ATHENA POWER

Detroit Edison Sensor Pilot

Data Analysis 2023 (First Half)

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Data Analysis 2023

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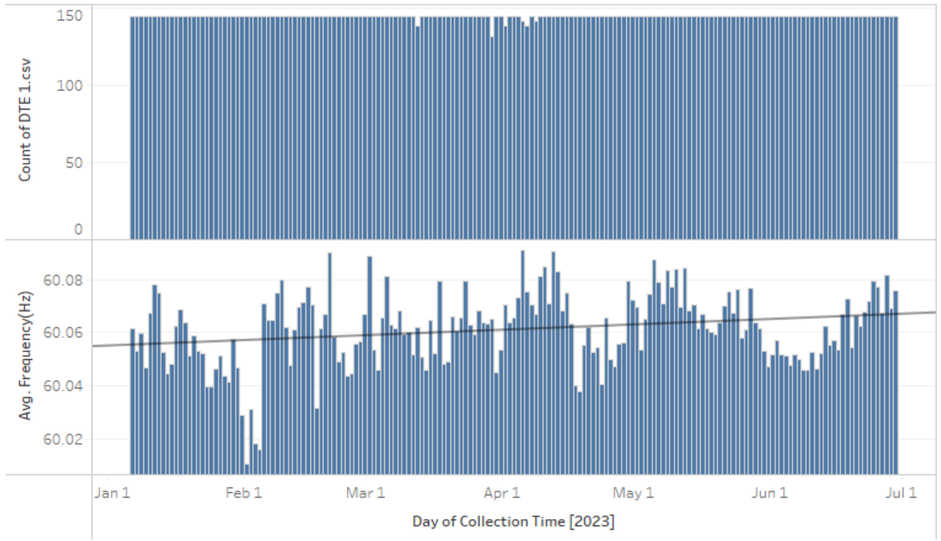
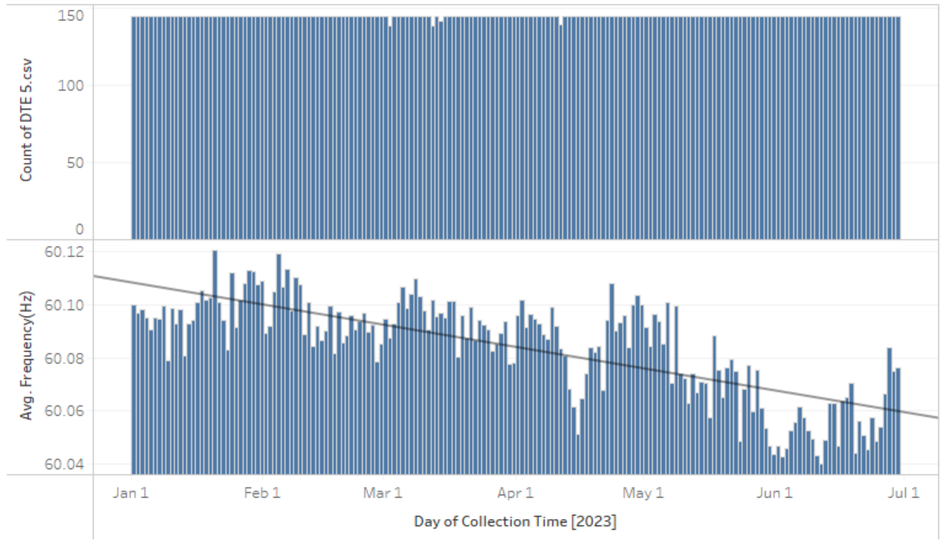
Sensor Daily Count / Collection

DTE1 Hourly

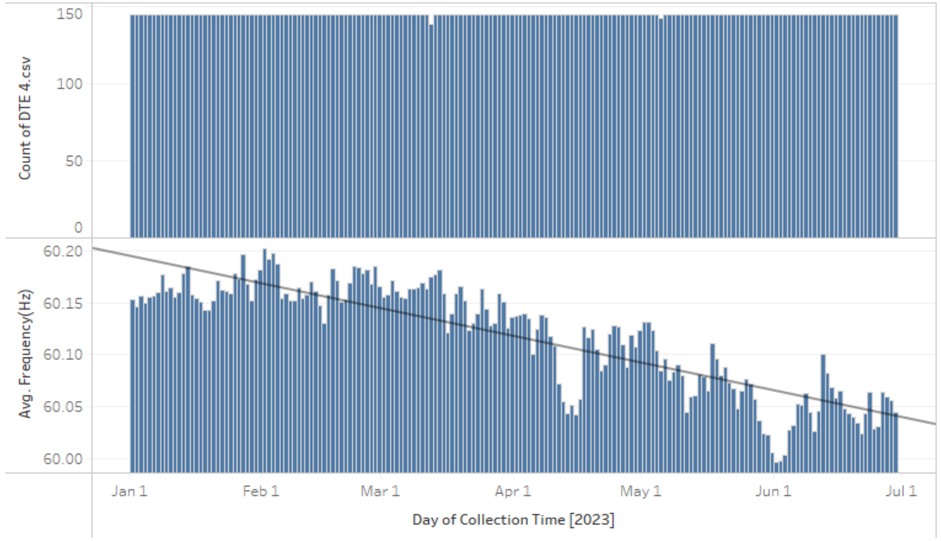


DTE5 Hourly

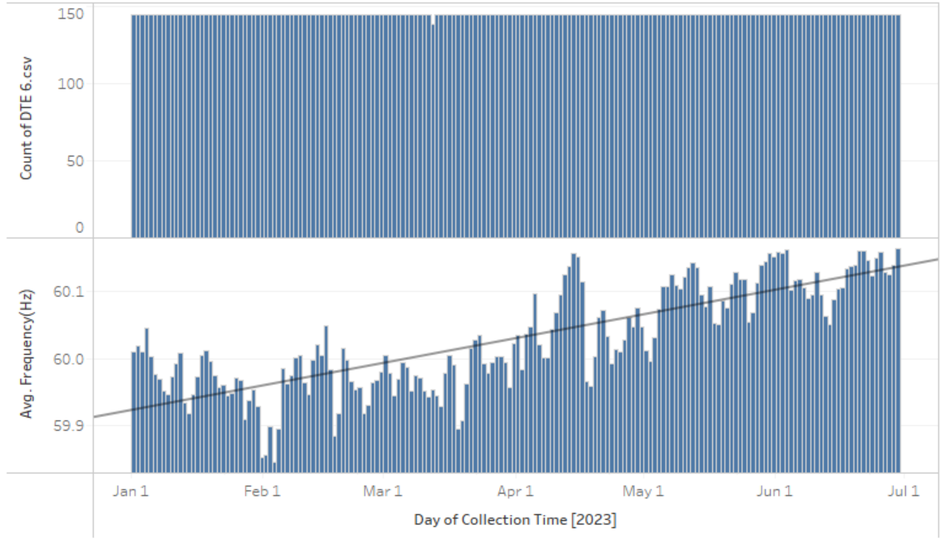


Day of Collection Time
January 1, 2023 to June ..

