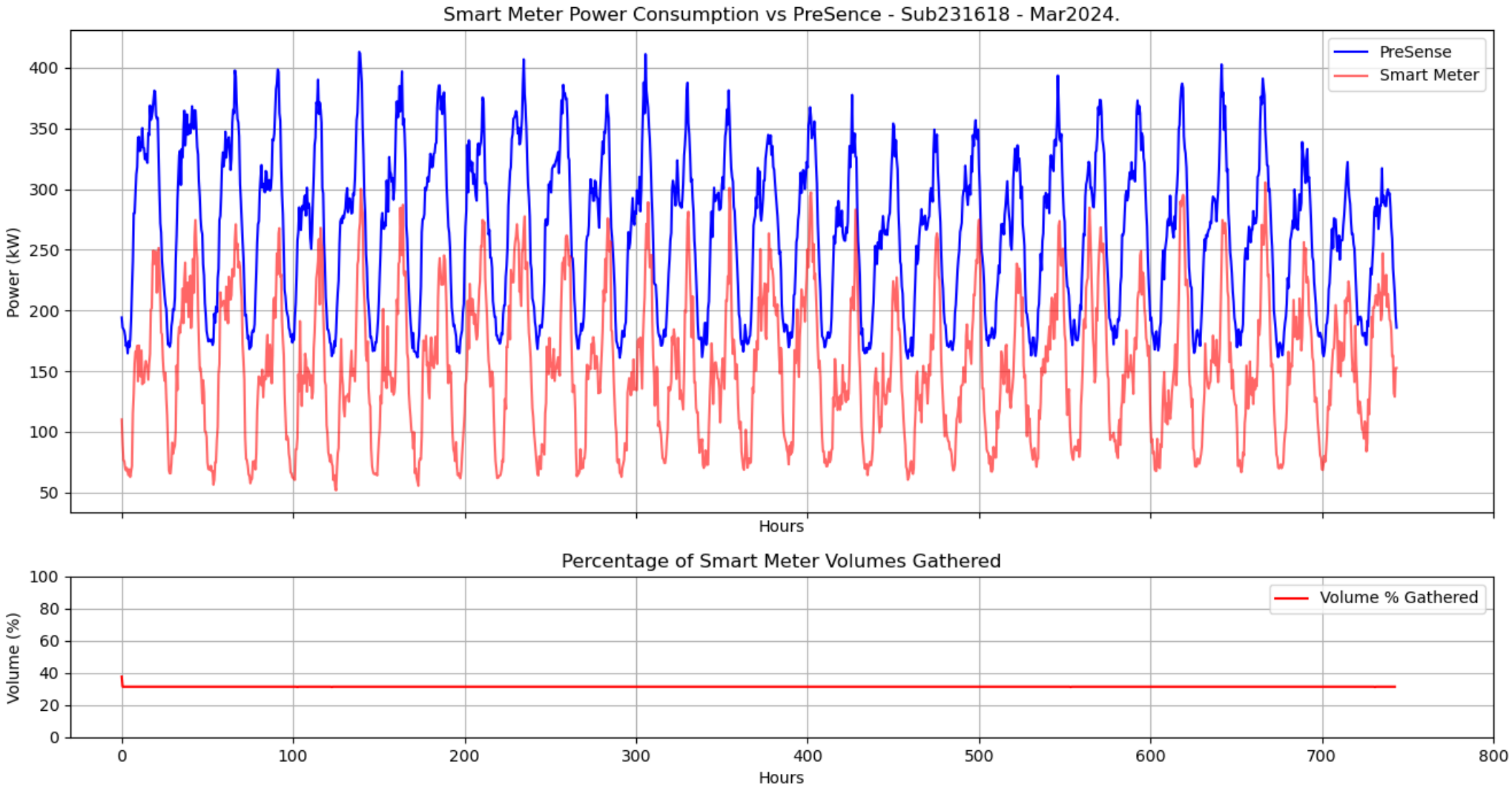
Substation 231618 – January 2024



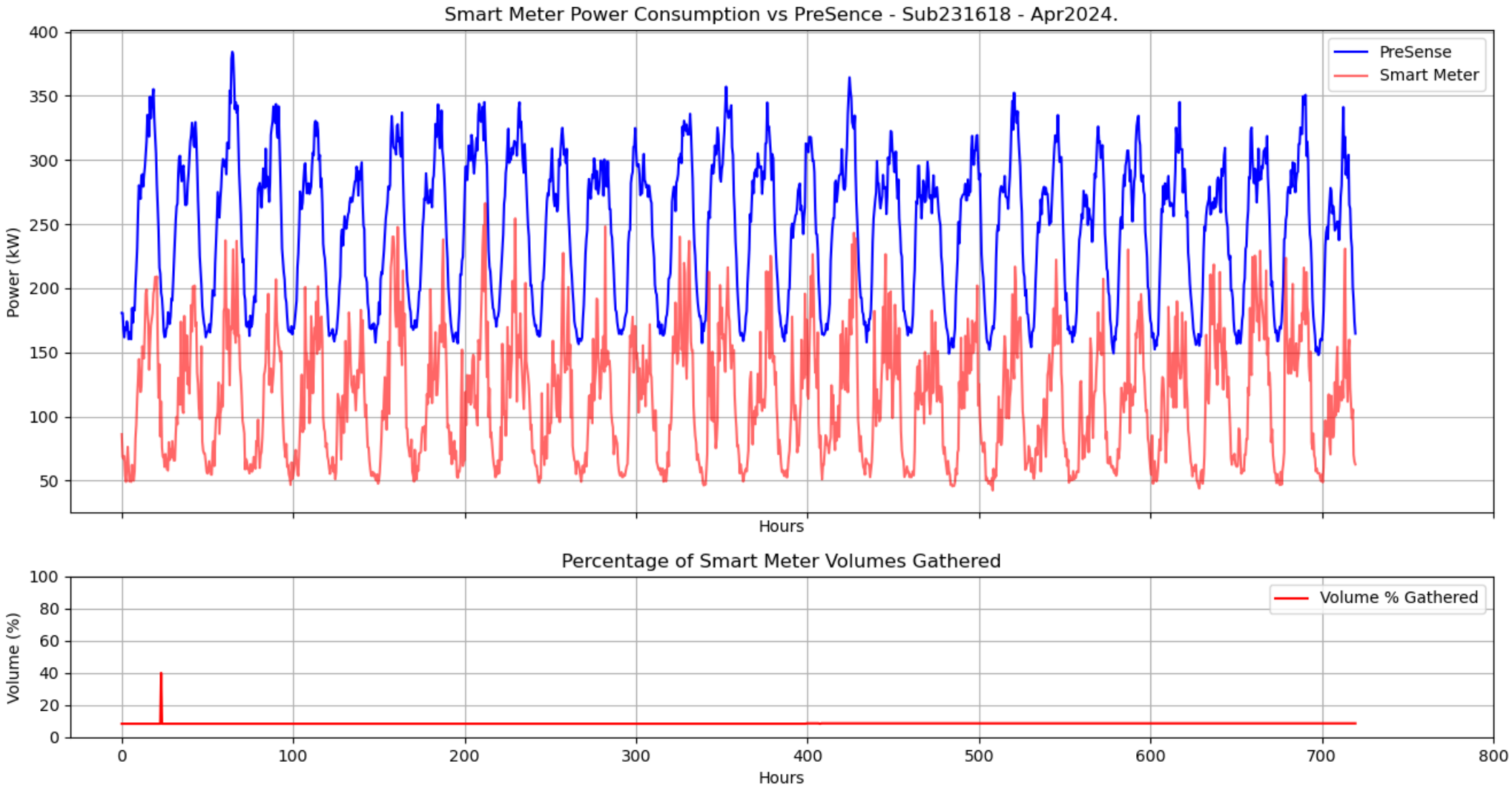
Substation 231618 – February 2024



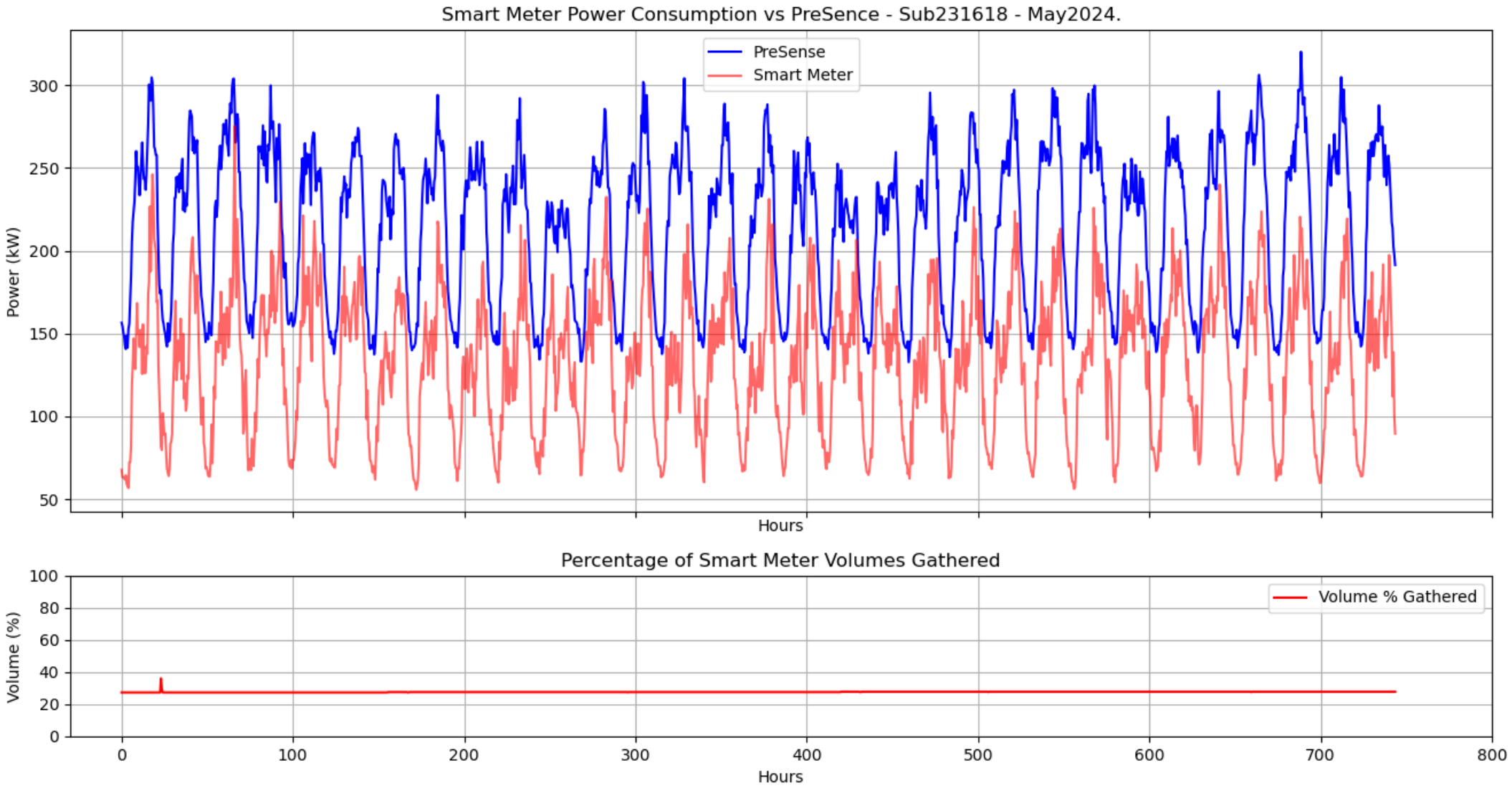
Substation 231618 – March 2024



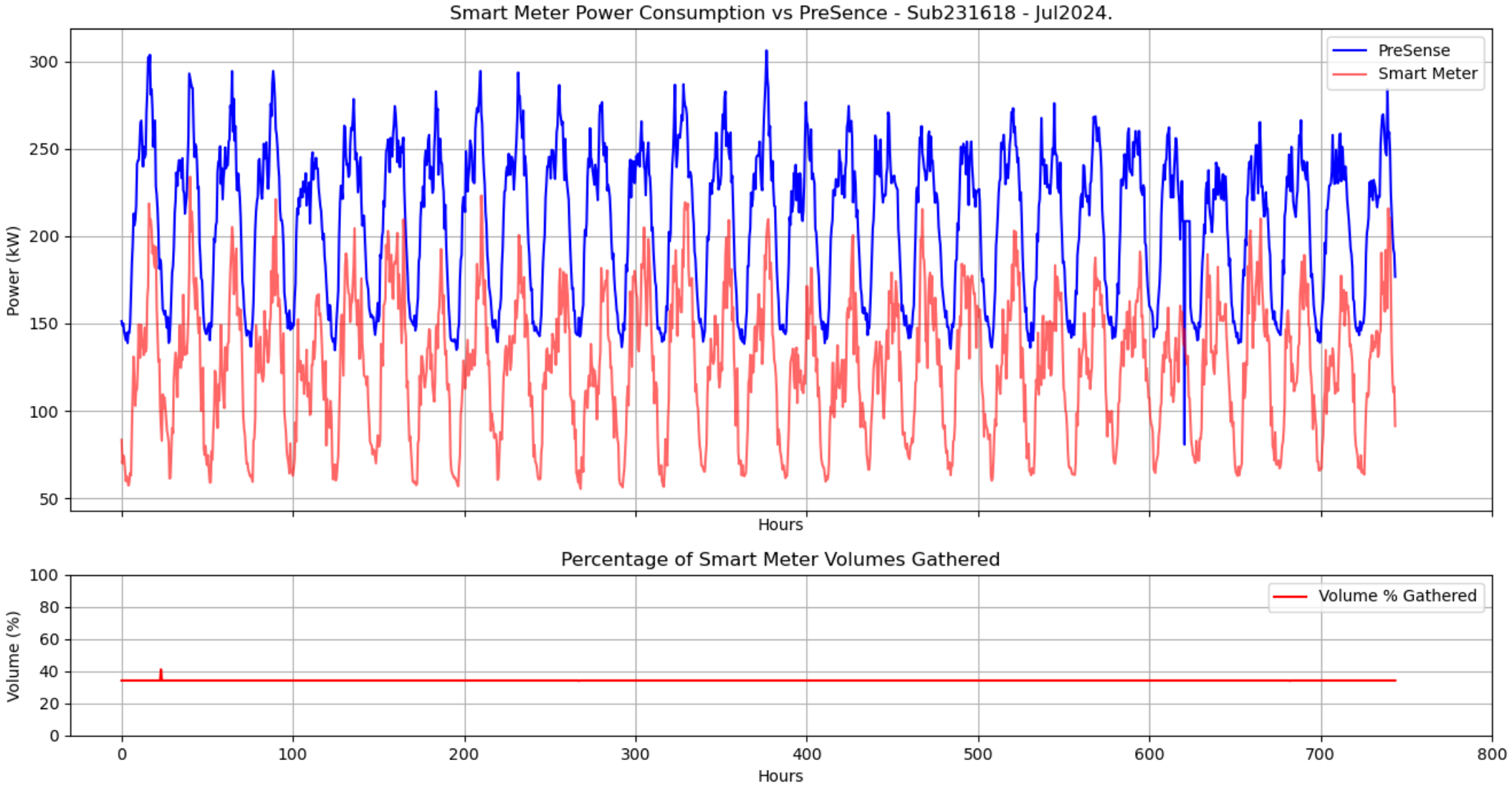
Substation 231618 – April 2024



Substation 231618 – May 2024



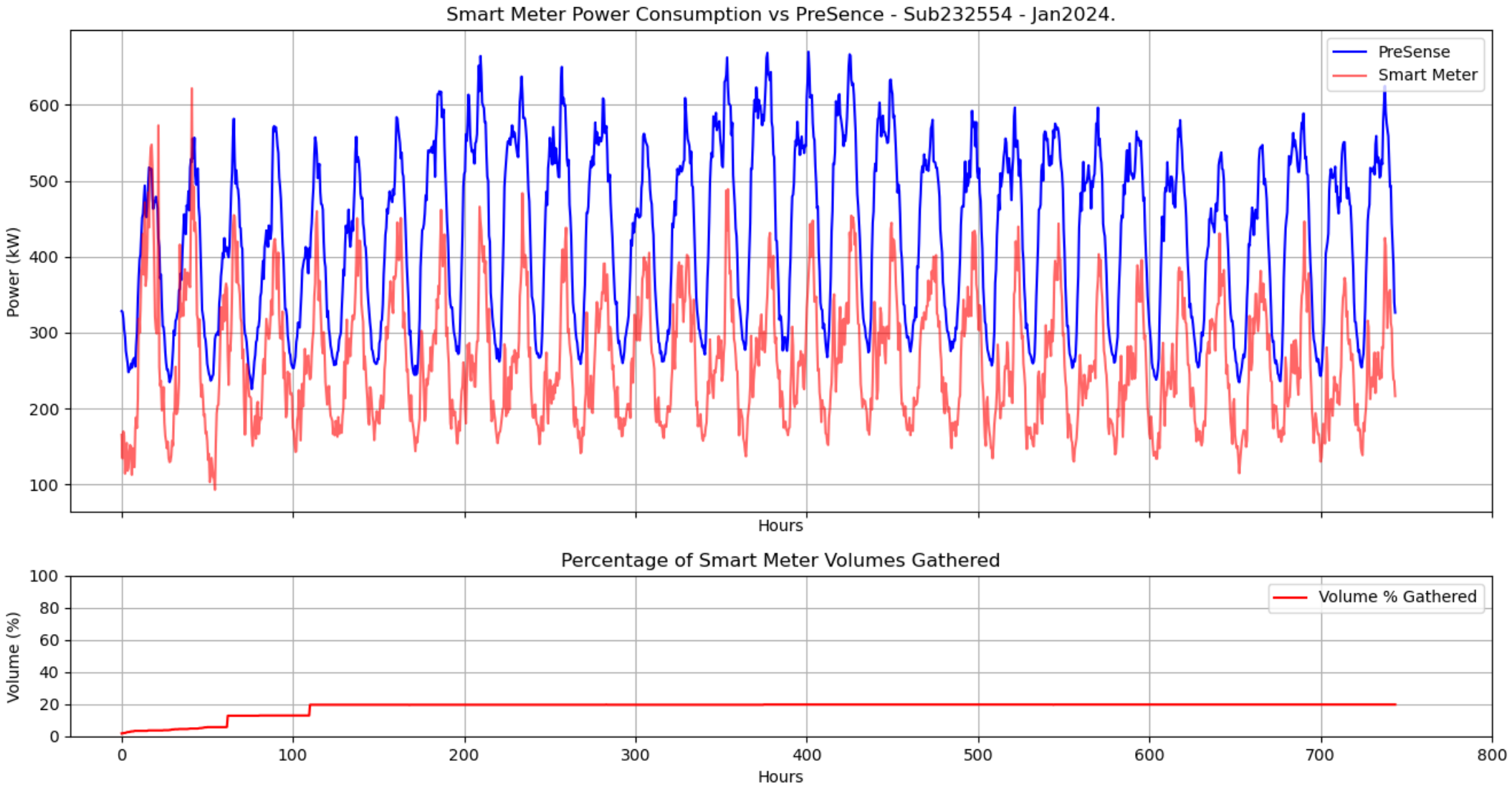
Substation 231618 – July 2024



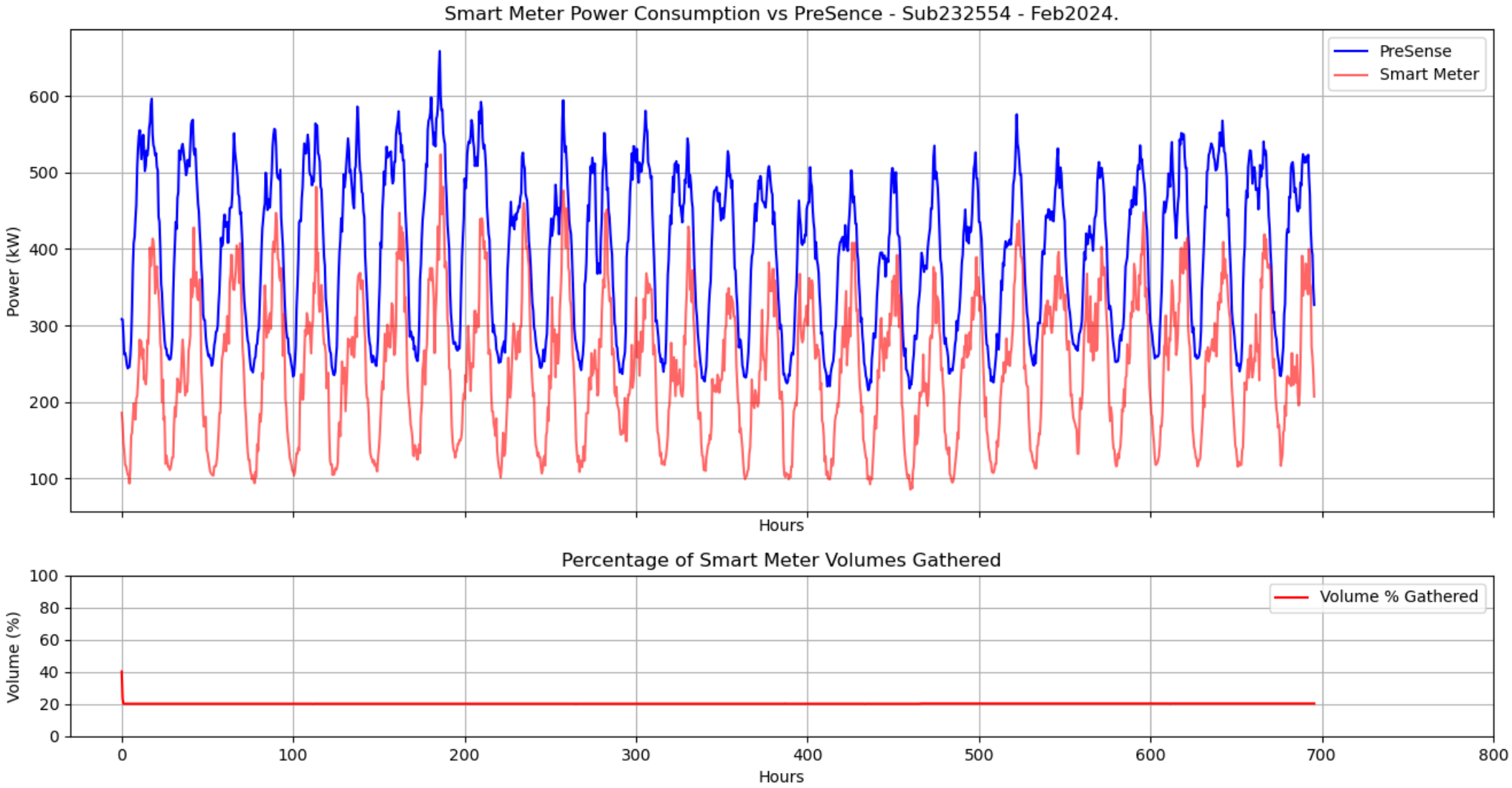
Appendix 2.9: Study results for substation 232554