DTE4 Hourly



DTE6 Hourly



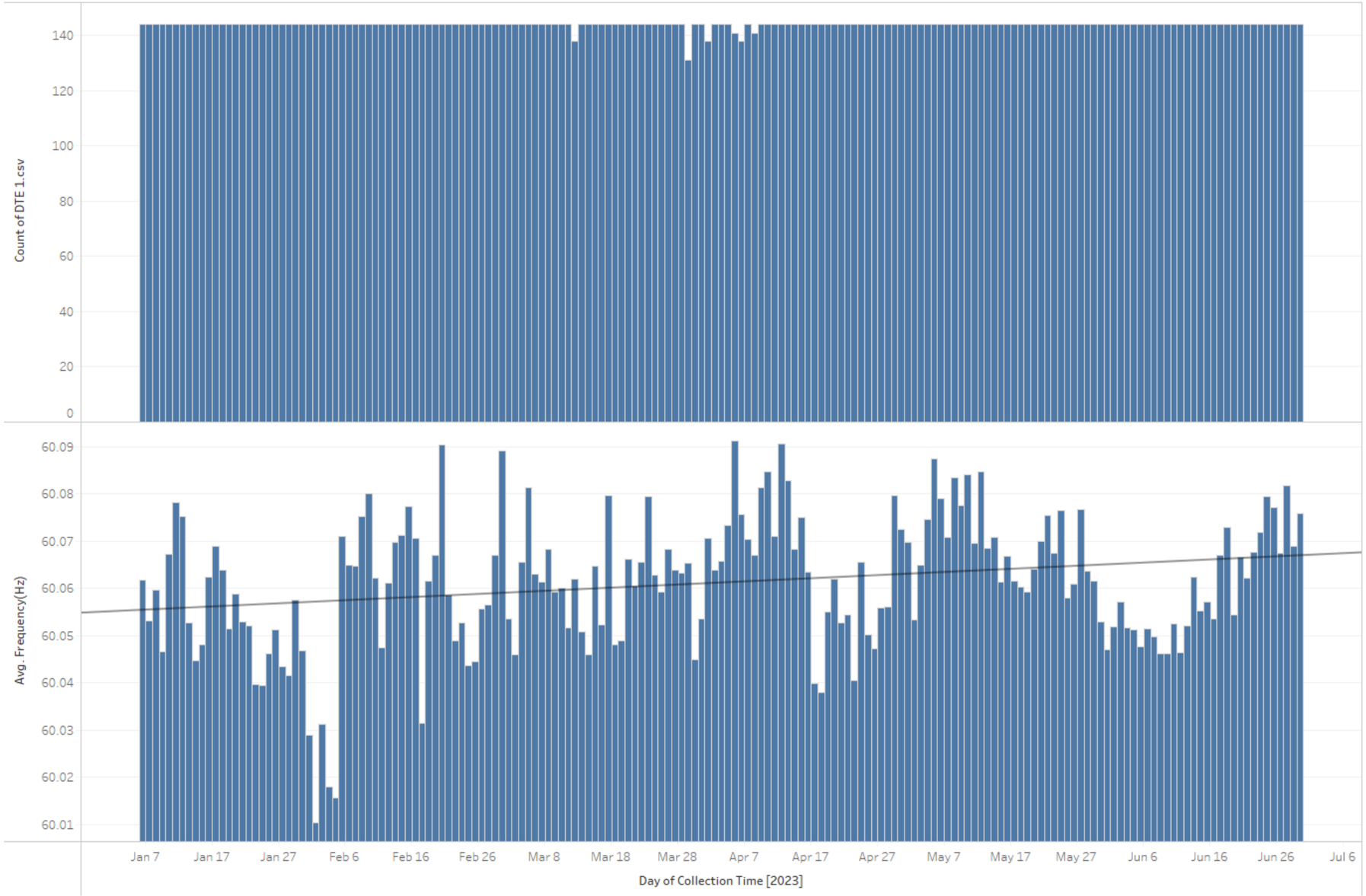
Data Analysis

1) All UFD Sensors provided rich data counts with minimal gaps in data generation and acquisition