electricity north west
Bringing energy to your door

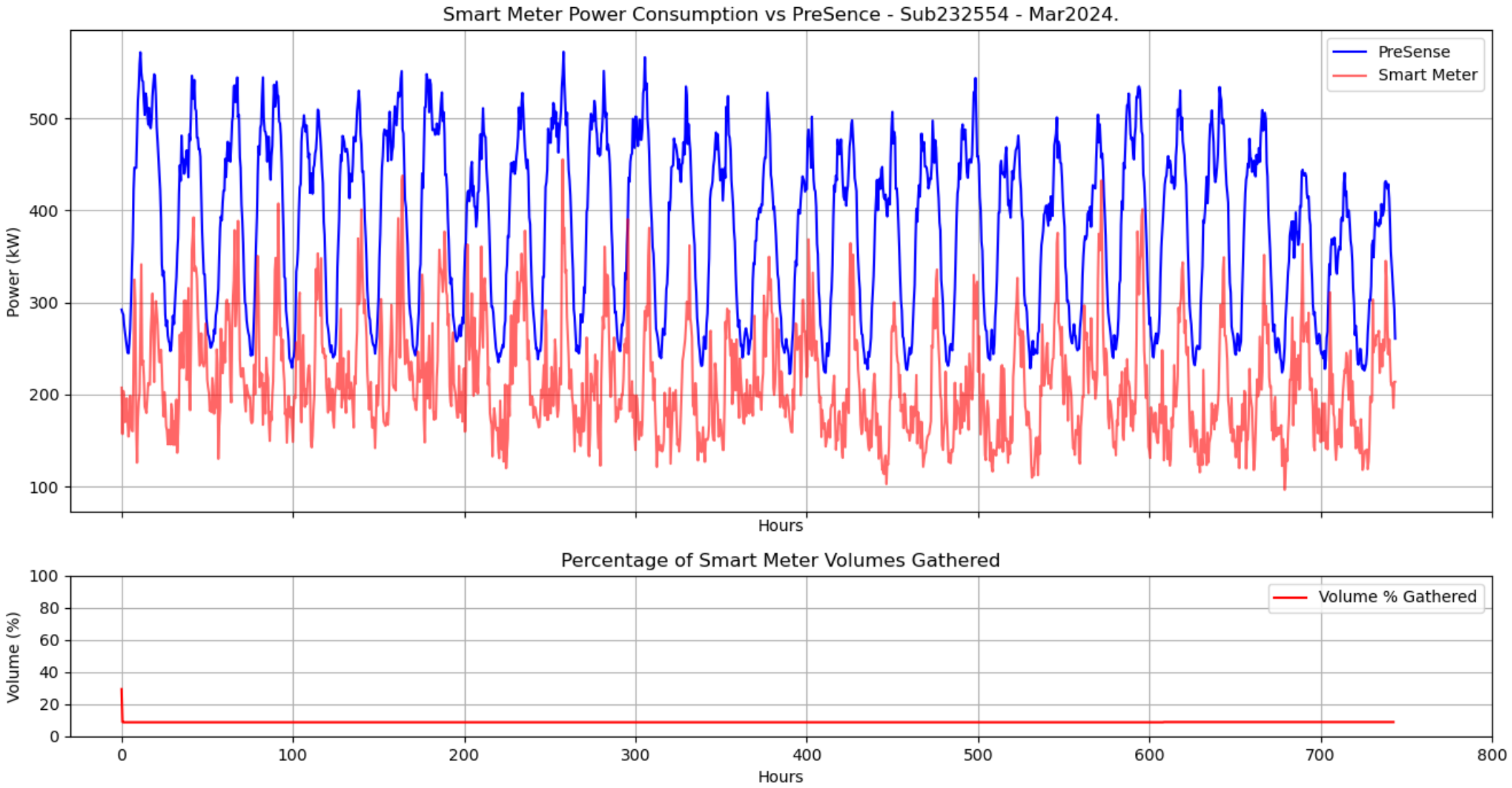
Substation 232554 – January 2024



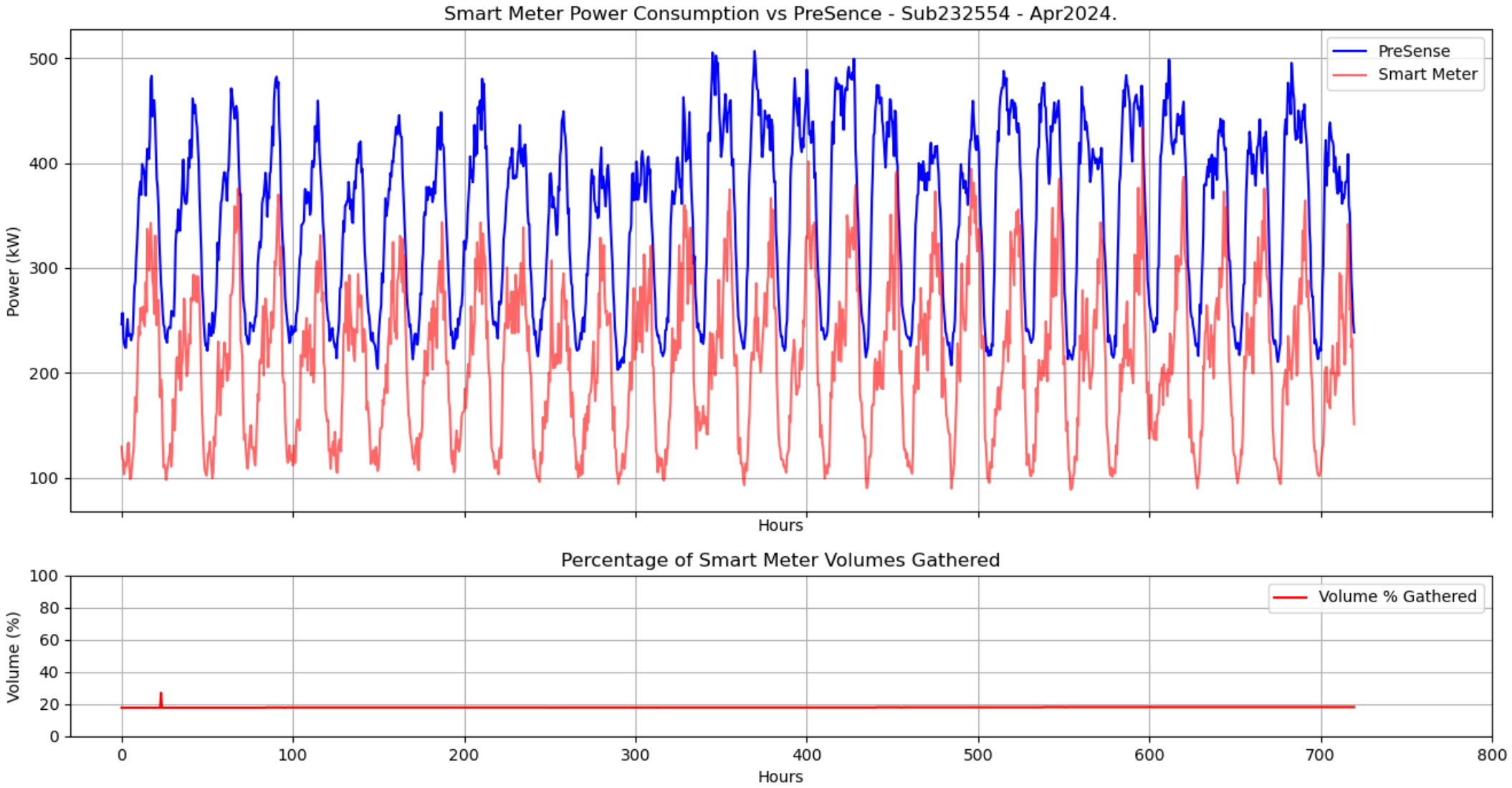
Substation 232554 – February 2024



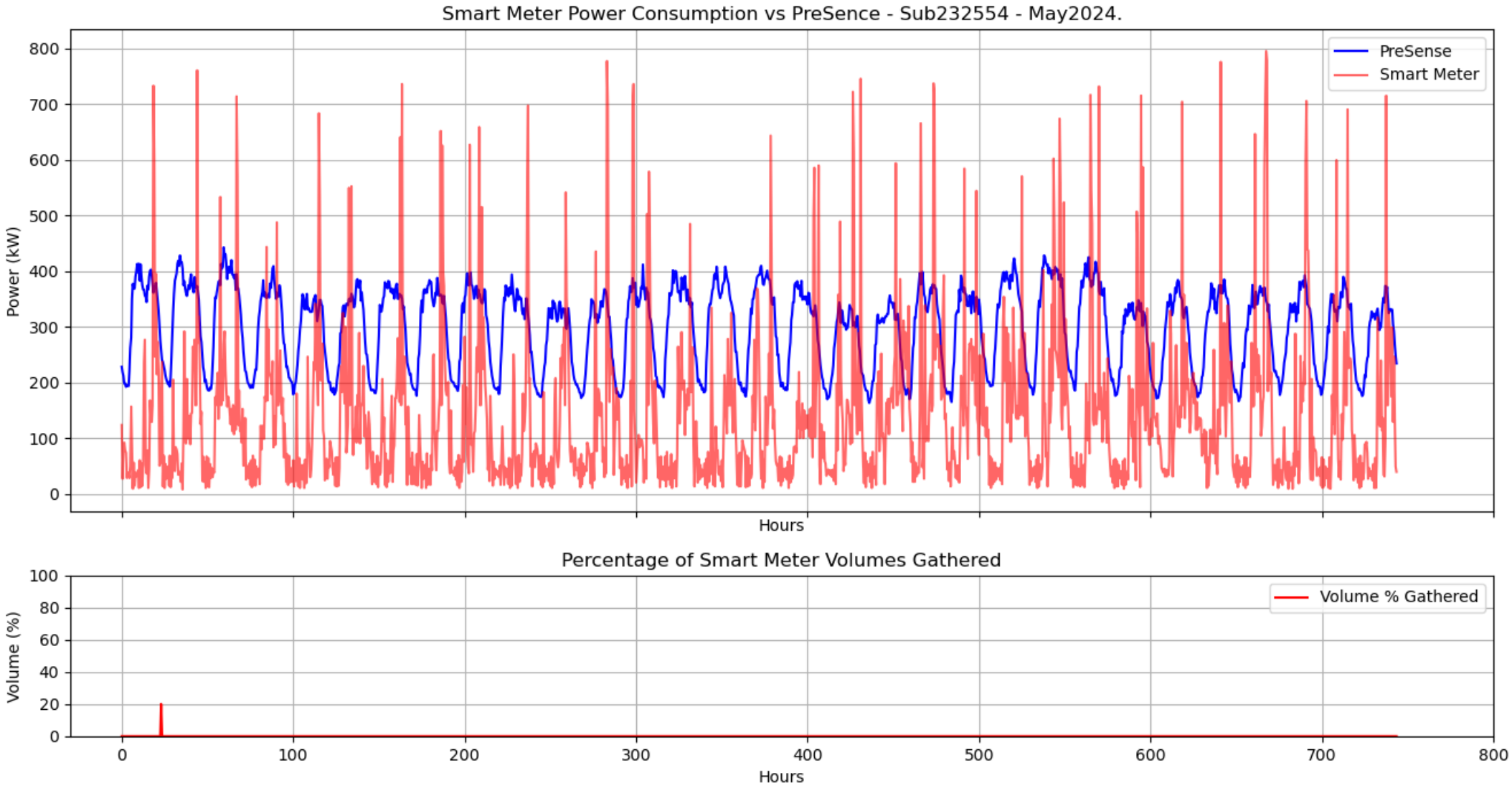
Substation 232554 – March 2024



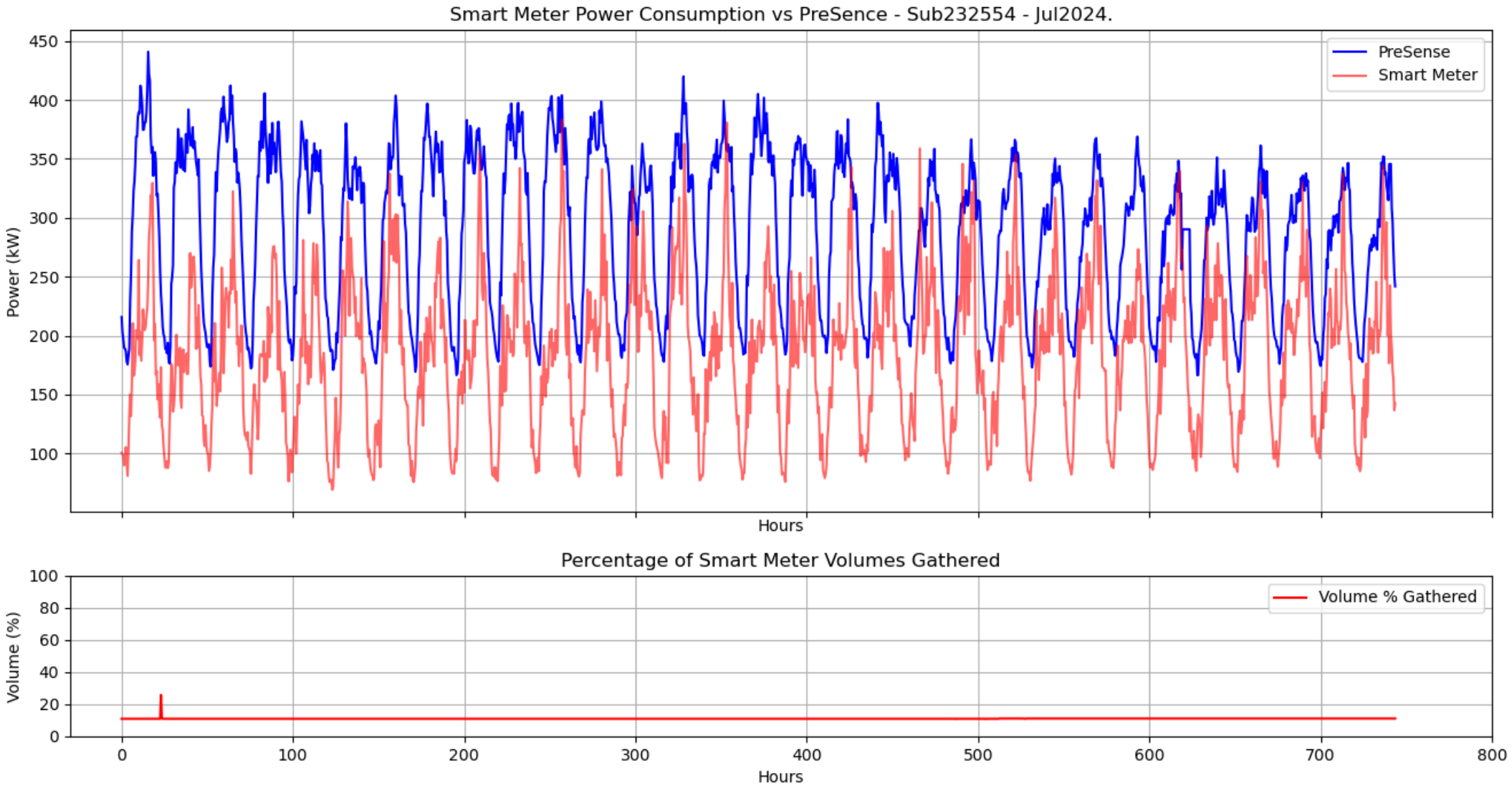
Substation 232554 – April 2024



Substation 232554 – May 2024



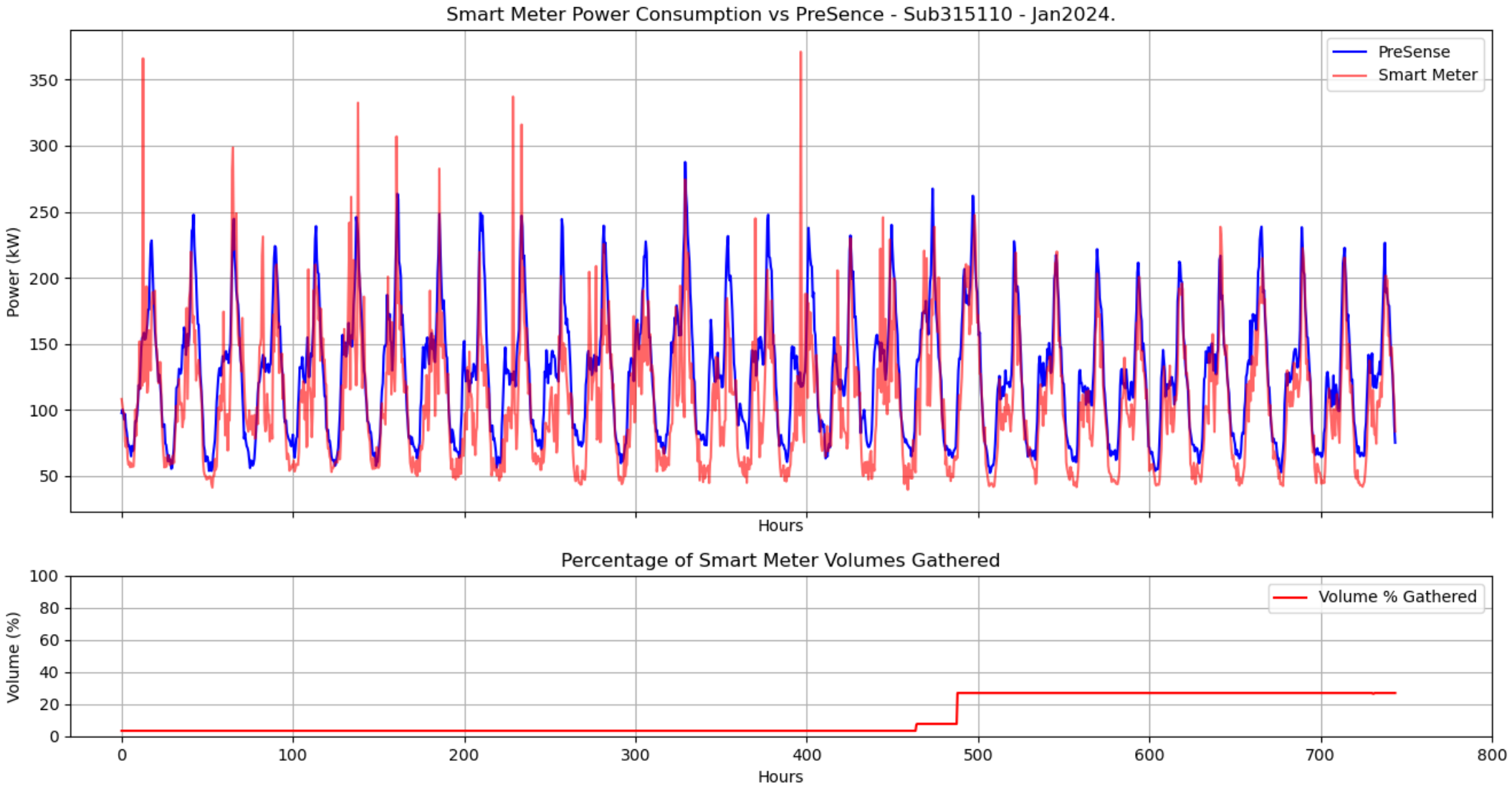
Substation 232554 – July 2024



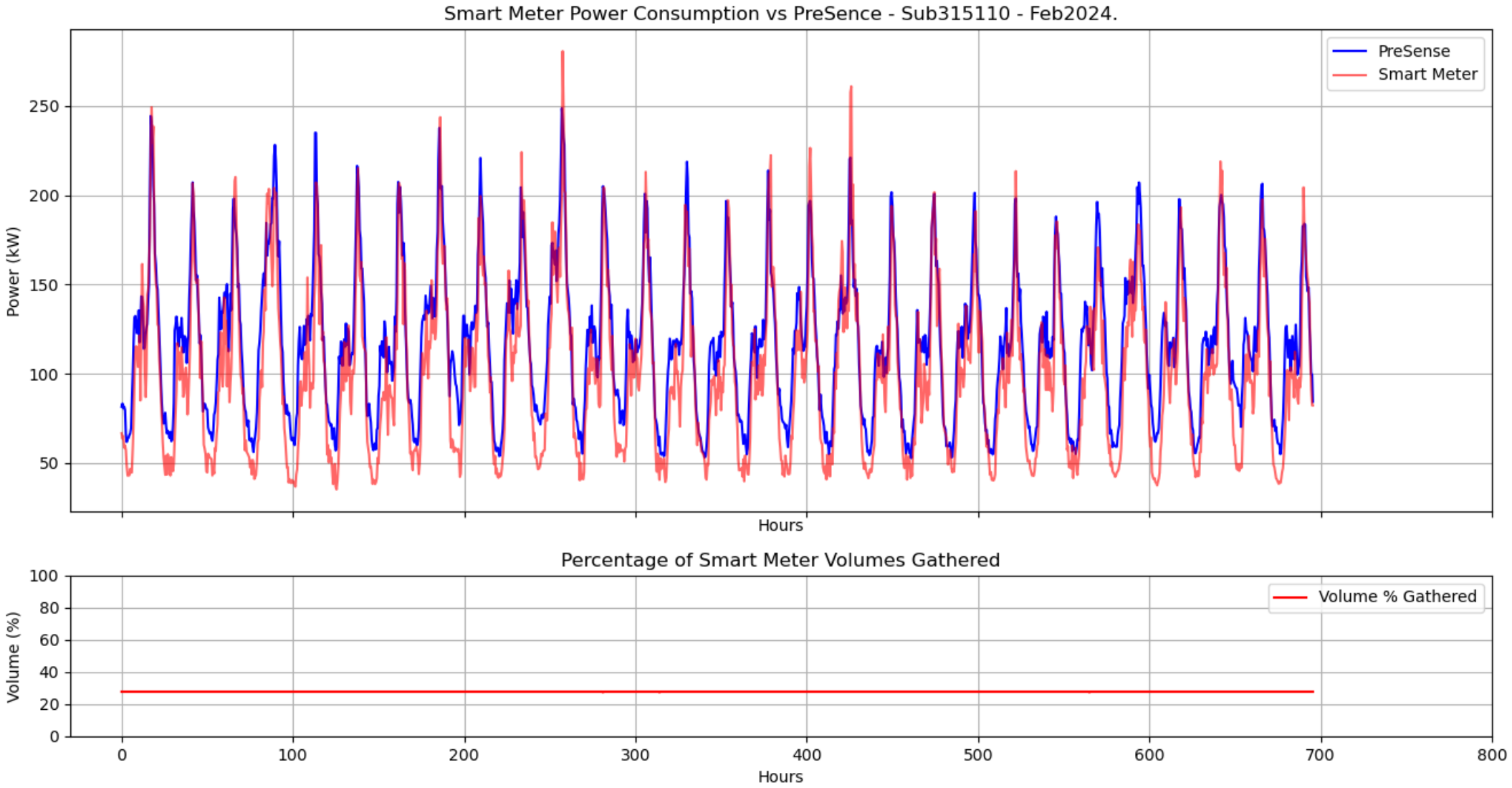
Appendix 2.10: Study results for substation 315110