2) DTE 1 maintained a flat trend-line with reasonable variations in Frequency

3) DTE 4, 5, and 6 had trending up & down Frequency

DTE1 Hourly

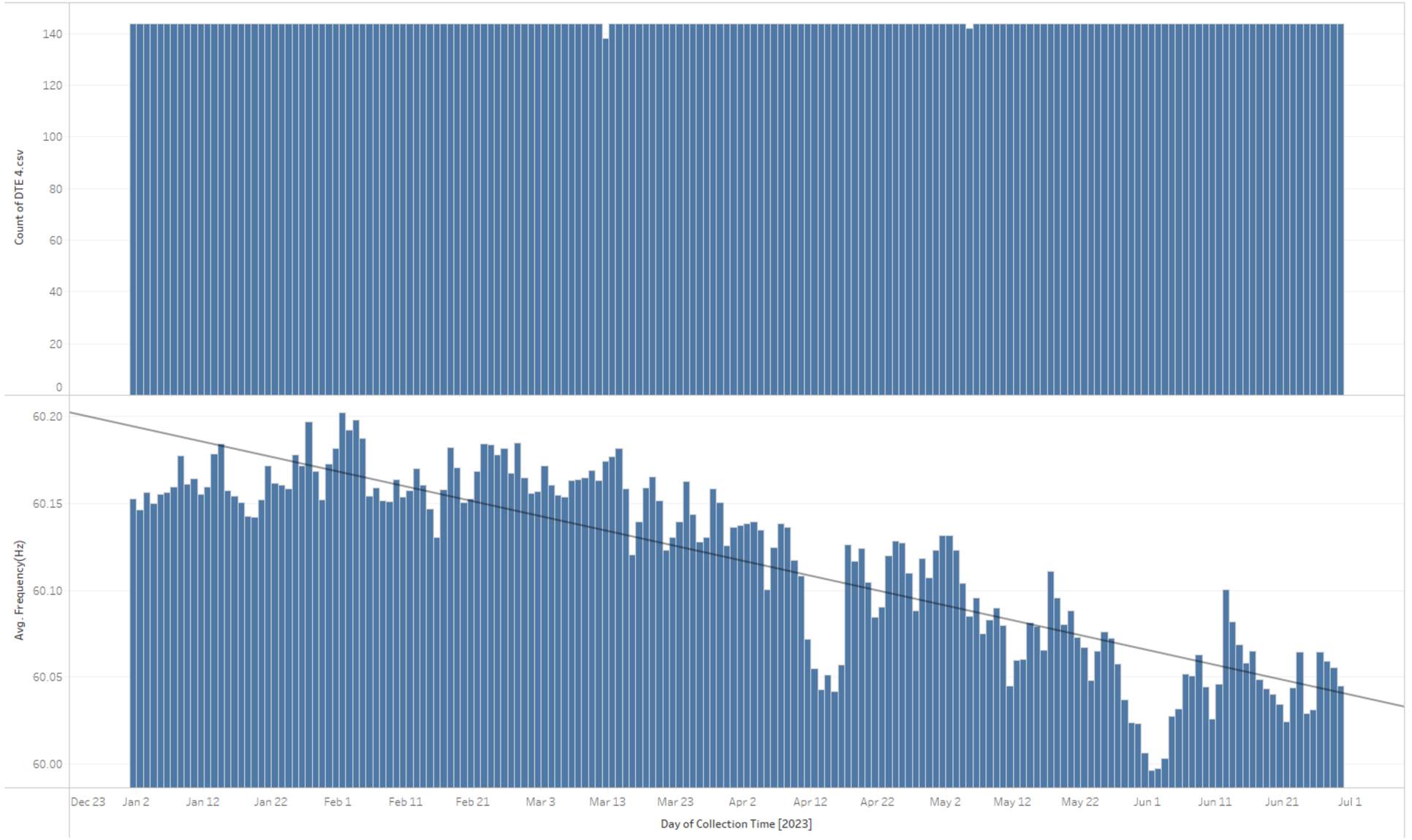


The plots of count of DTE 1.csv and average of Frequency(Hz) for Collection Time Day. The data is filtered on Collection Time, which ranges from 1/6/2023 12:00:00 AM to 6/29/2023 11:53:12 PM. The view is filtered on Collection Time Day, which ranges from January 1, 2023 to June 29, 2023.

Data Analysis

1) DTE 1 maintained a flat trend-line with reasonable variations in Frequency

DTE4 Hourly



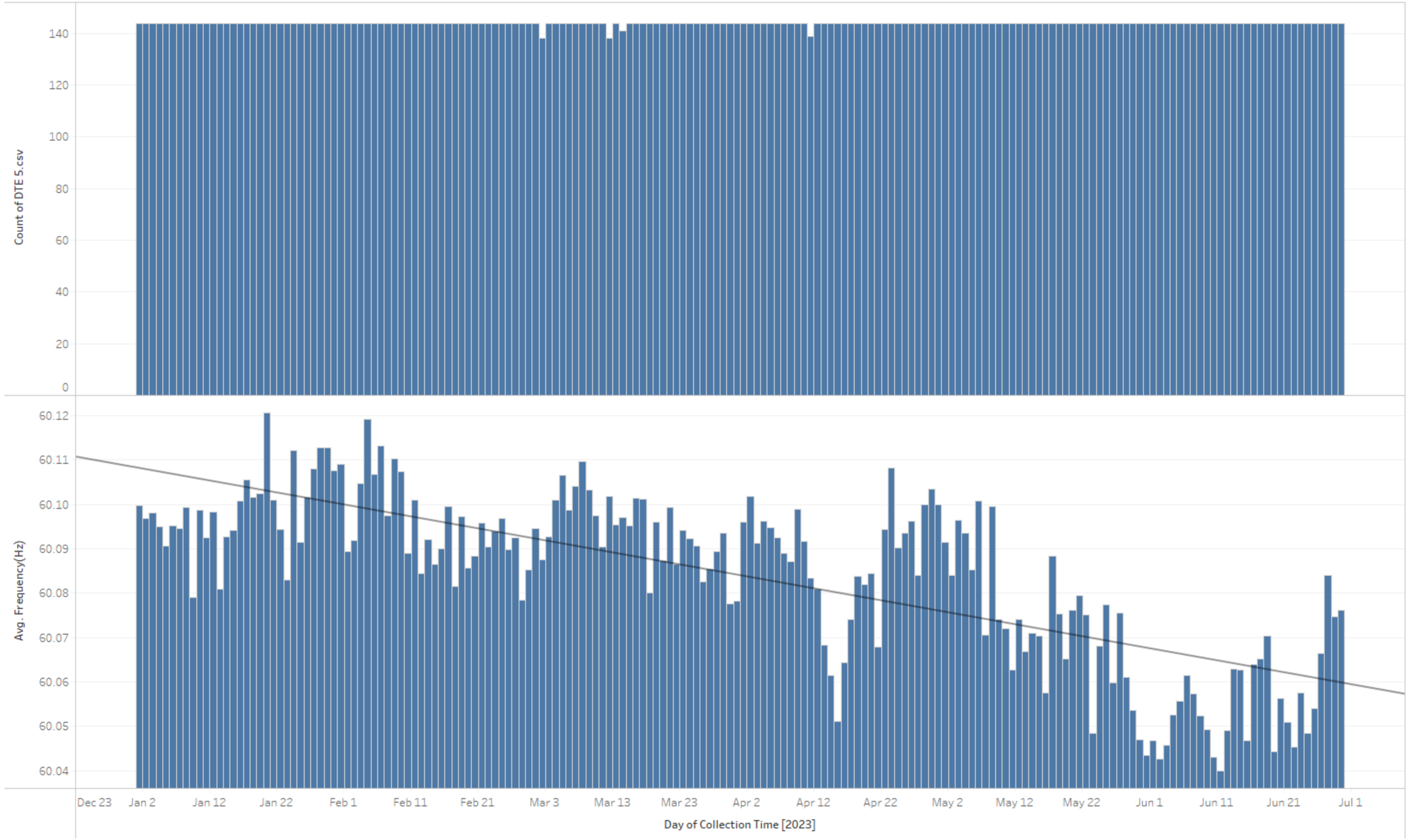
The plots of count of DTE 4.csv and average of Frequency(Hz) for Collection Time Day. The data is filtered on Collection Time (DTE 1) Day, which ranges from January 1, 2023 to June 29, 2023.

Data Analysis

1) DTE 4 is displaying a downward trend in Frequency

2) Further assessment is suggested for this issue

DTE5 Hourly



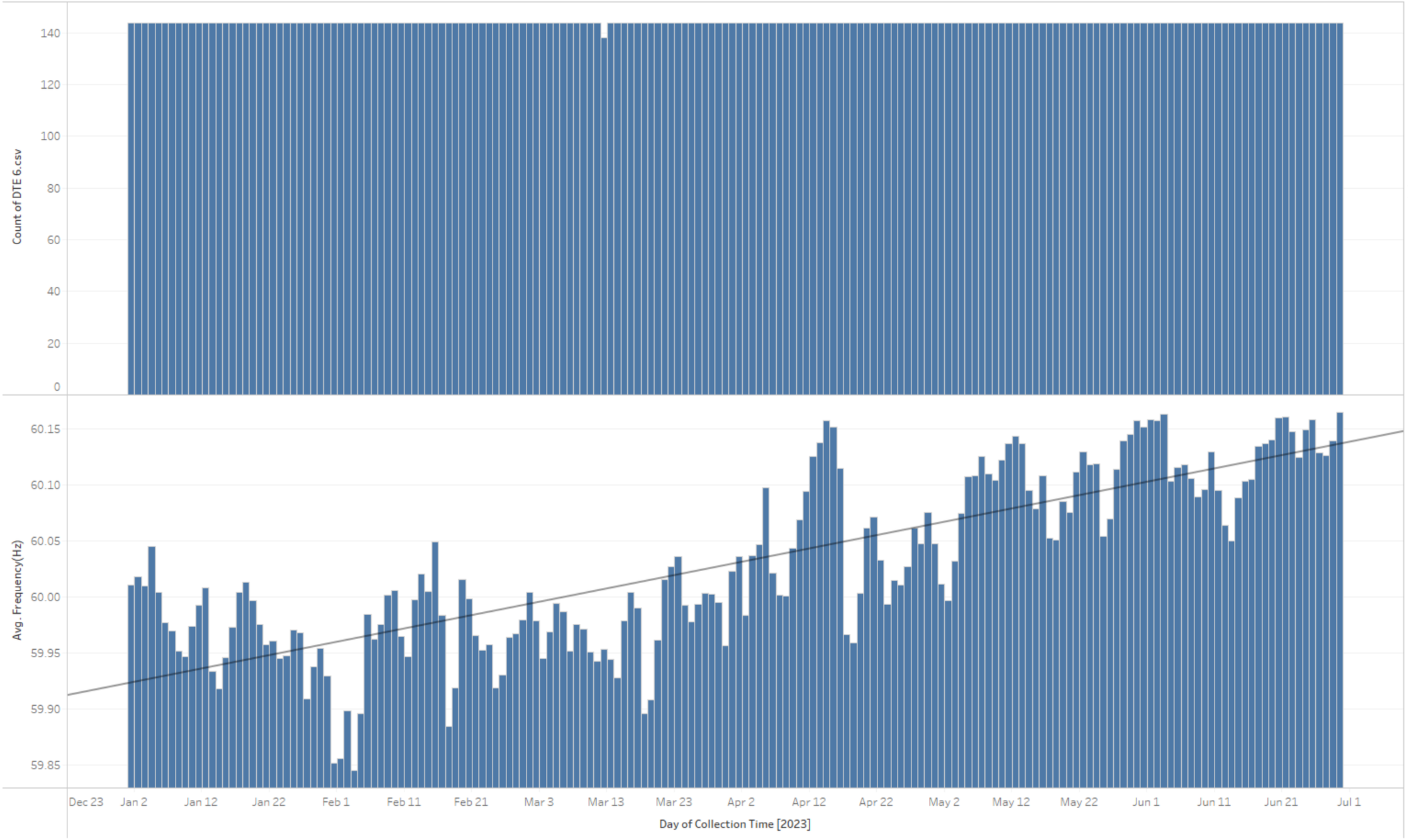
The plots of count of DTE 5.csv and average of Frequency(Hz) for Collection Time Day. The data is filtered on Collection Time (DTE 1) Day, which ranges from January 1, 2023 to June 29, 2023.

Data Analysis

1) DTE 5 is displaying a downward trend in Frequency

2) Further assessment is suggested for this issue

DTE6 Hourly



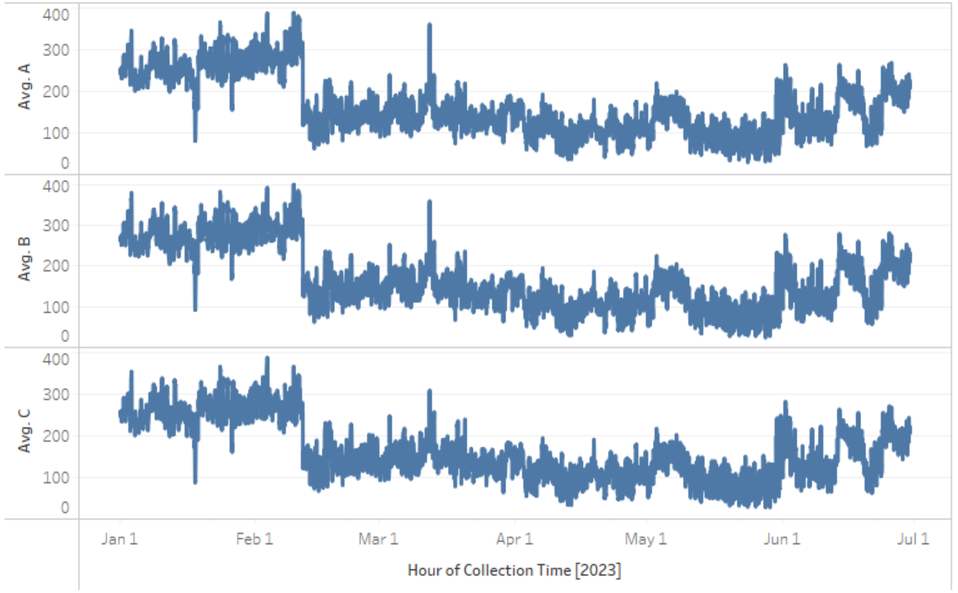
The plots of count of DTE 6.csv and average of Frequency(Hz) for Collection Time Day. The data is filtered on Collection Time (DTE 1) Day, which ranges from January 1, 2023 to June 29, 2023.