electricity north west
Bringing energy to your door

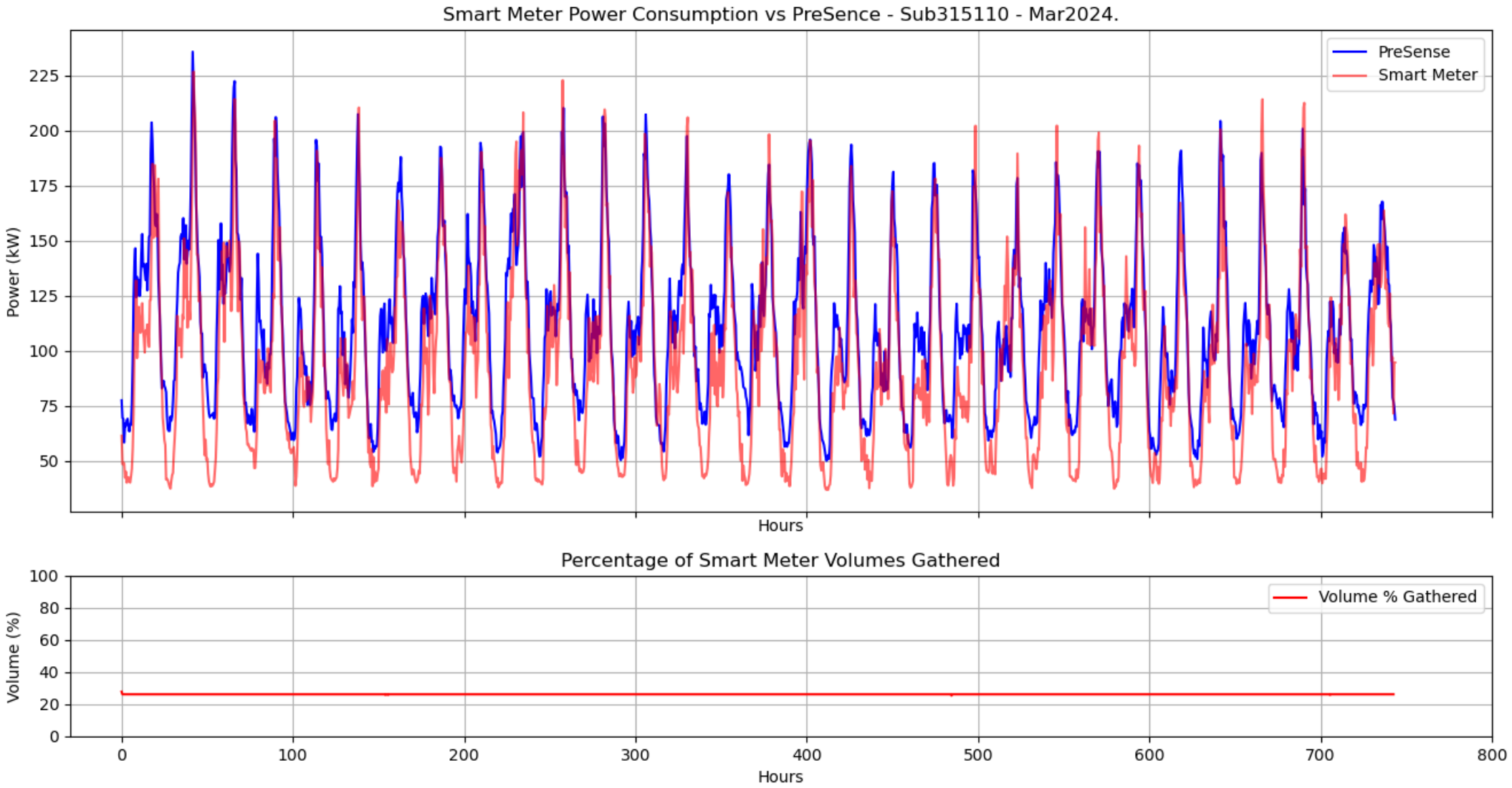
Substation 315110 – January 2024



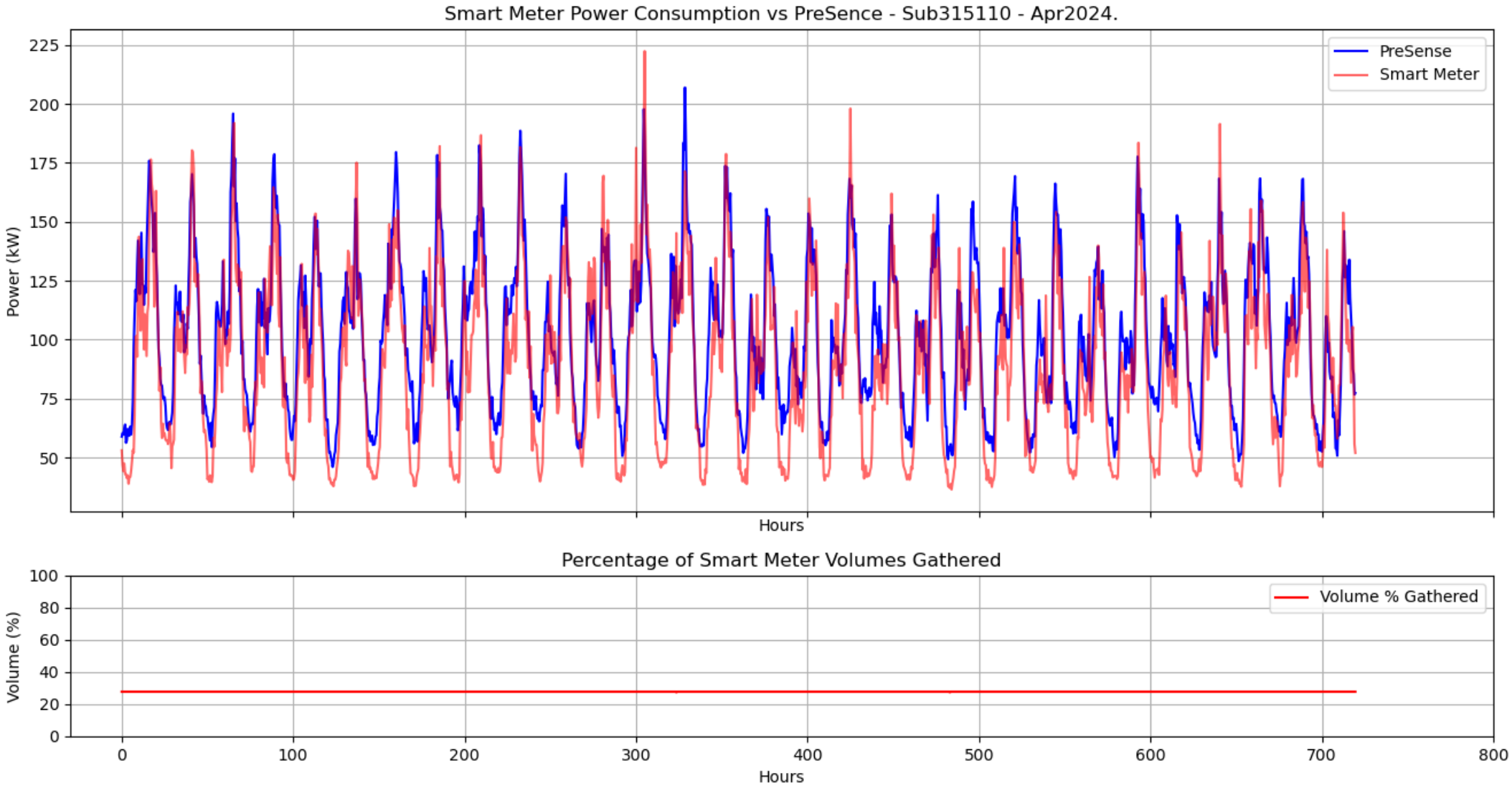
Substation 315110 – February 2024



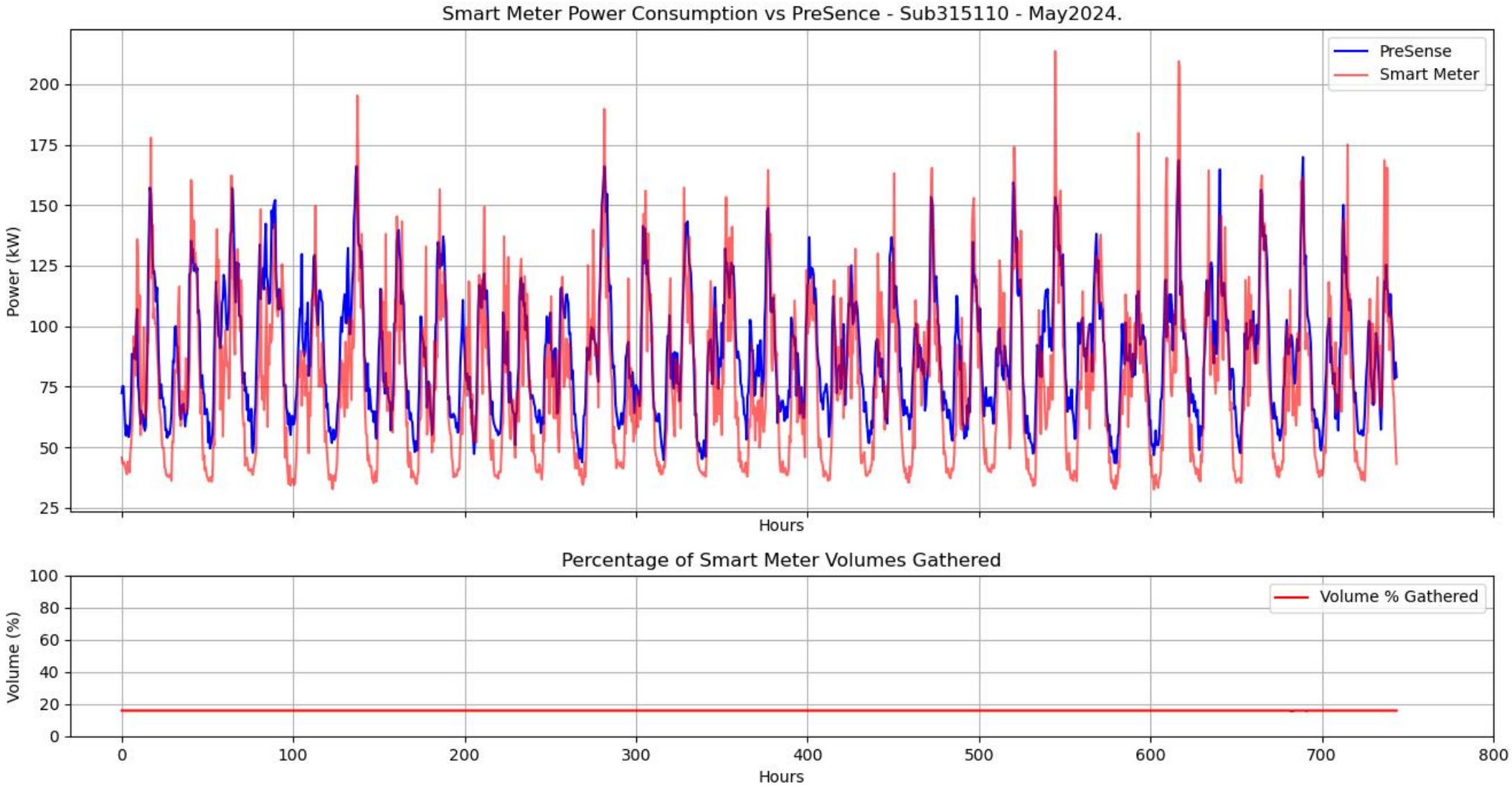
Substation 315110 – March 2024



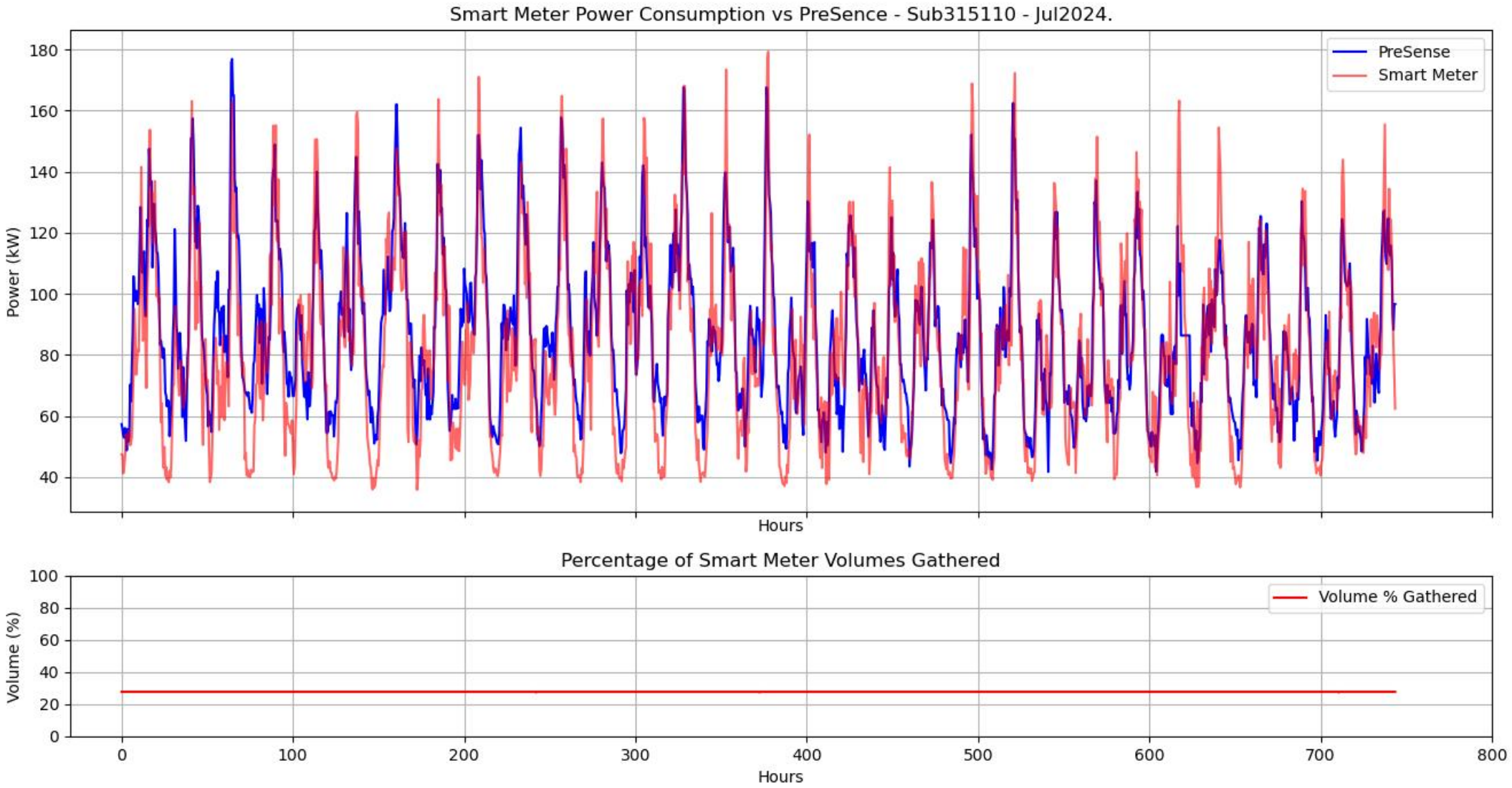
Substation 315110 – April 2024



Substation 315110 – May 2024



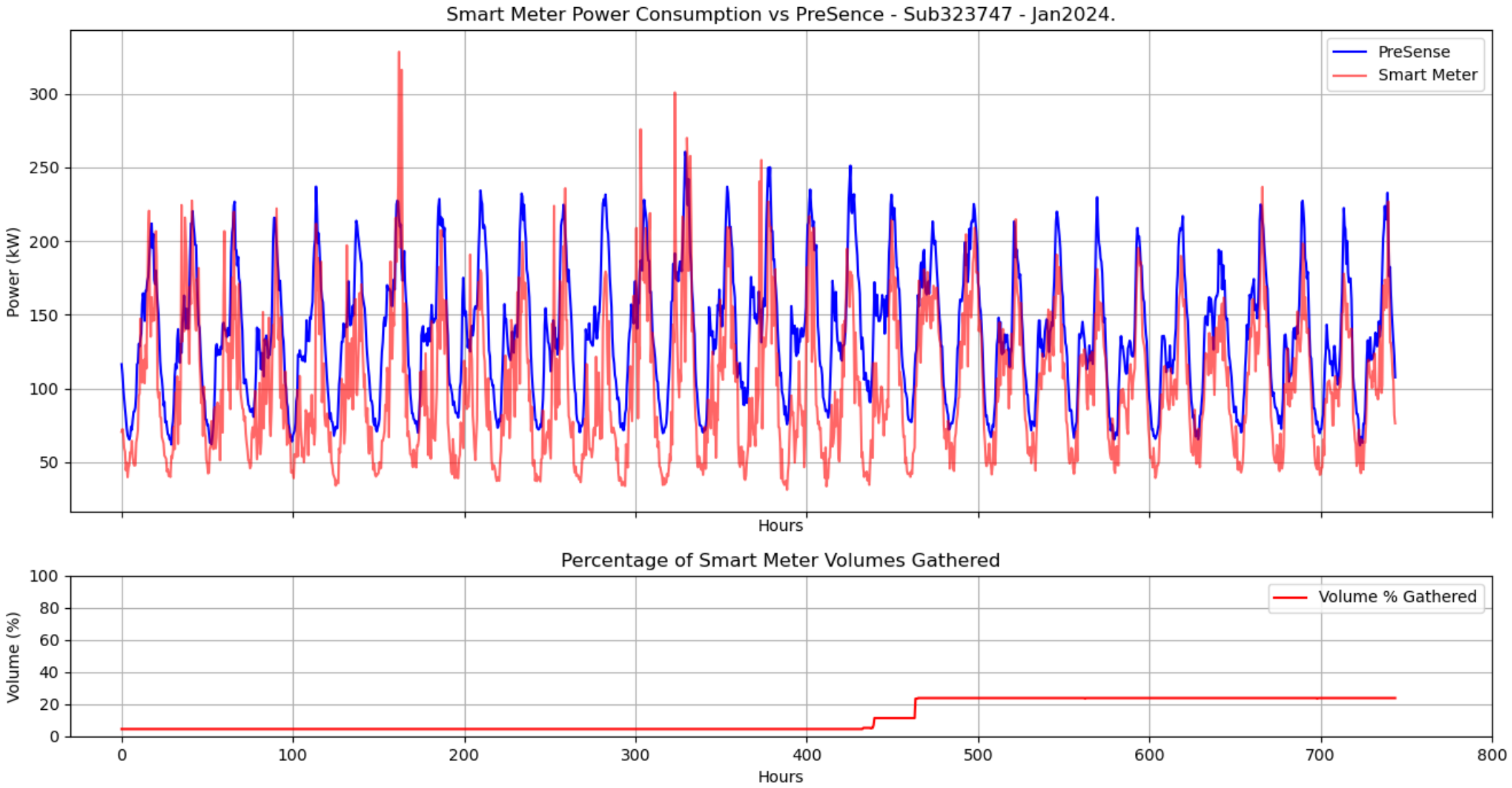
Substation 315110 – July 2024



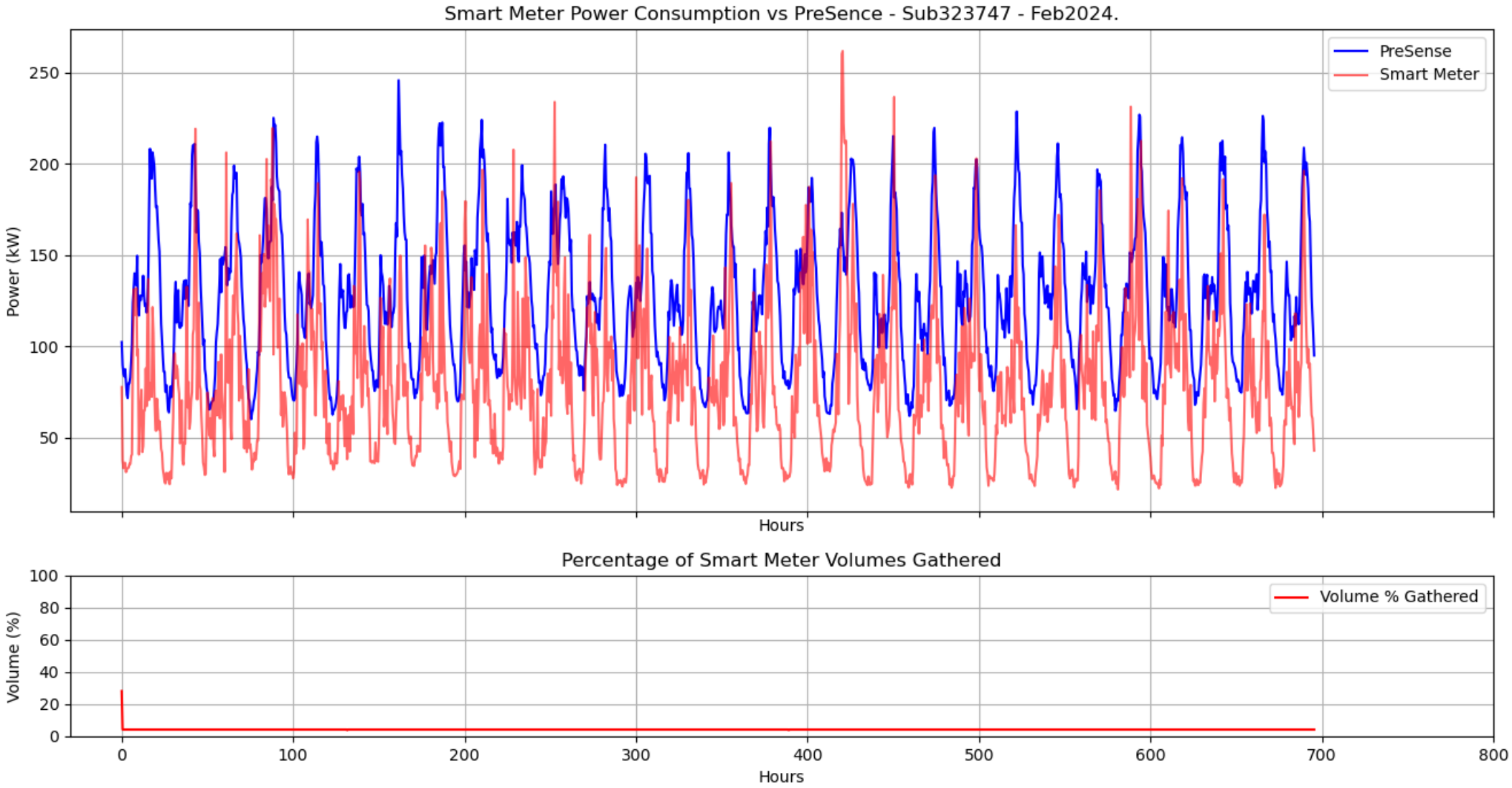
Appendix 2.11: Study results for substation 323747

electricity north west
Bringing energy to your door

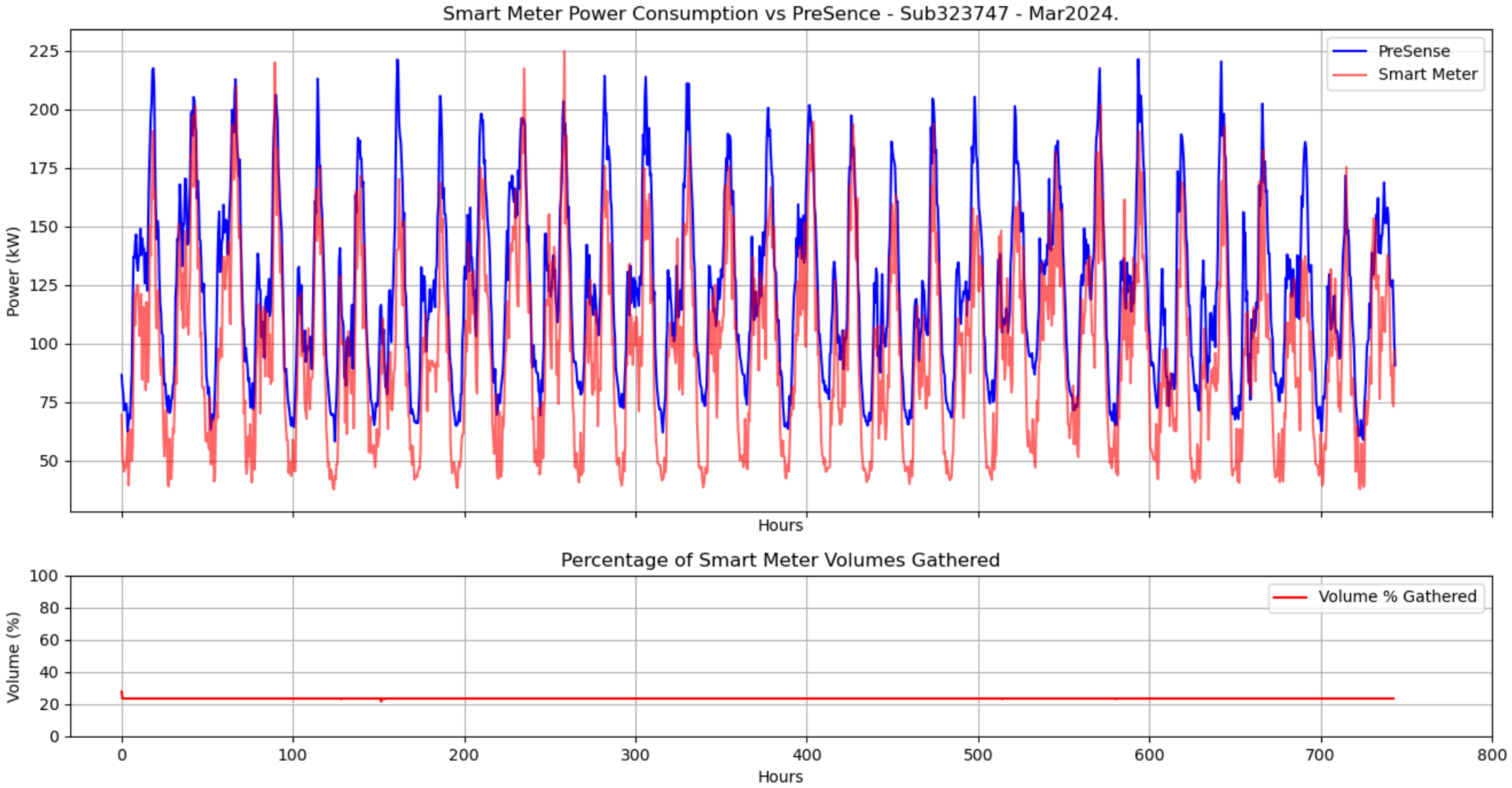
Substation 323747 – January 2024



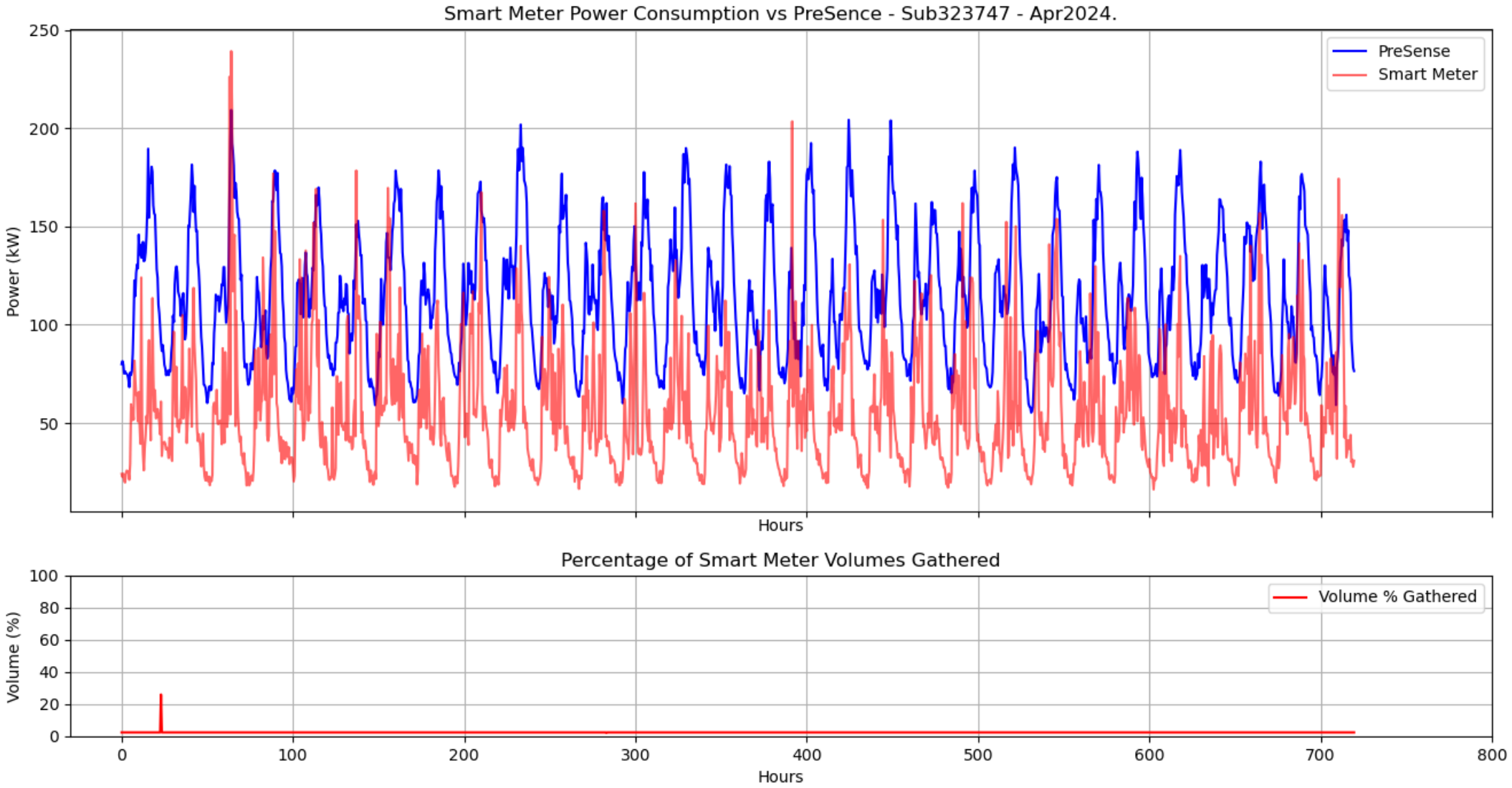
Substation 323747 – February 2024



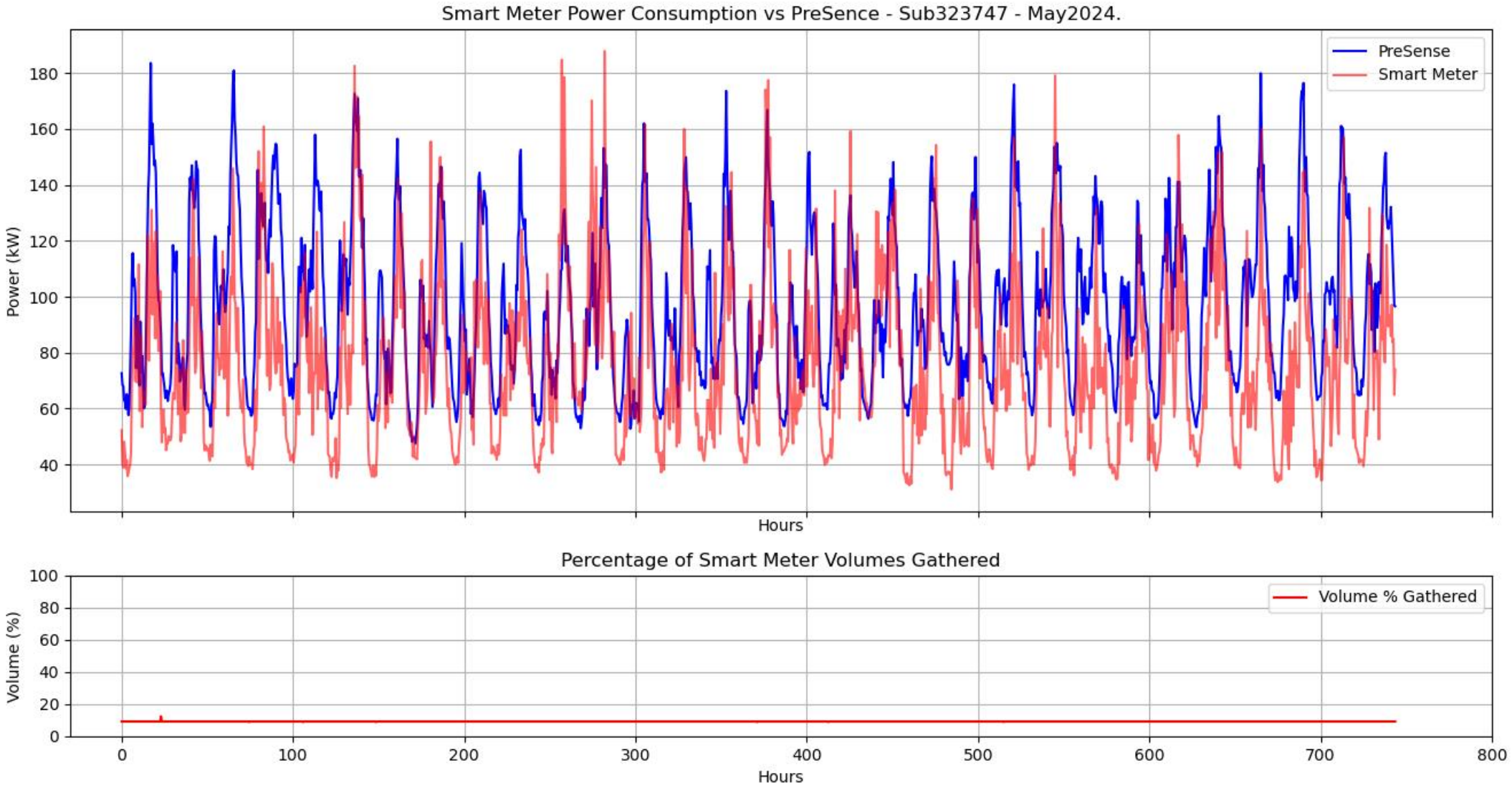
Substation 323747 – March 2024



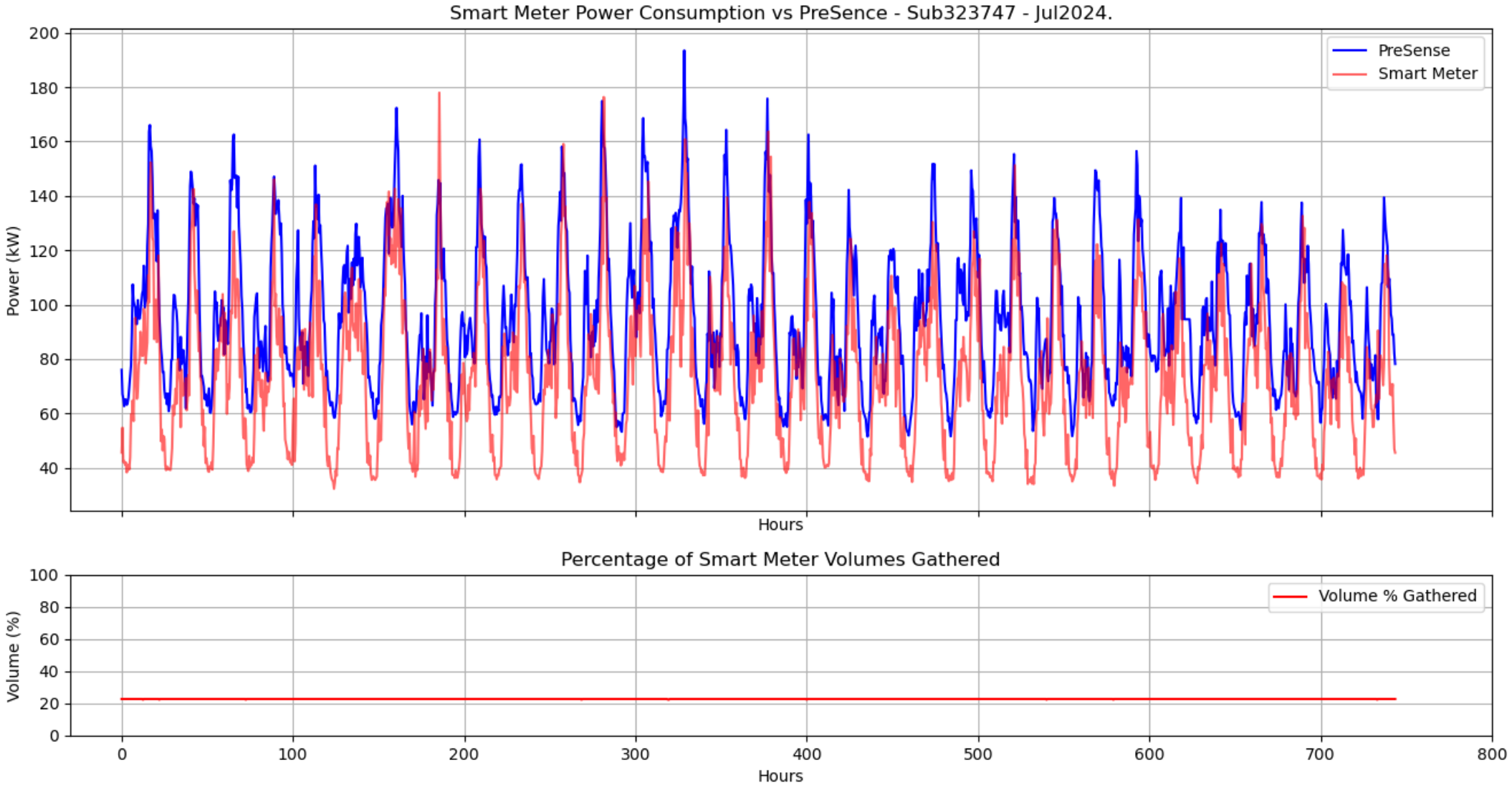
Substation 323747 – April 2024



Substation 323747 – May 2024

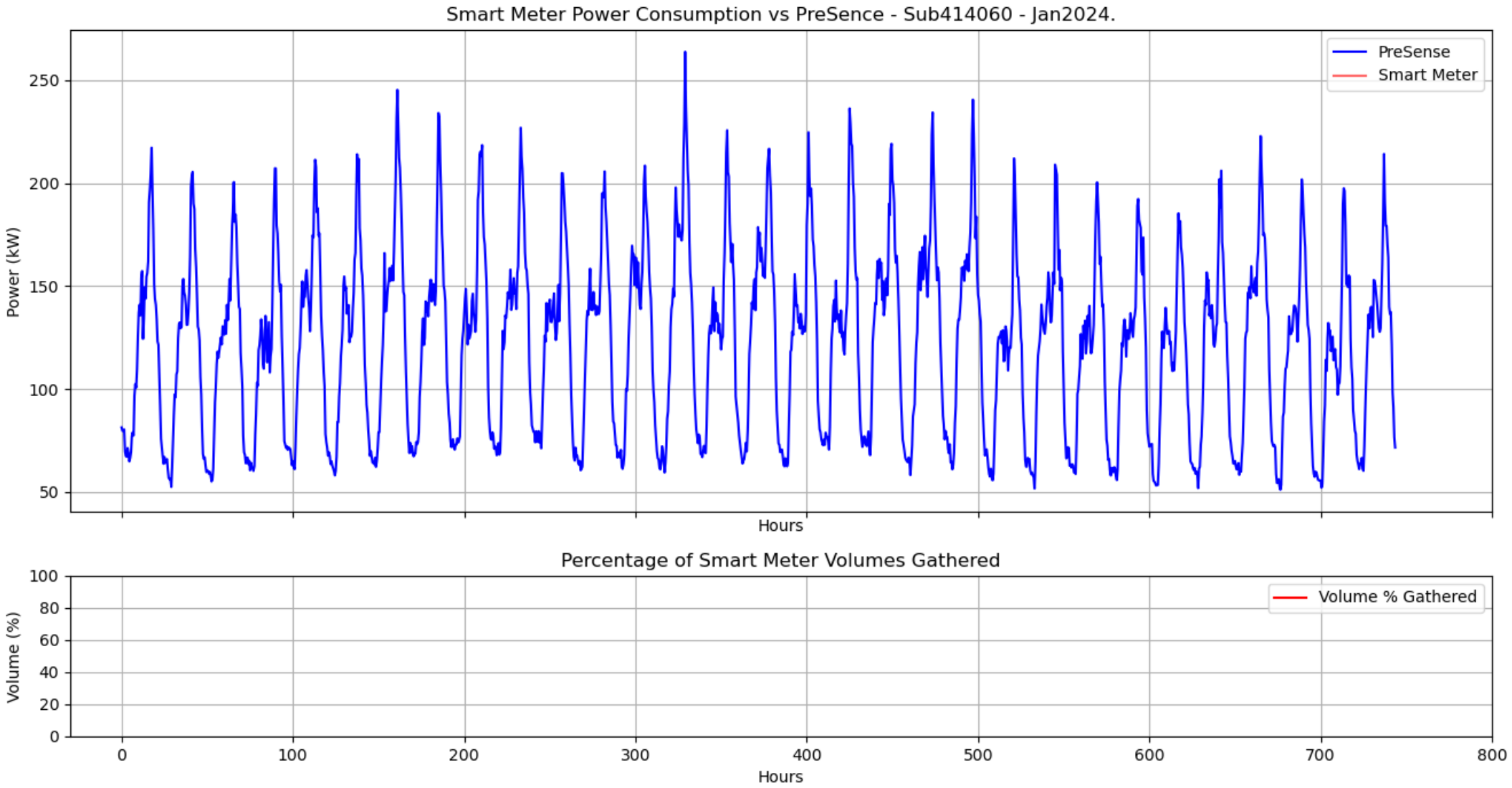


Substation 323747 – July 2024

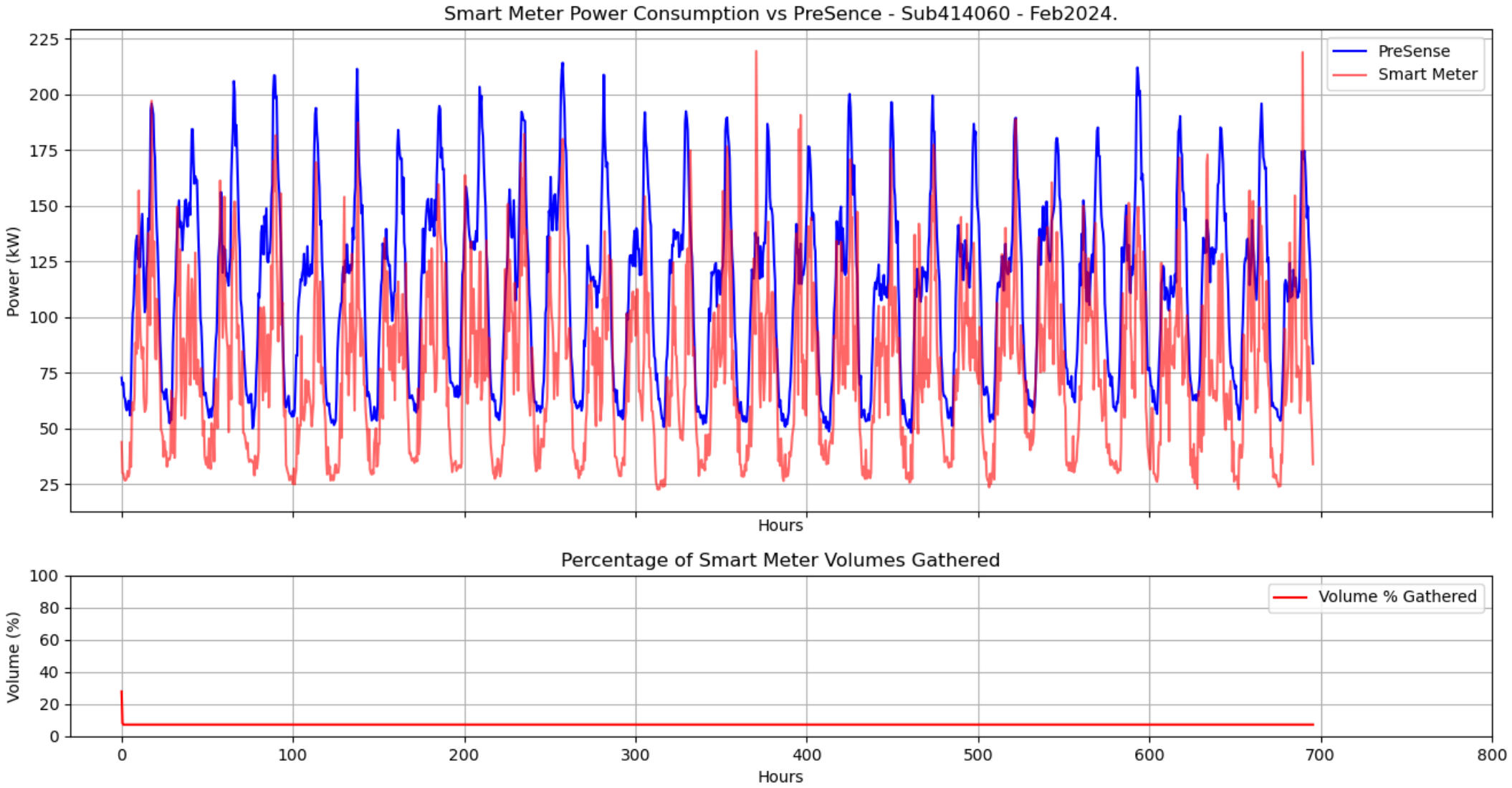