Data Analysis

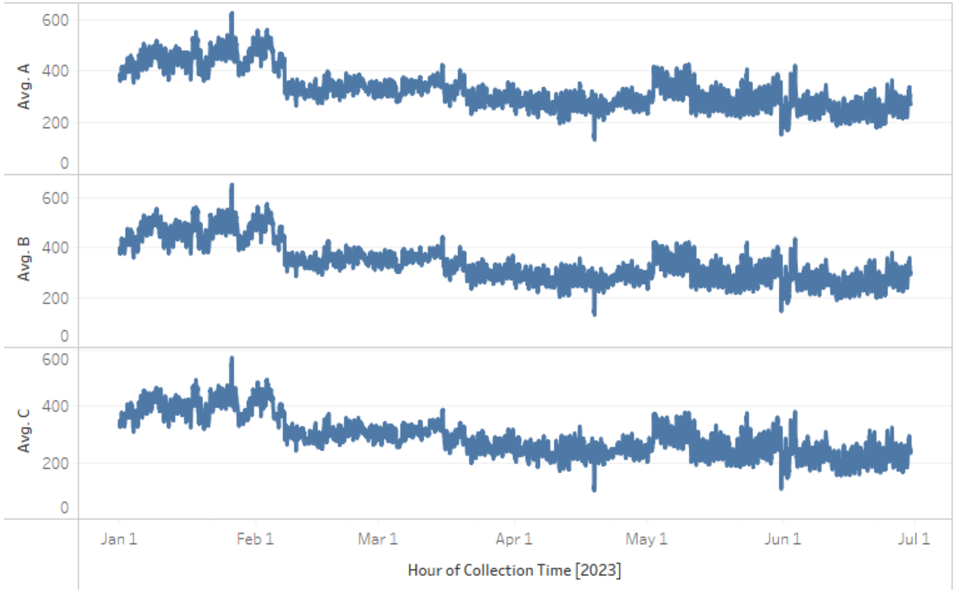
1) DTE 5 is displaying a upward trend in Frequency

2) Further assessment is suggested for this issue

DTE1 Current

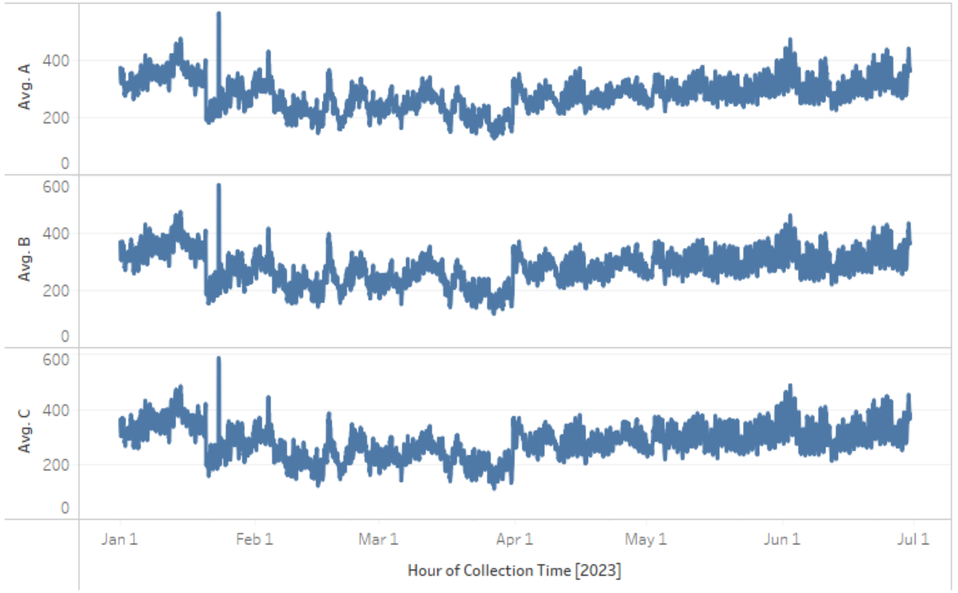


DTE5 Current

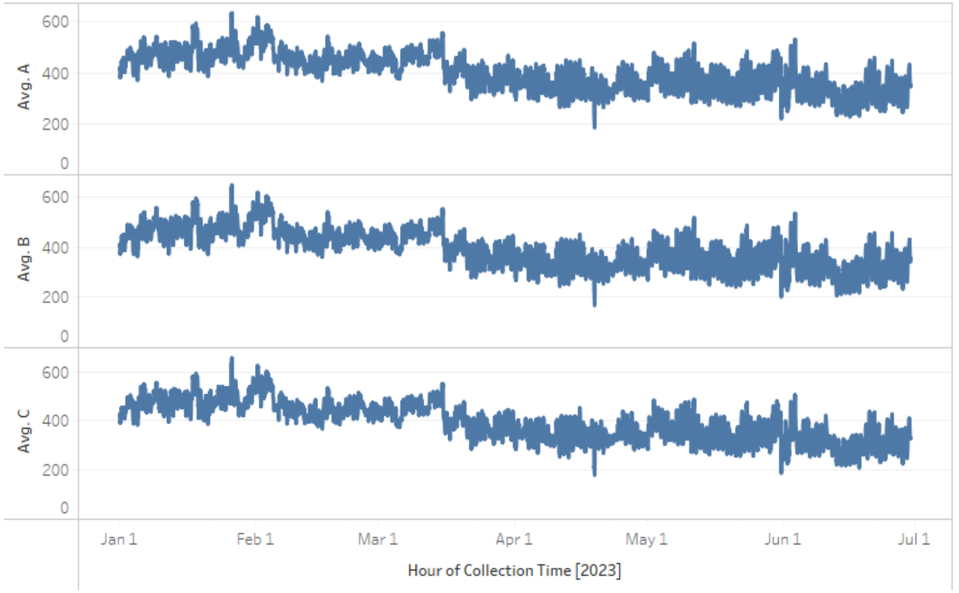


Day of Collection Time
January 1, 2023 to June ..

DTE4 Current



DTE6 Current



Data Analysis

1) DTE 1 showed large drop in Current on Feb 10th (possible tap change) and several times in January

2) DTE 1 showed Large spike in Current on March 12th

3) DTE 4 showed large spike on Jan 21st

DTE1 Current

The trends of average of A, average of B and average of C for Collection Time Hour. The data is filtered on Collection Time Day, which ranges from January 1, 2023 to June 29, 2023.