Appendix 2.12: Study results for substation 414060

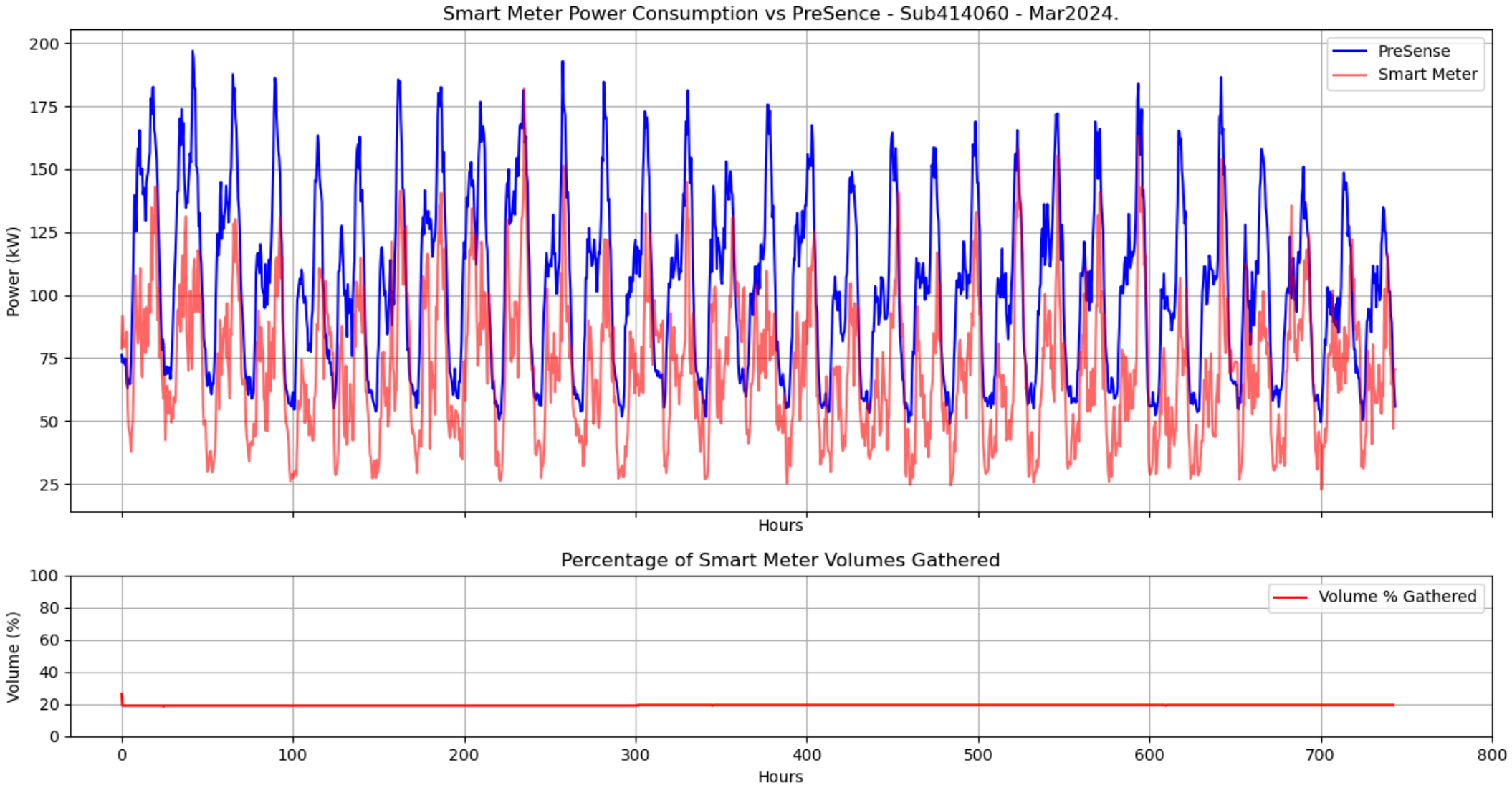
Substation 414060 – January 2024



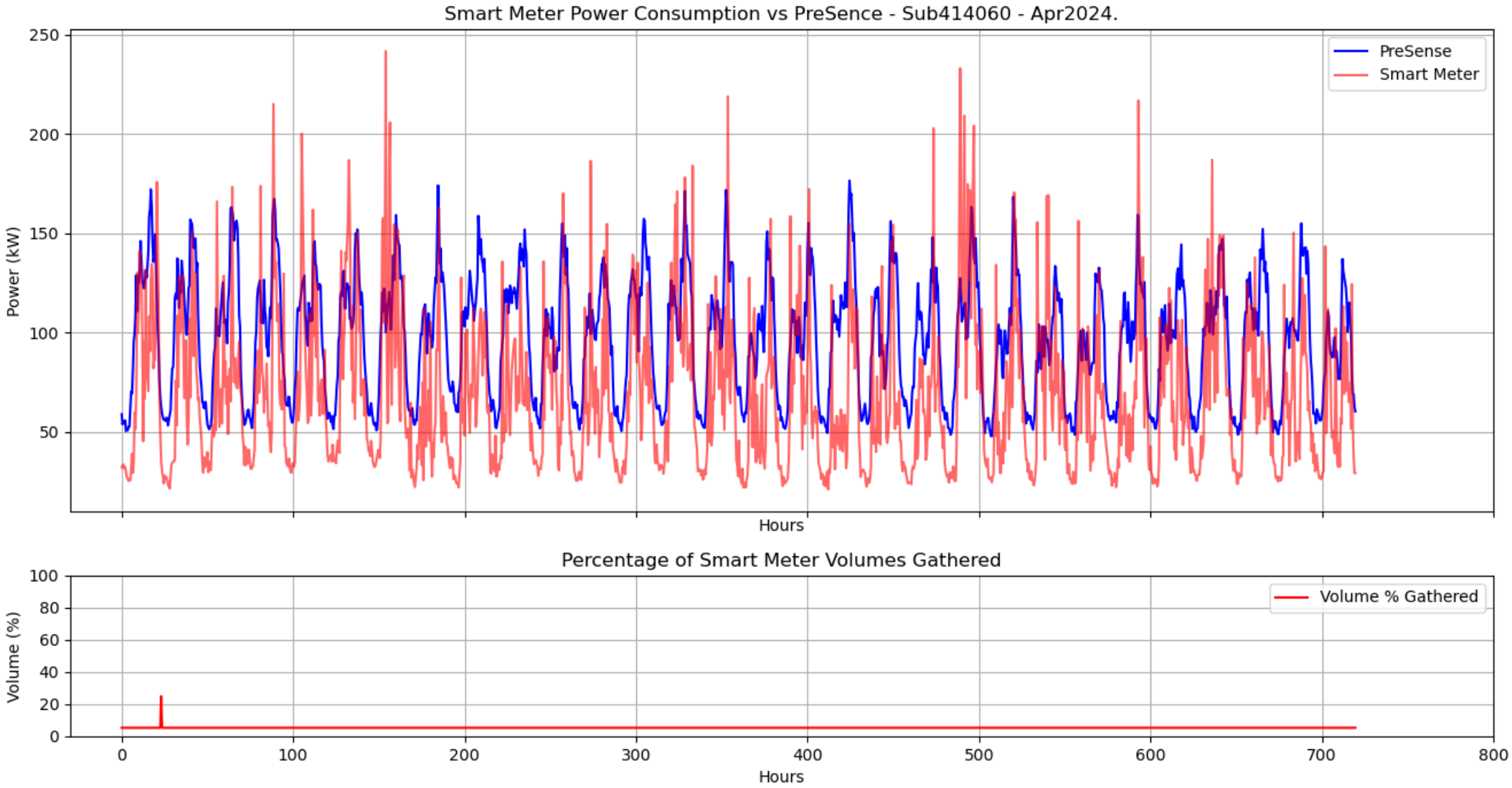
Substation 414060 – February 2024



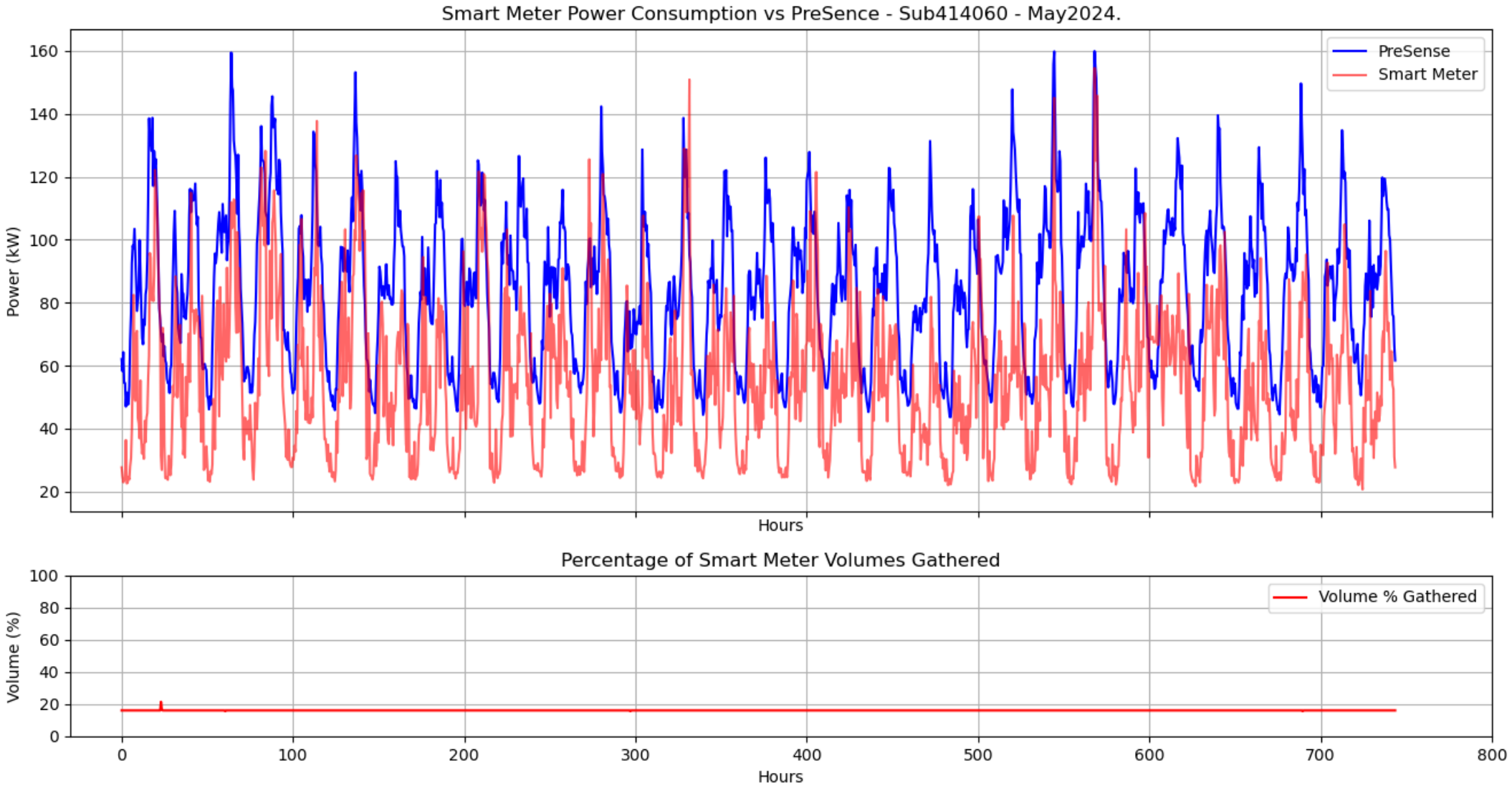
Substation 414060 – March 2024



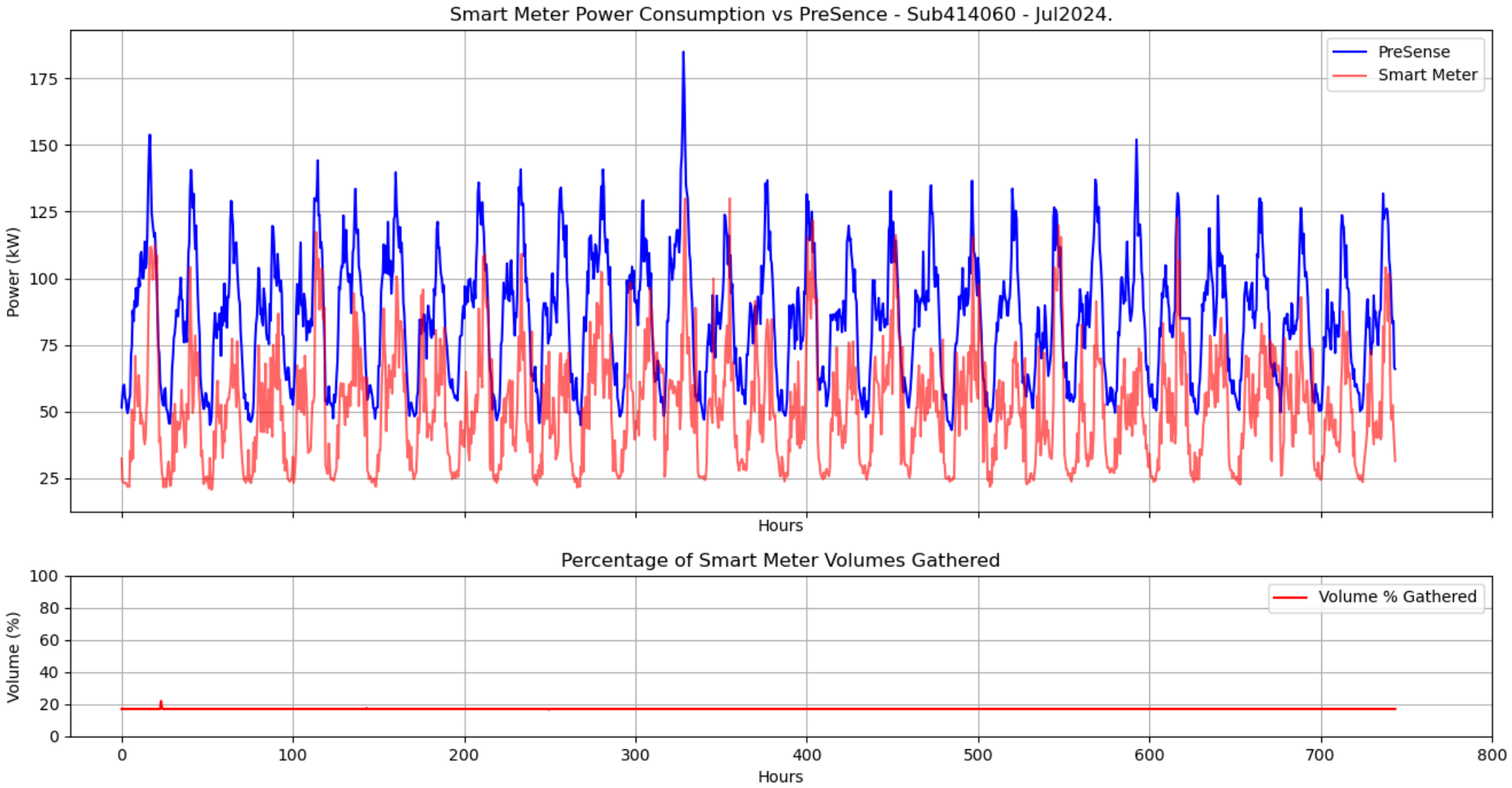
Substation 414060 – April 2024



Substation 414060 – May 2024

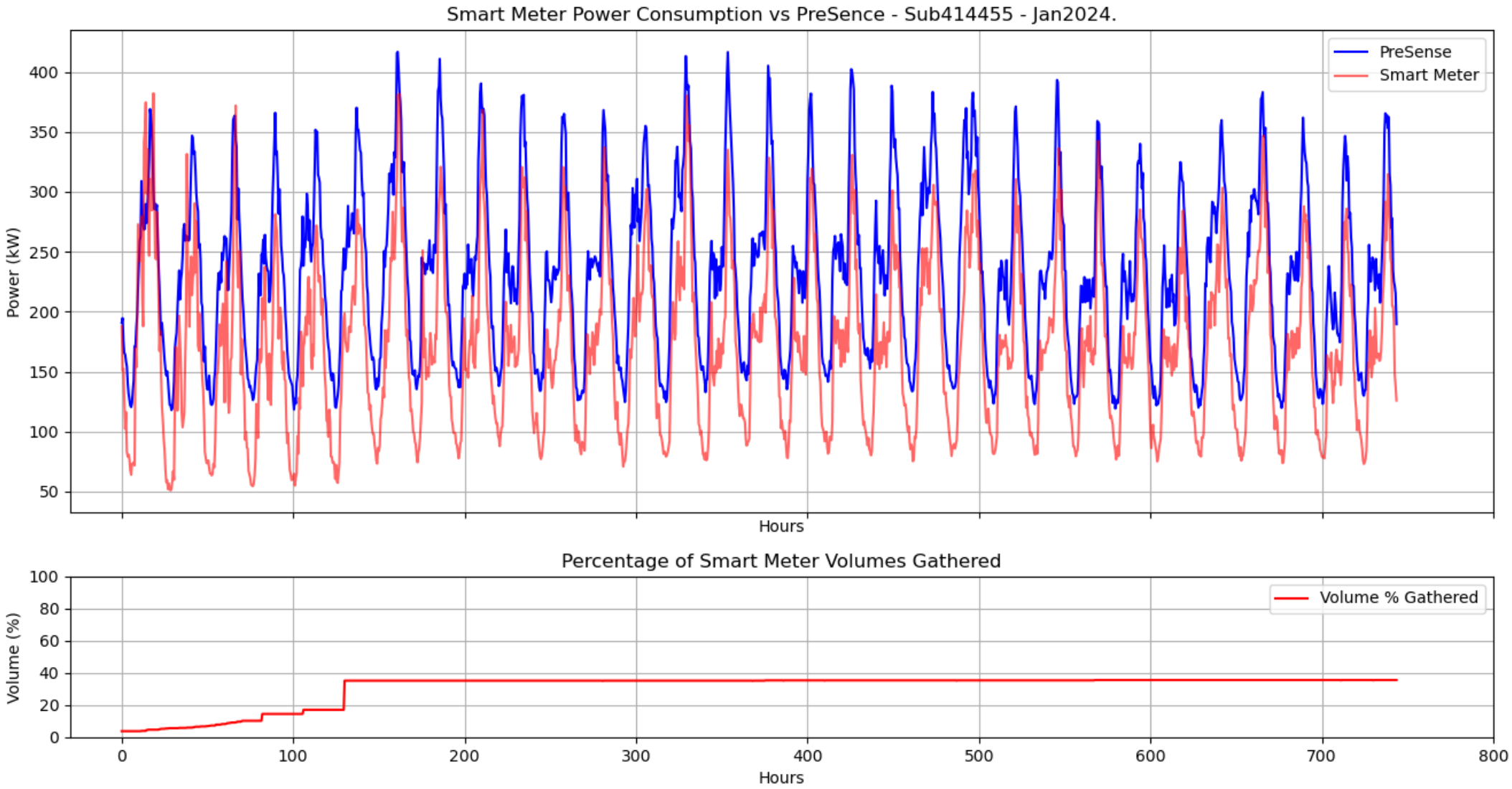


Substation 414060 – July 2024