Data Analysis

1) DTE 1 showed large drop in Current on Feb 10th (possible tap change) and several times in January

2) DTE 1 showed Large spike in Current on March 12th

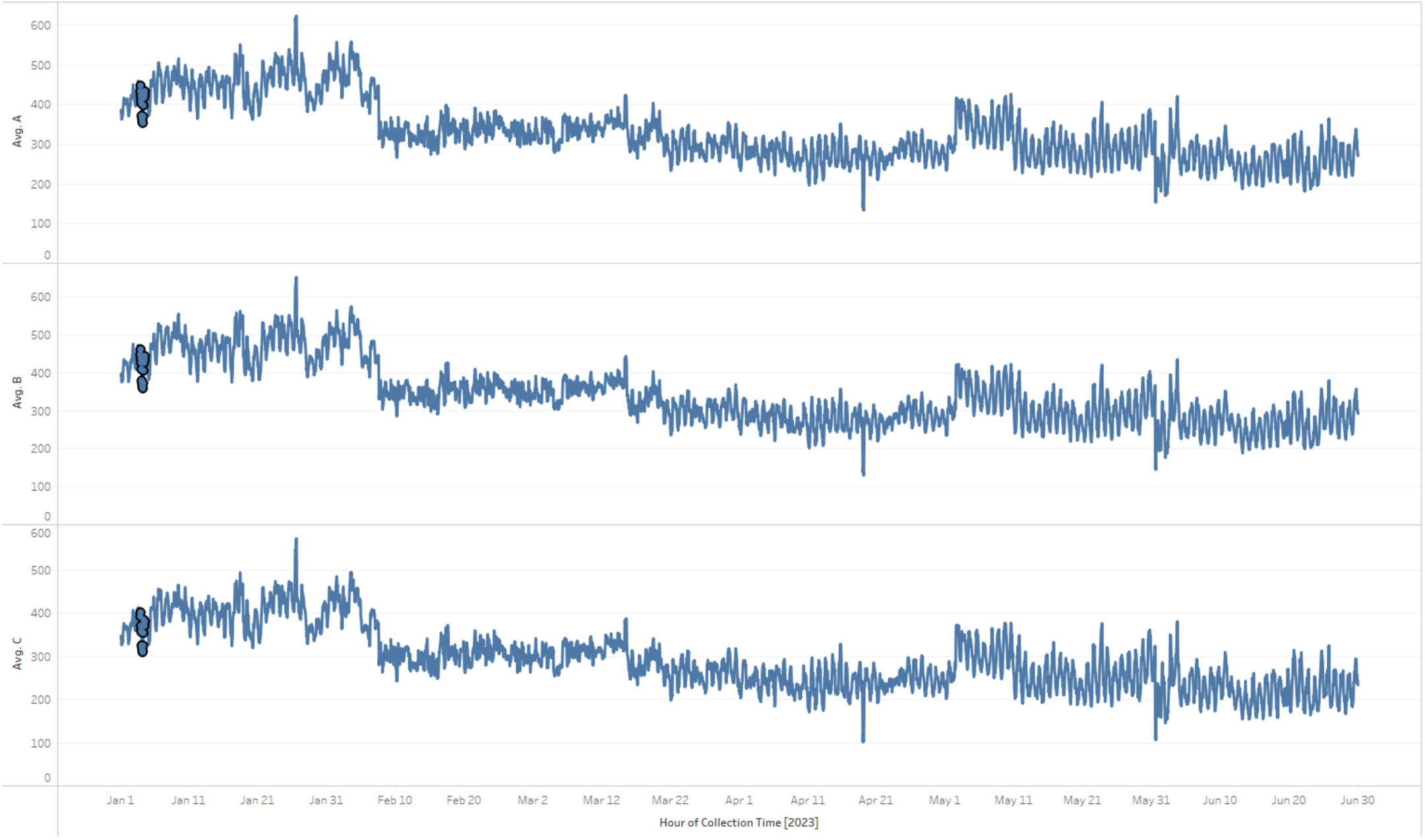
DTE4 Current

The trends of average of A (DTE 4), average of B (DTE 4) and average of C (DTE 4) for Collection Time Hour. The data is filtered on Collection Time Day, which ranges from January 1, 2023 to June 29, 2023.

Data Analysis

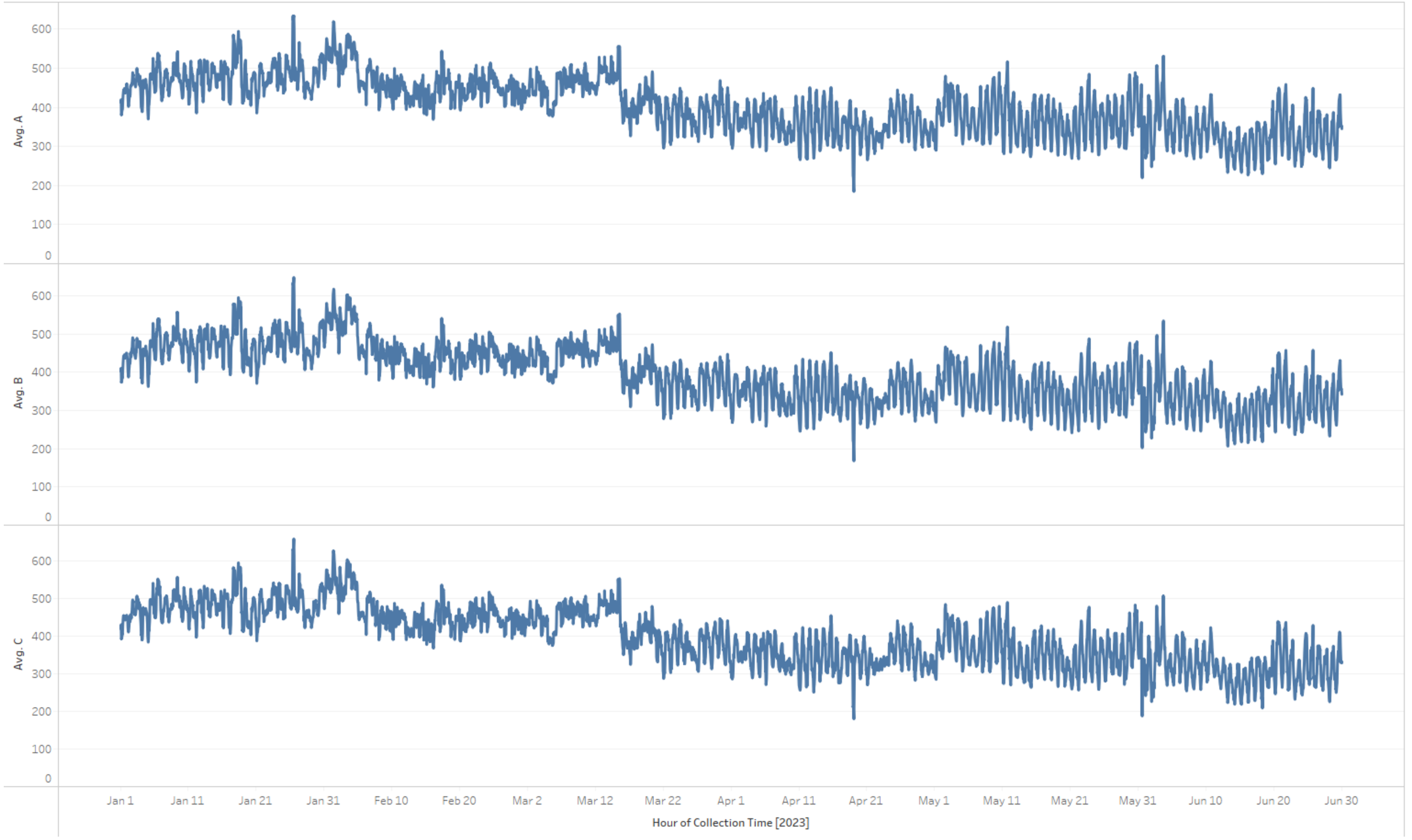
1) DTE 4 showed large spike on Jan 21st

DTE5 Current



The trends of average of A (DTE 5), average of B (DTE 5) and average of C (DTE 5) for Collection Time Hour. The data is filtered on Collection Time Day, which ranges from January 1, 2023 to June 29, 2023.