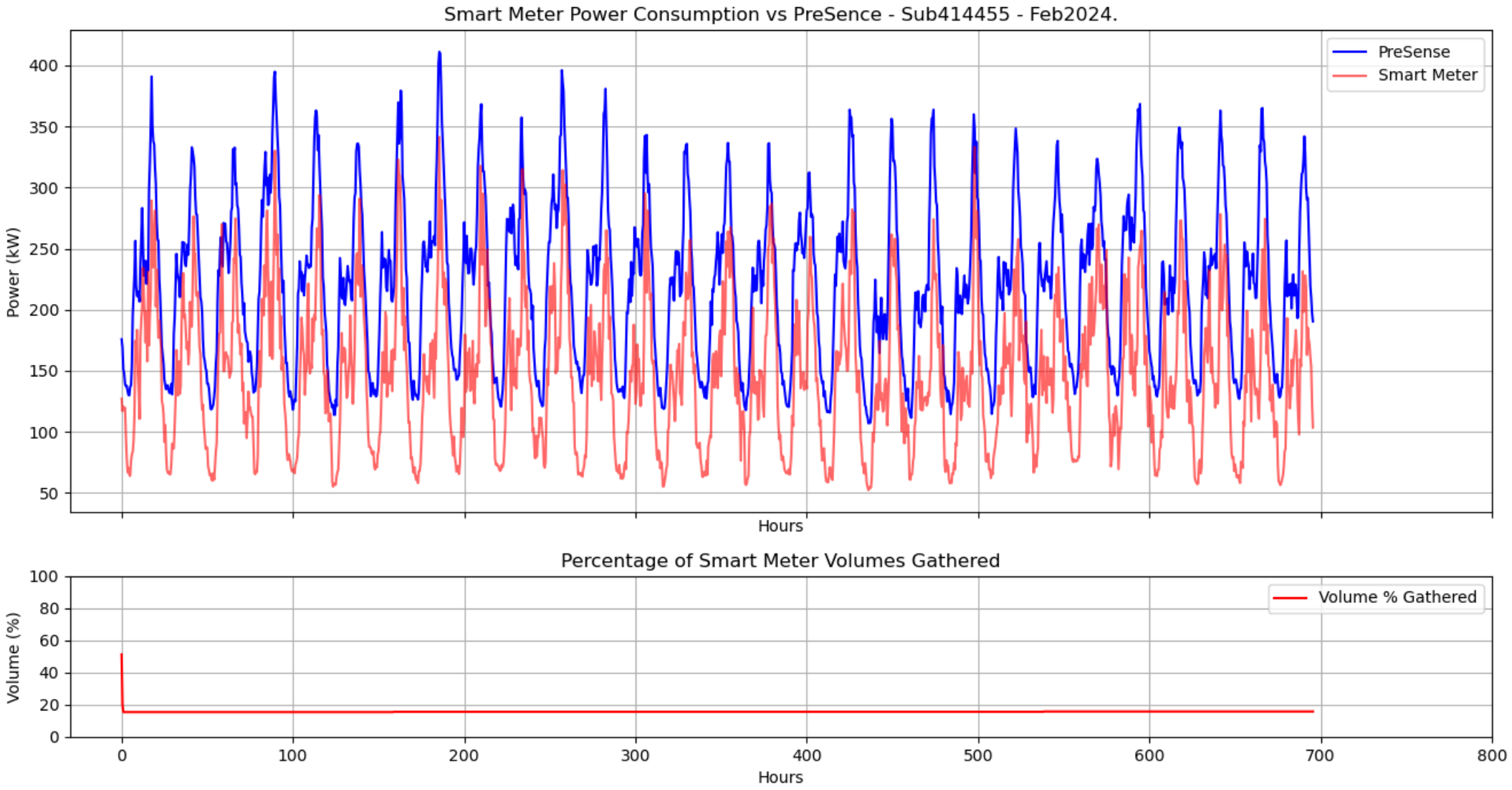


Appendix 2.13: Study results for substation 414455

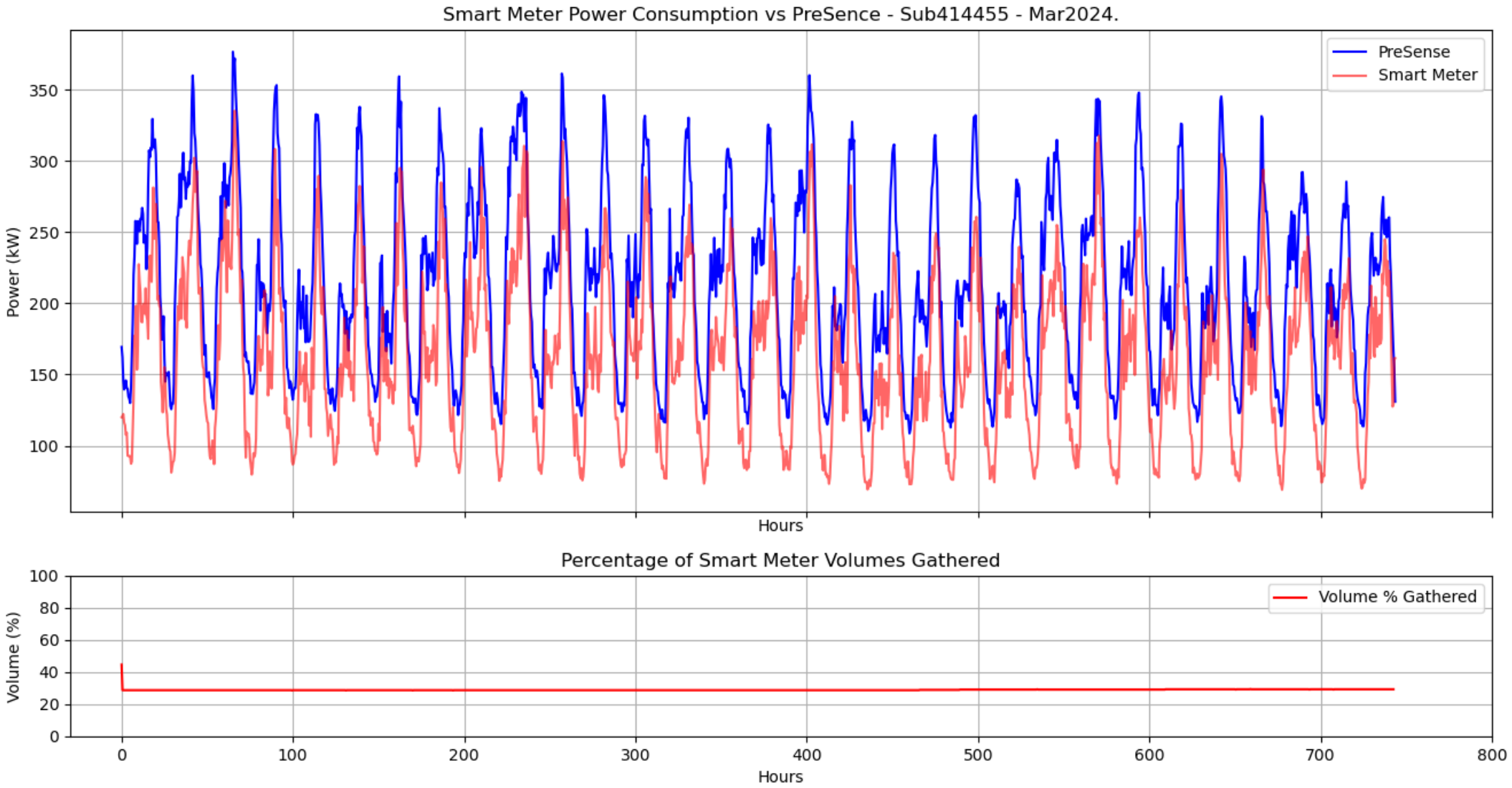
Substation 414455 – January 2024



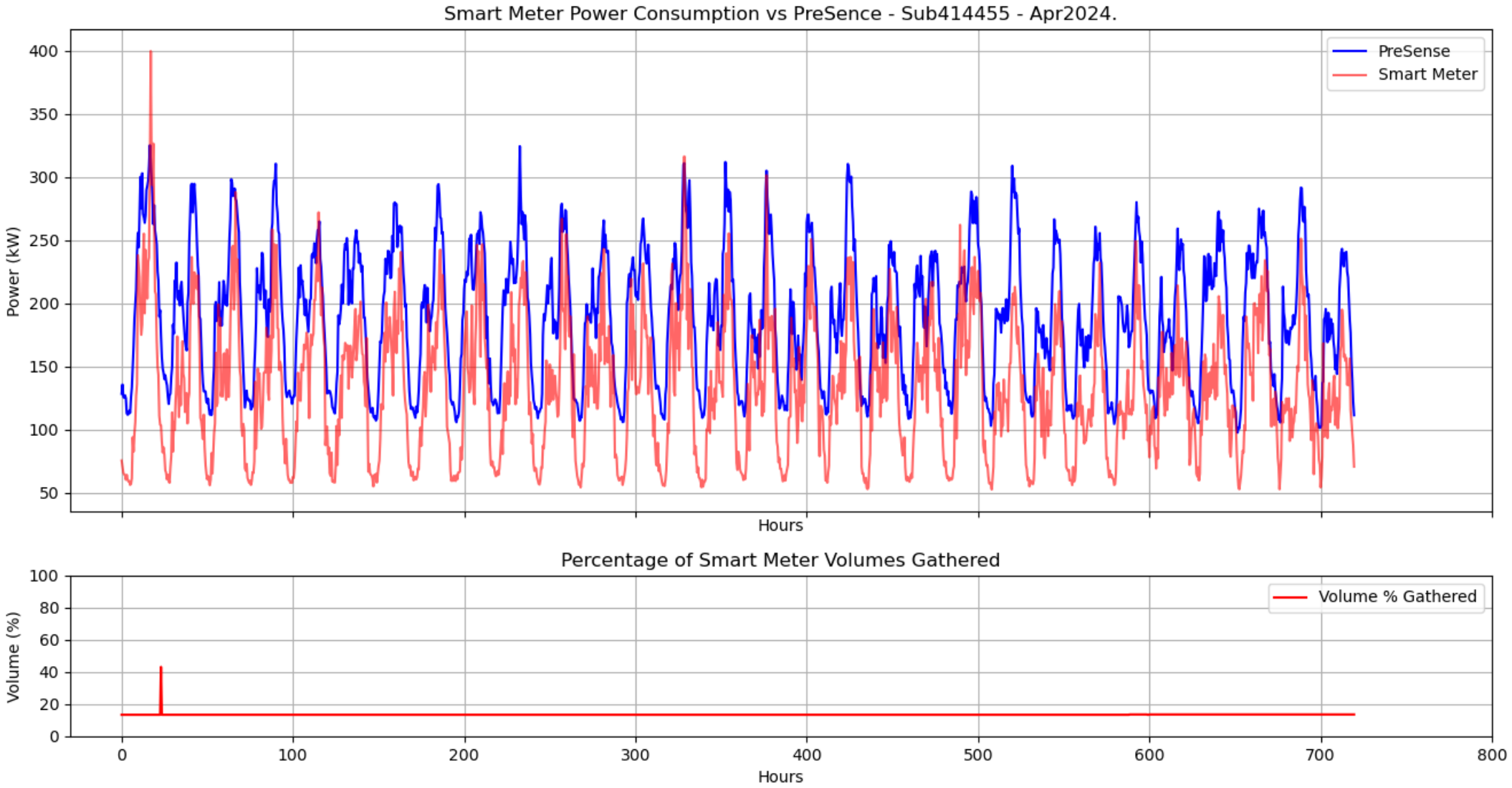
Substation 414455 – February 2024



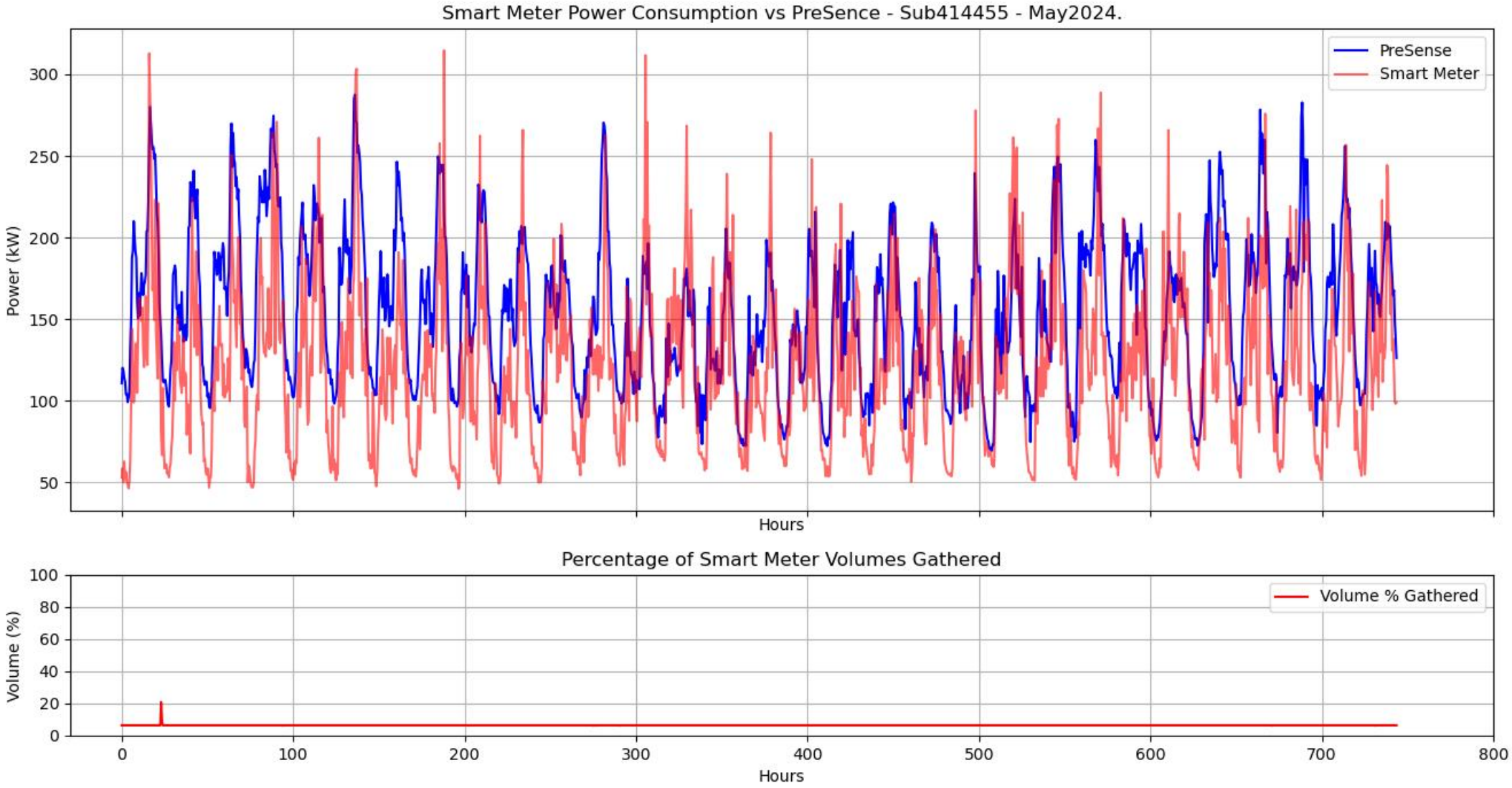
Substation 414455 – March 2024



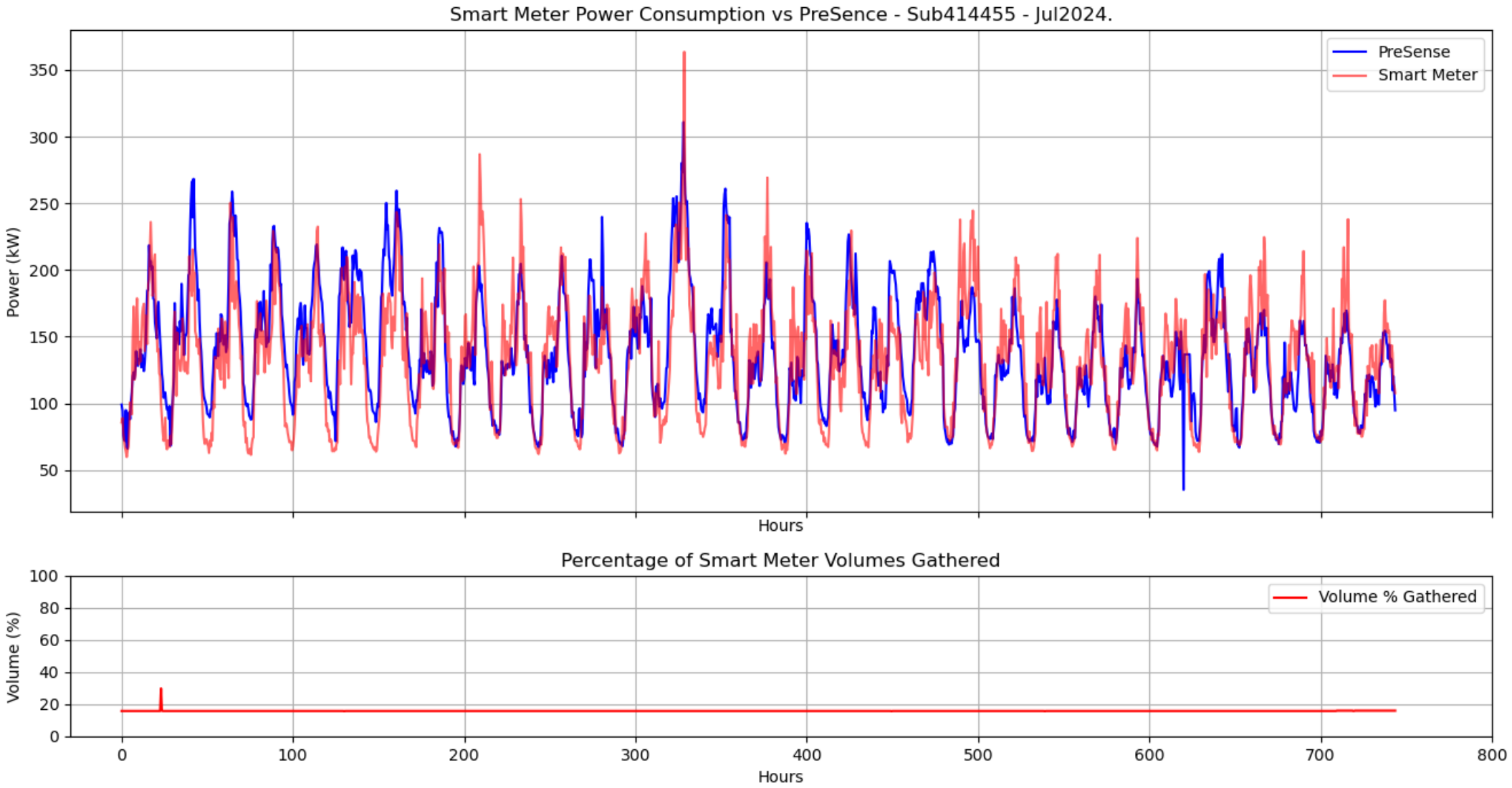
Substation 414455 – April 2024



Substation 414455 – May 2024

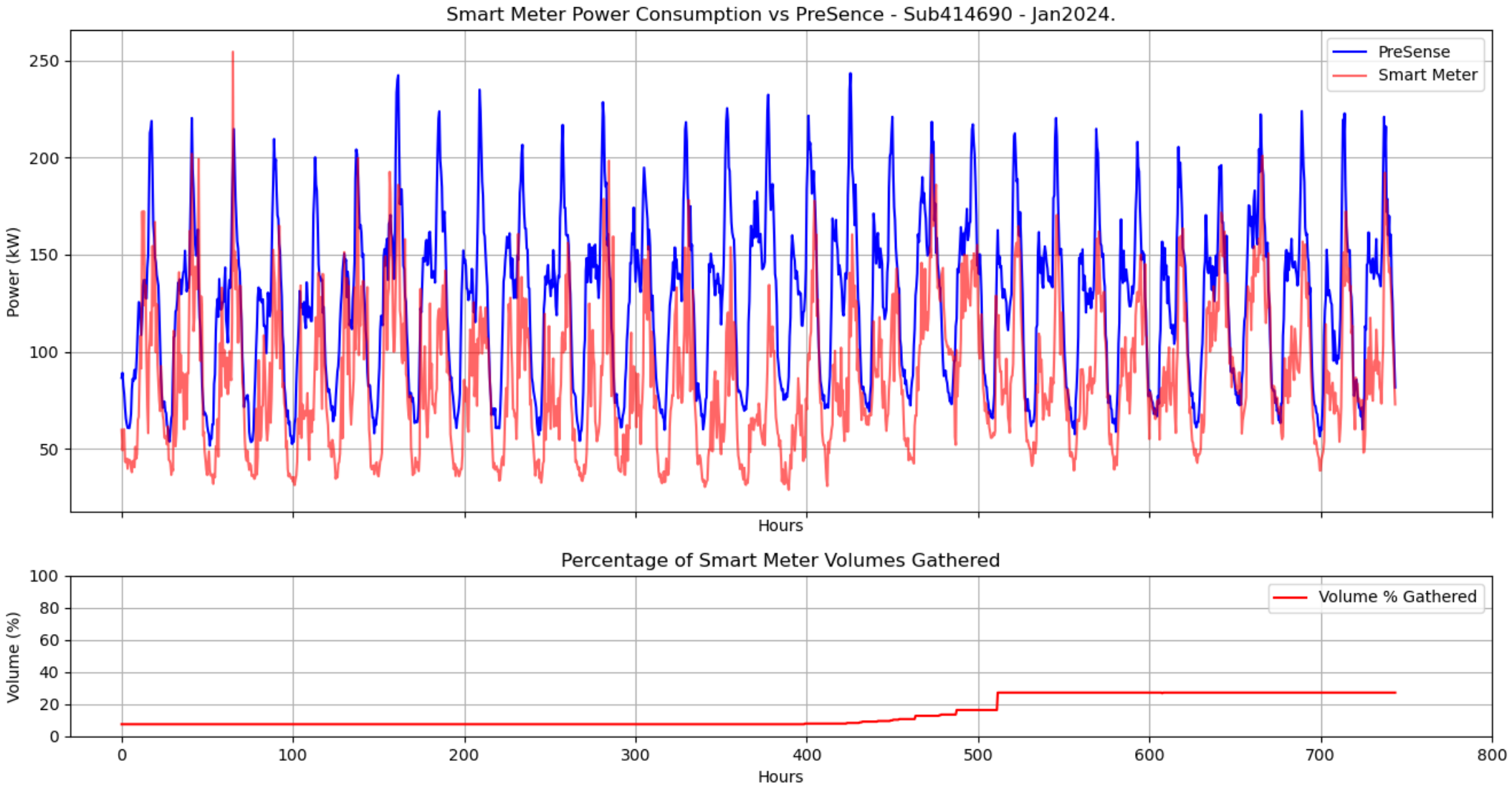


Substation 414455 – July 2024