DTE6 Current



The trends of average of A (DTE 6), average of B (DTE 6) and average of C (DTE 6) for Collection Time Hour. The data is filtered on Collection Time Day, which ranges from January 1, 2023 to June 29, 2023.

Delta Current

(Phase Imbalance)

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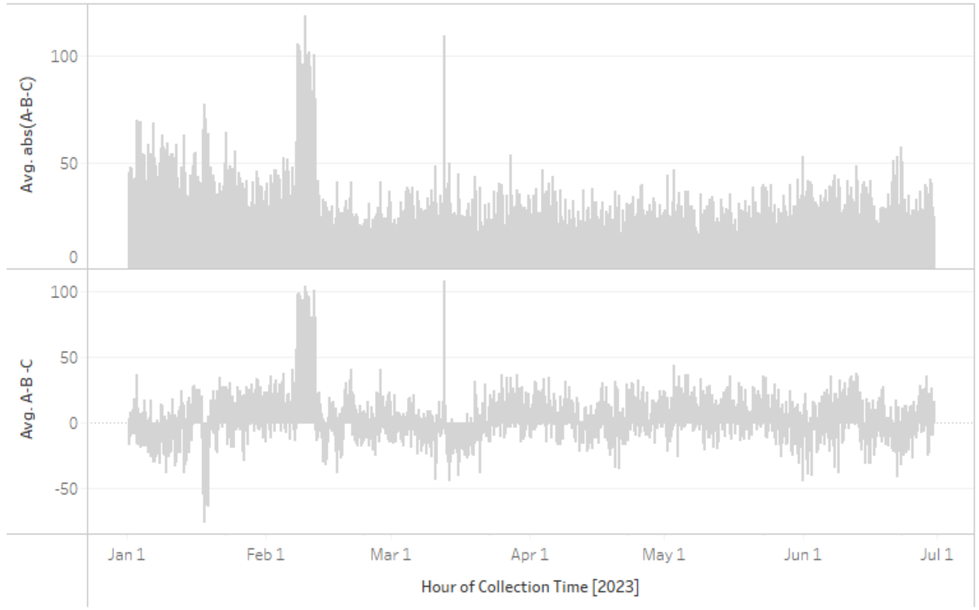
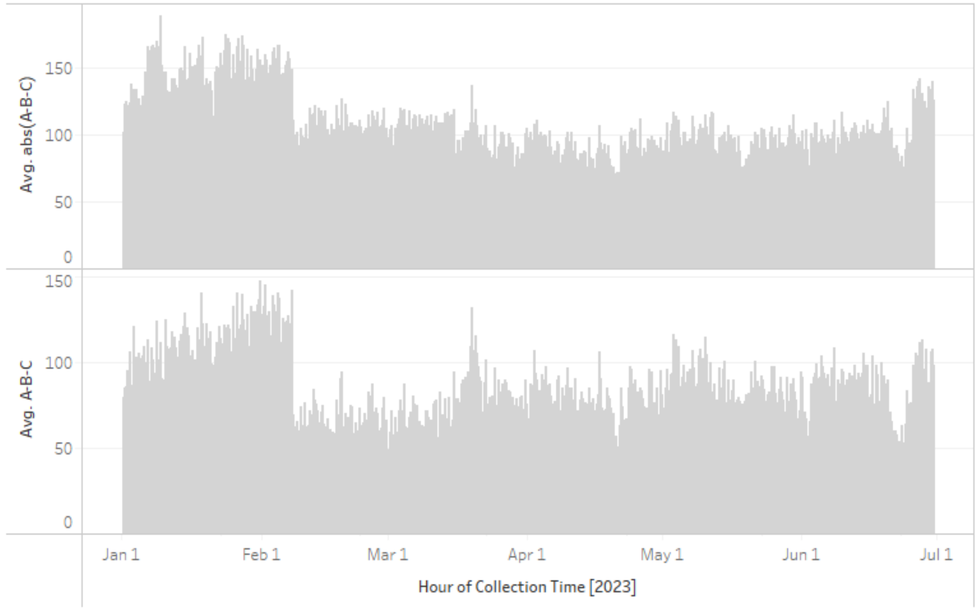
DTE1 Delta



DTE5 Delta



Day of Collection Time
January 1, 2023 to June ..

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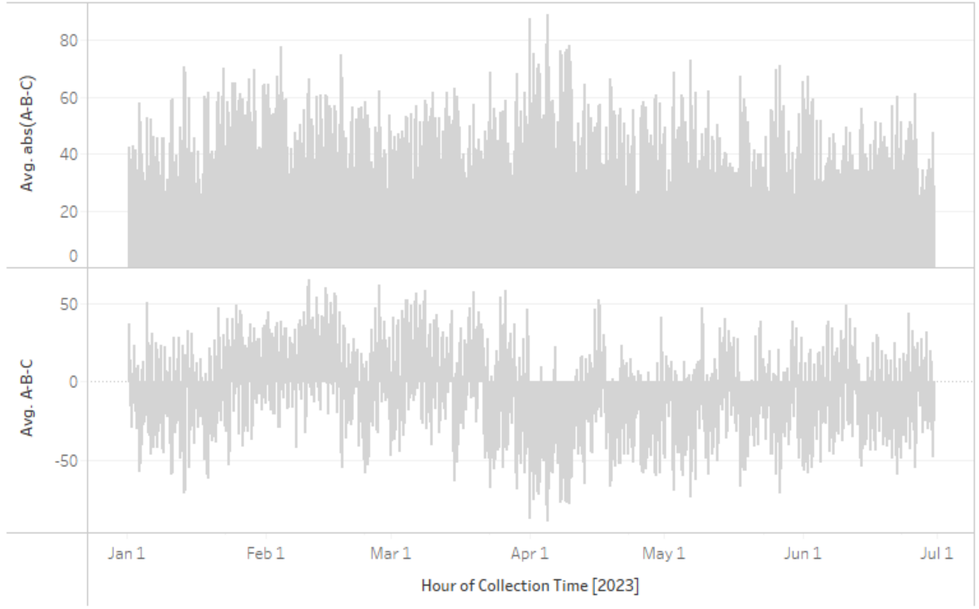
Data Analysis