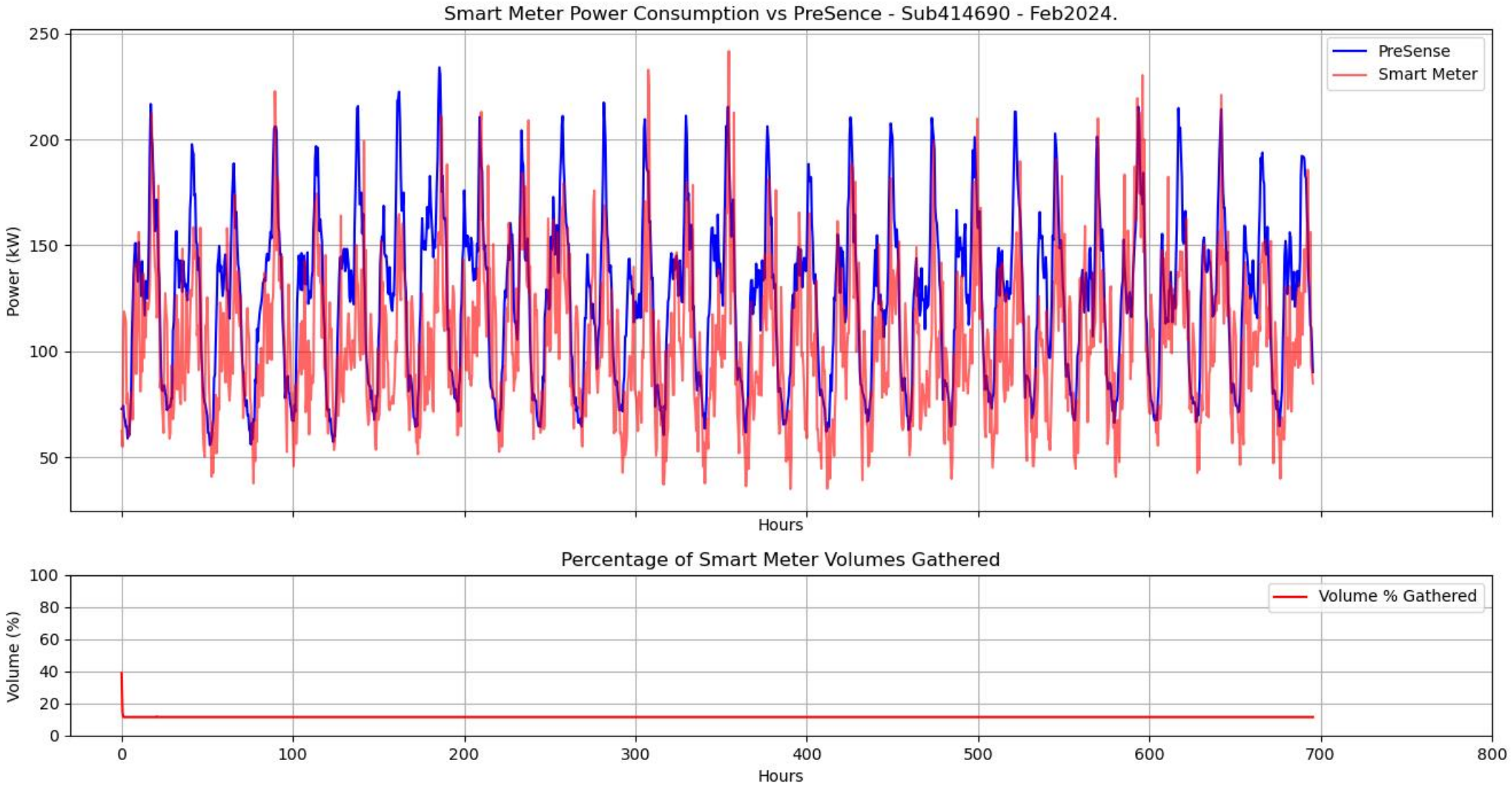


Appendix 2.14: Study results for substation 414690

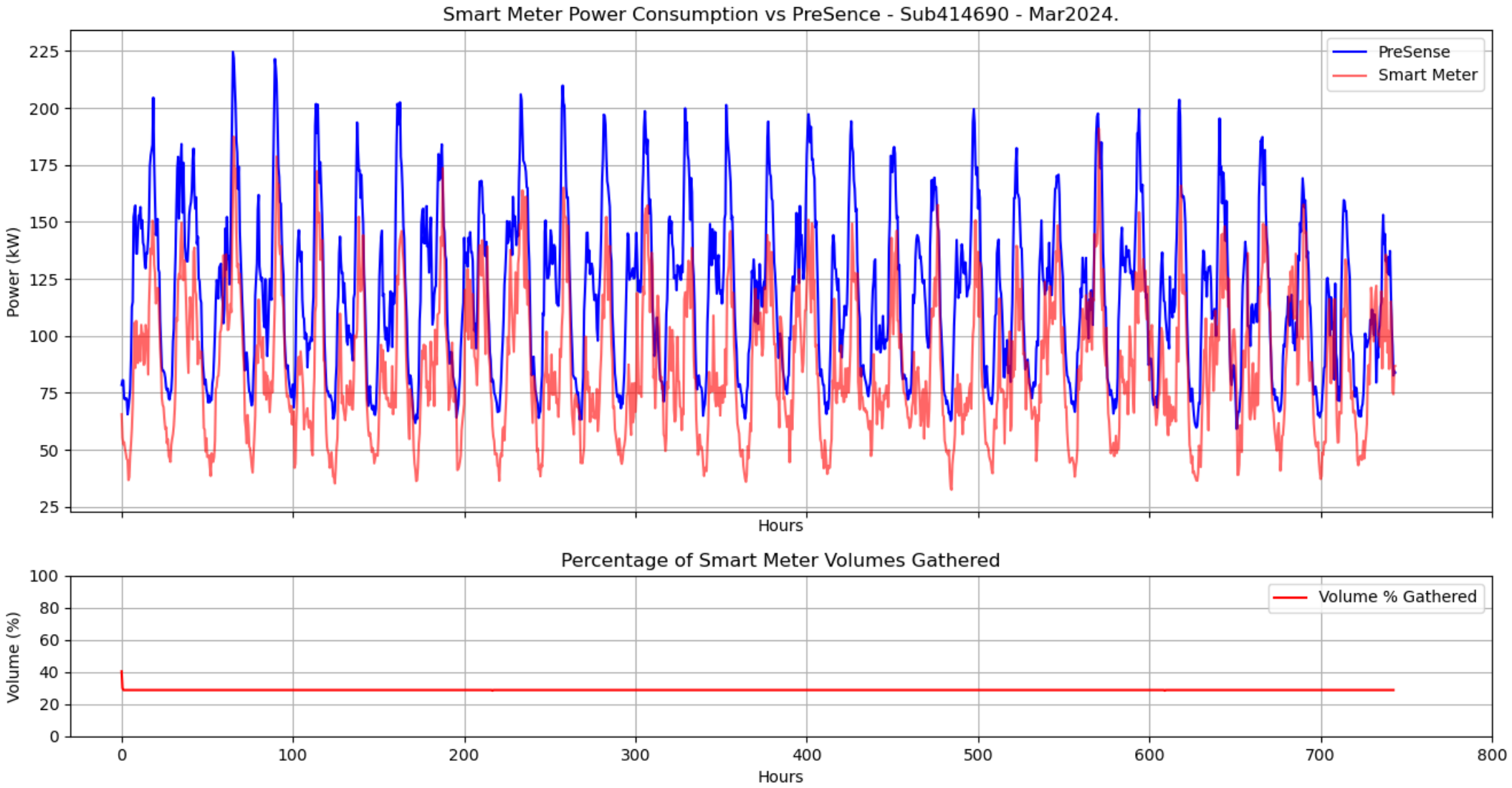
Substation 414690 – January 2024



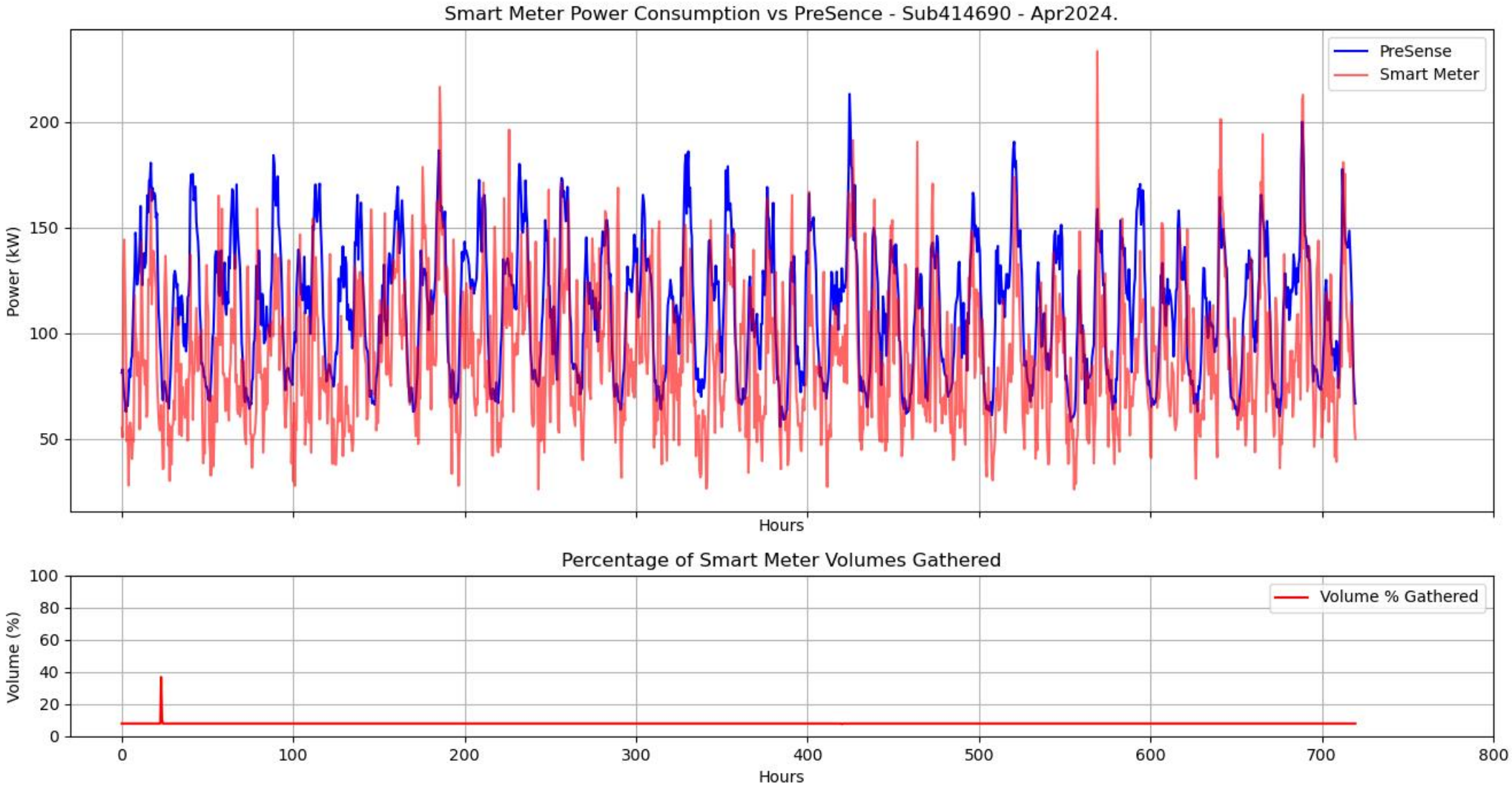
Substation 414690 – February 2024



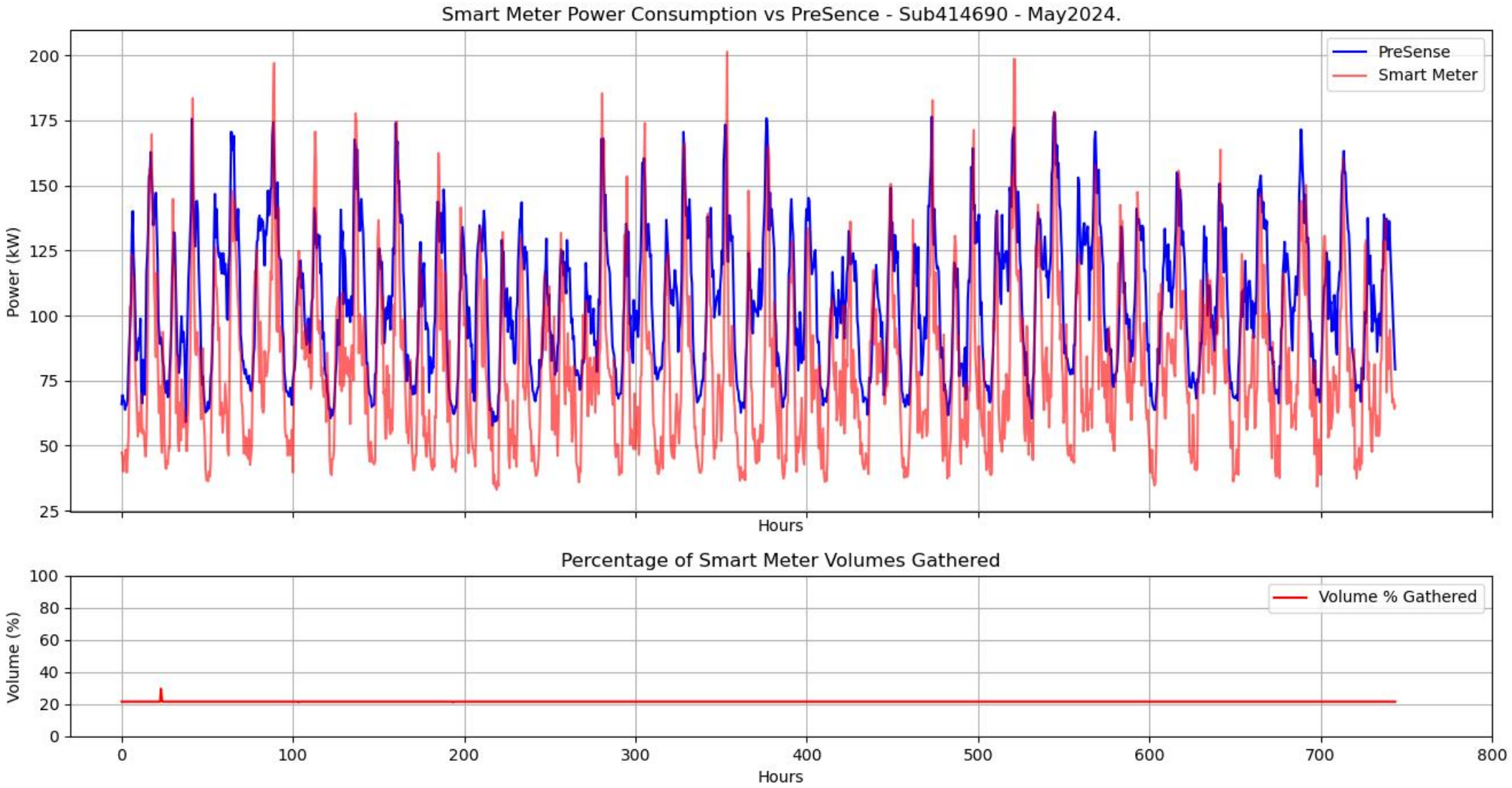
Substation 414690 – March 2024



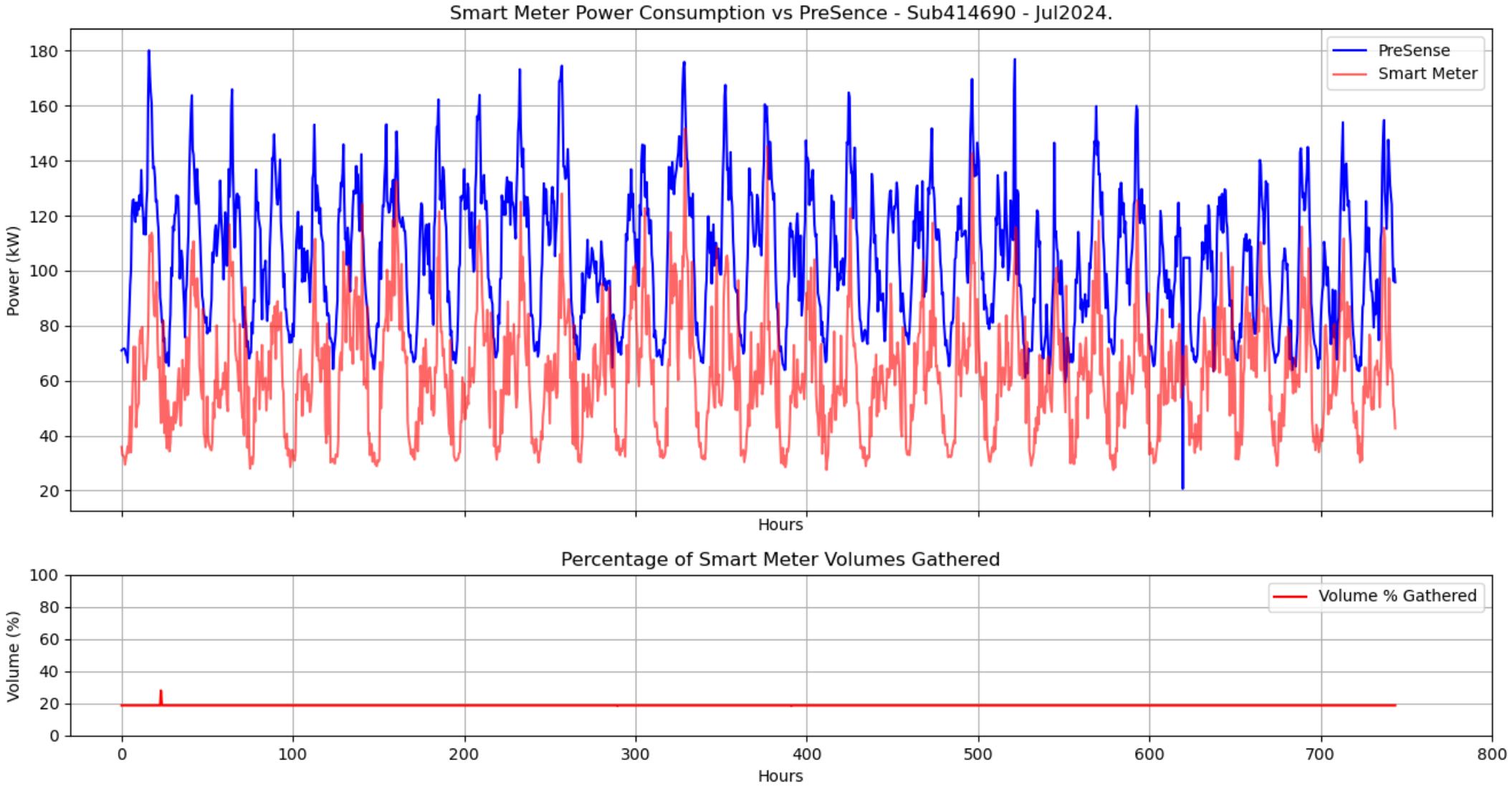
Substation 414690 – April 2024



Substation 414690 – May 2024



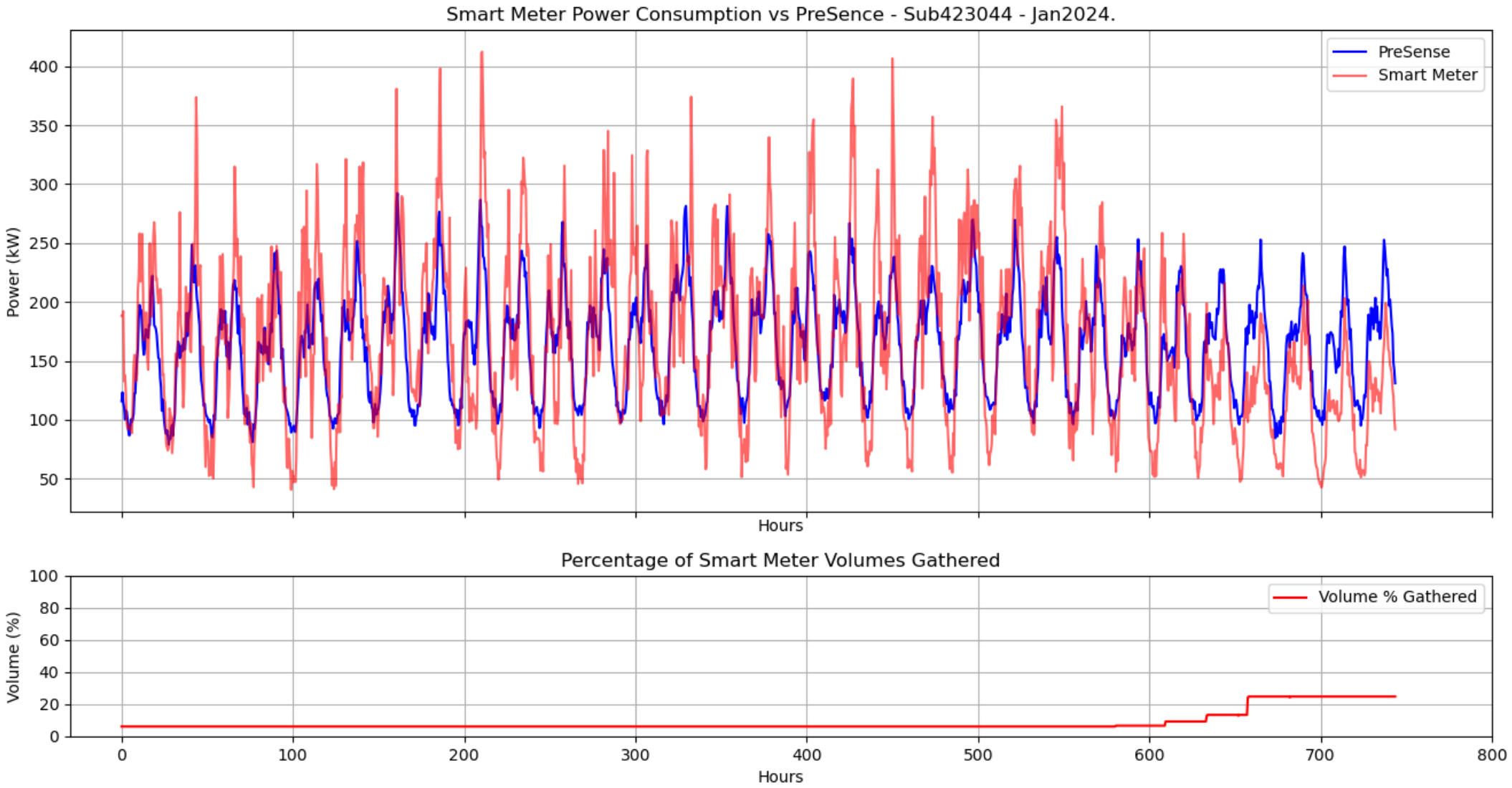
Substation 414690 – July 2024



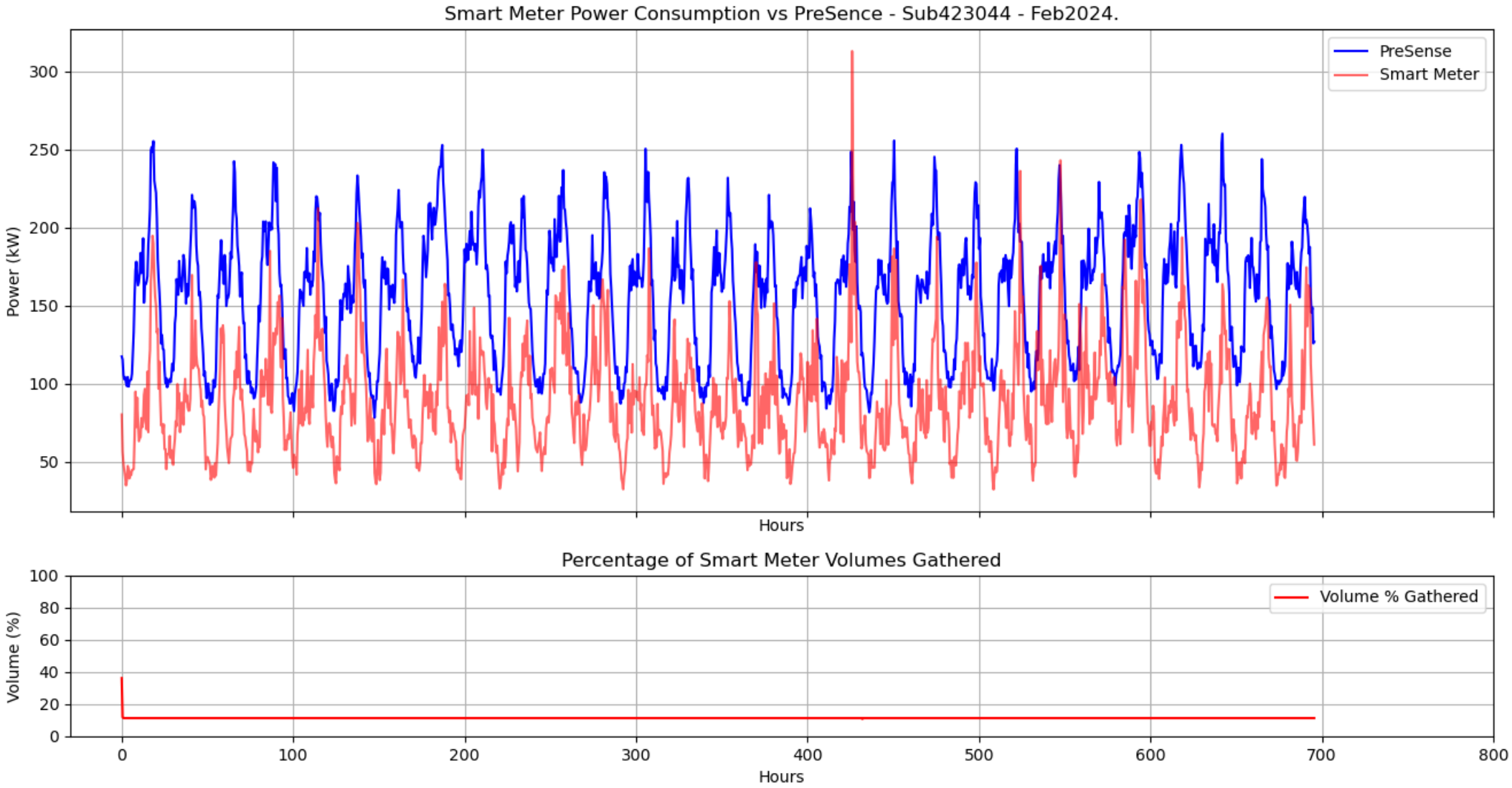
Appendix 2.15: Study results for substation 423044

electricity north west
Bringing energy to your door

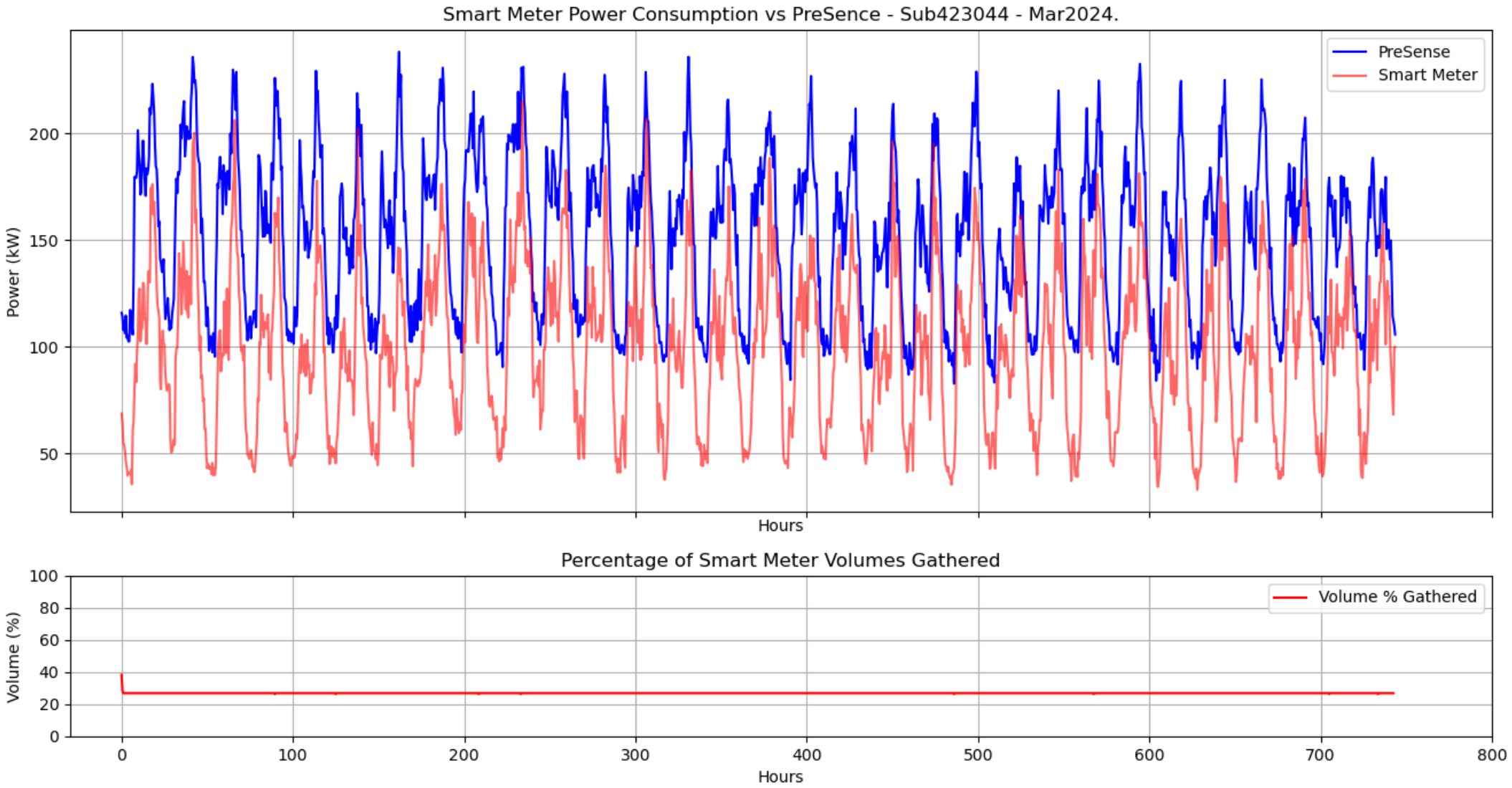
Substation 423044 – January 2024



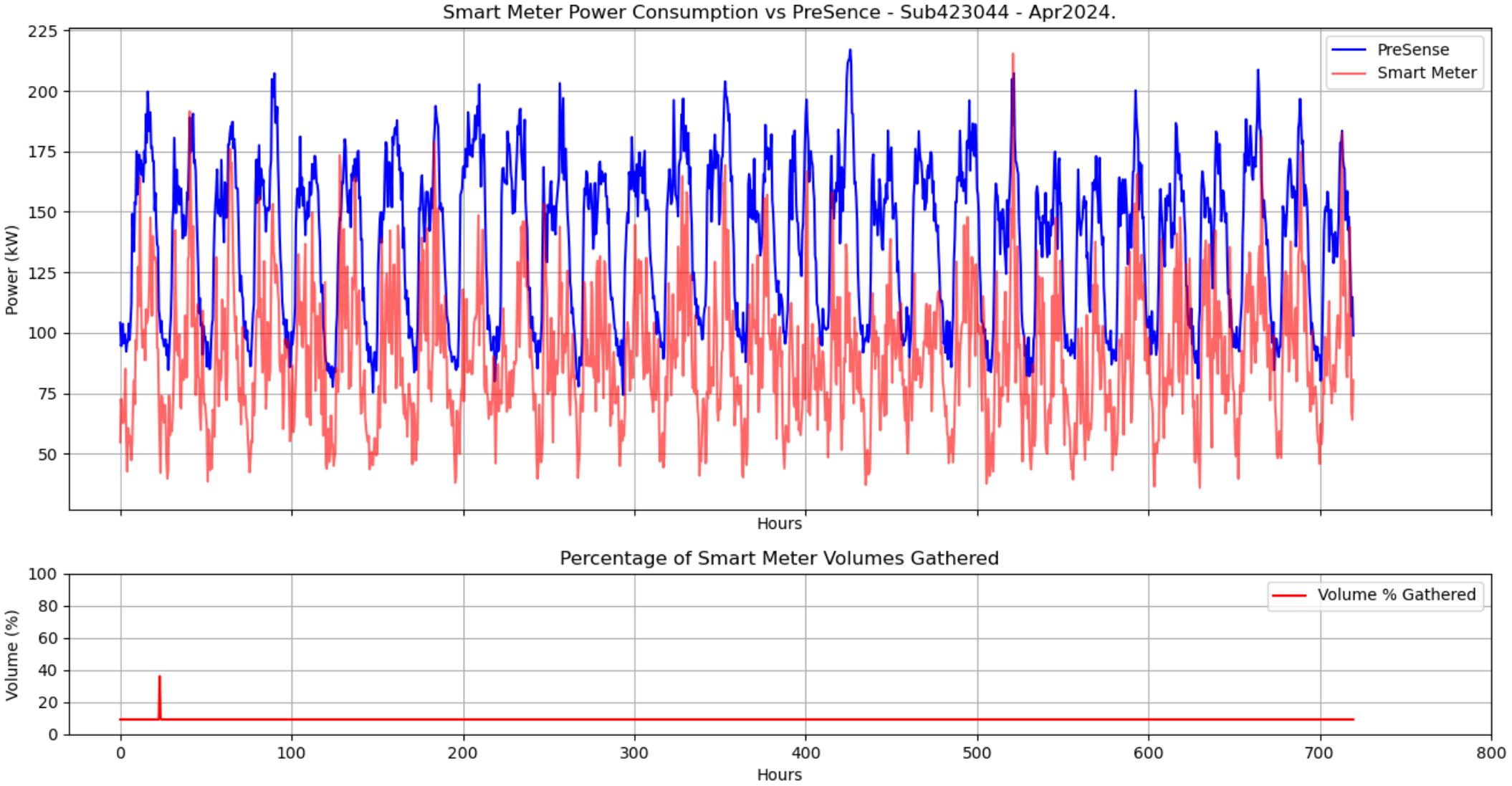
Substation 423044 – February 2024



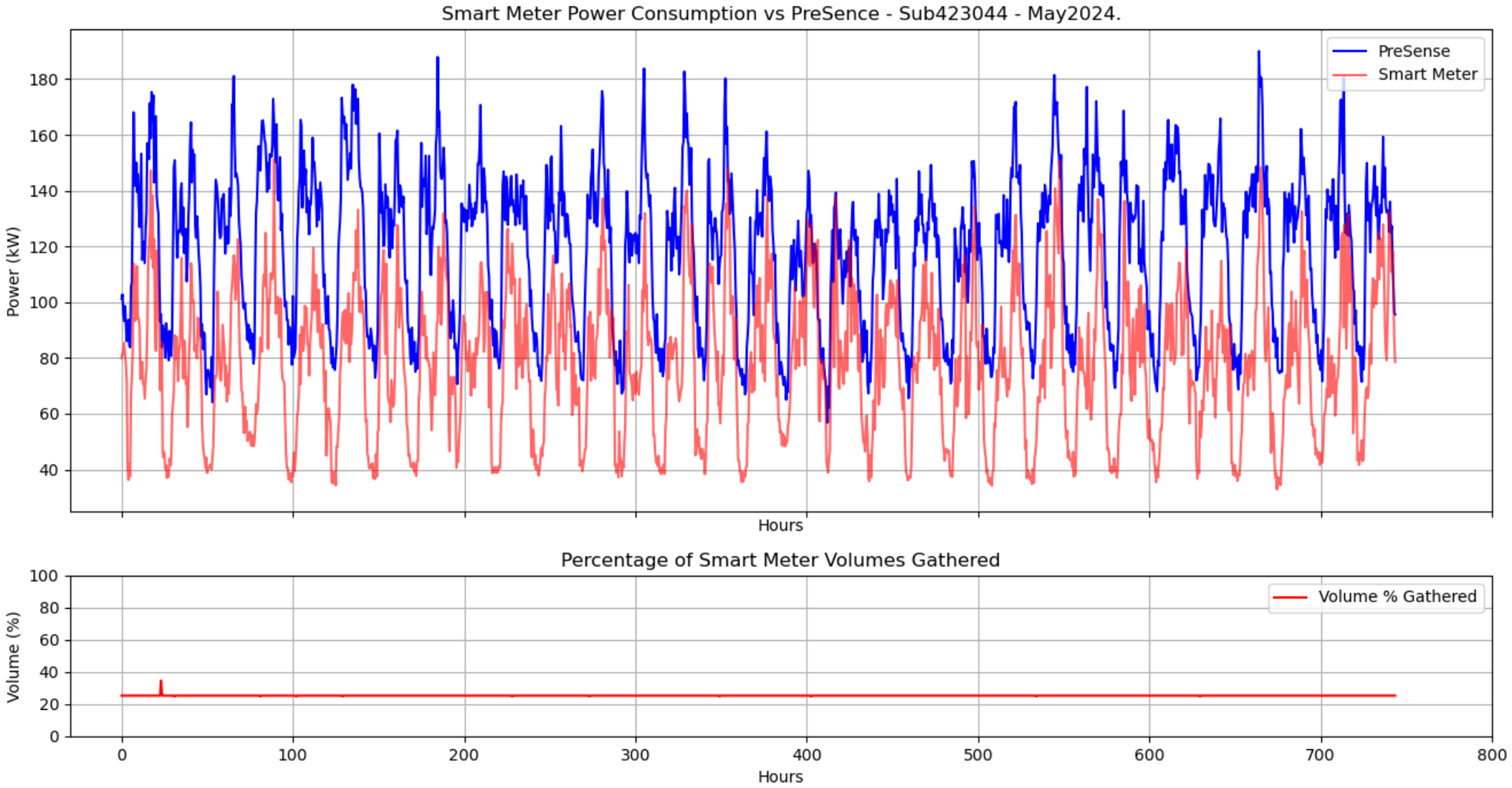
Substation 423044 – March 2024



Substation 423044 – April 2024



Substation 423044 – May 2024



Substation 423044 – July 2024