1) DTE 1 showing significant Phase Imbalance in February and large Imbalance on March 13th

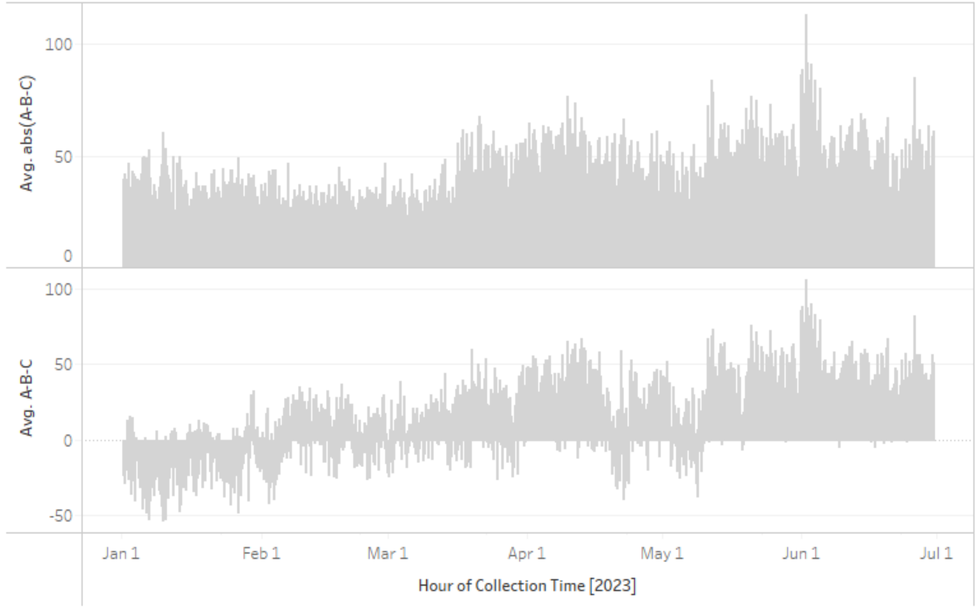
2) DTE 4 and 5 show constant Phase Imbalances throughout the year

3) Absolute Value of additional load shown on top chart. Bottom chart allows for cancellations

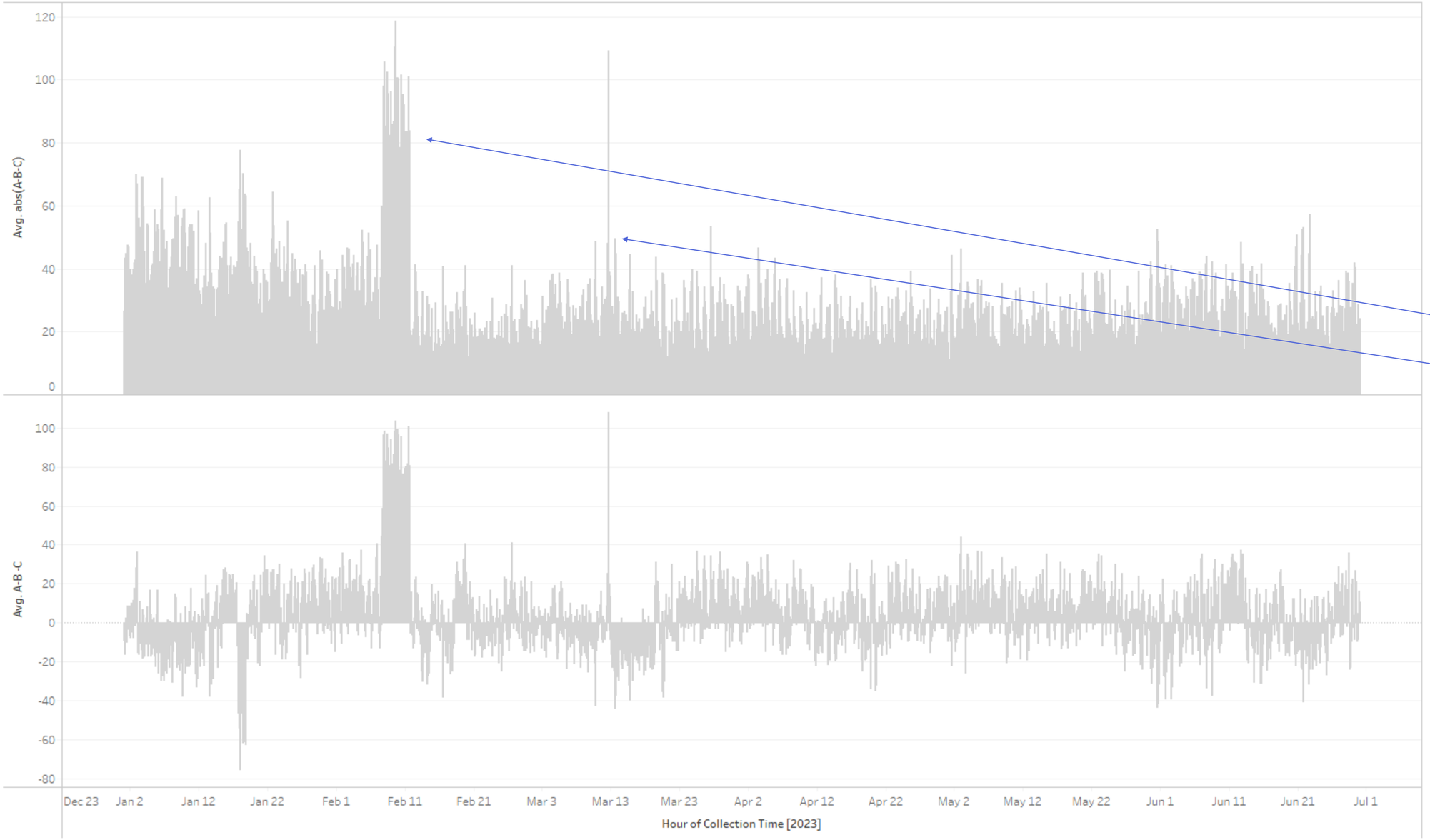
DTE4 Delta



DTE6 Delta



DTE1 Delta

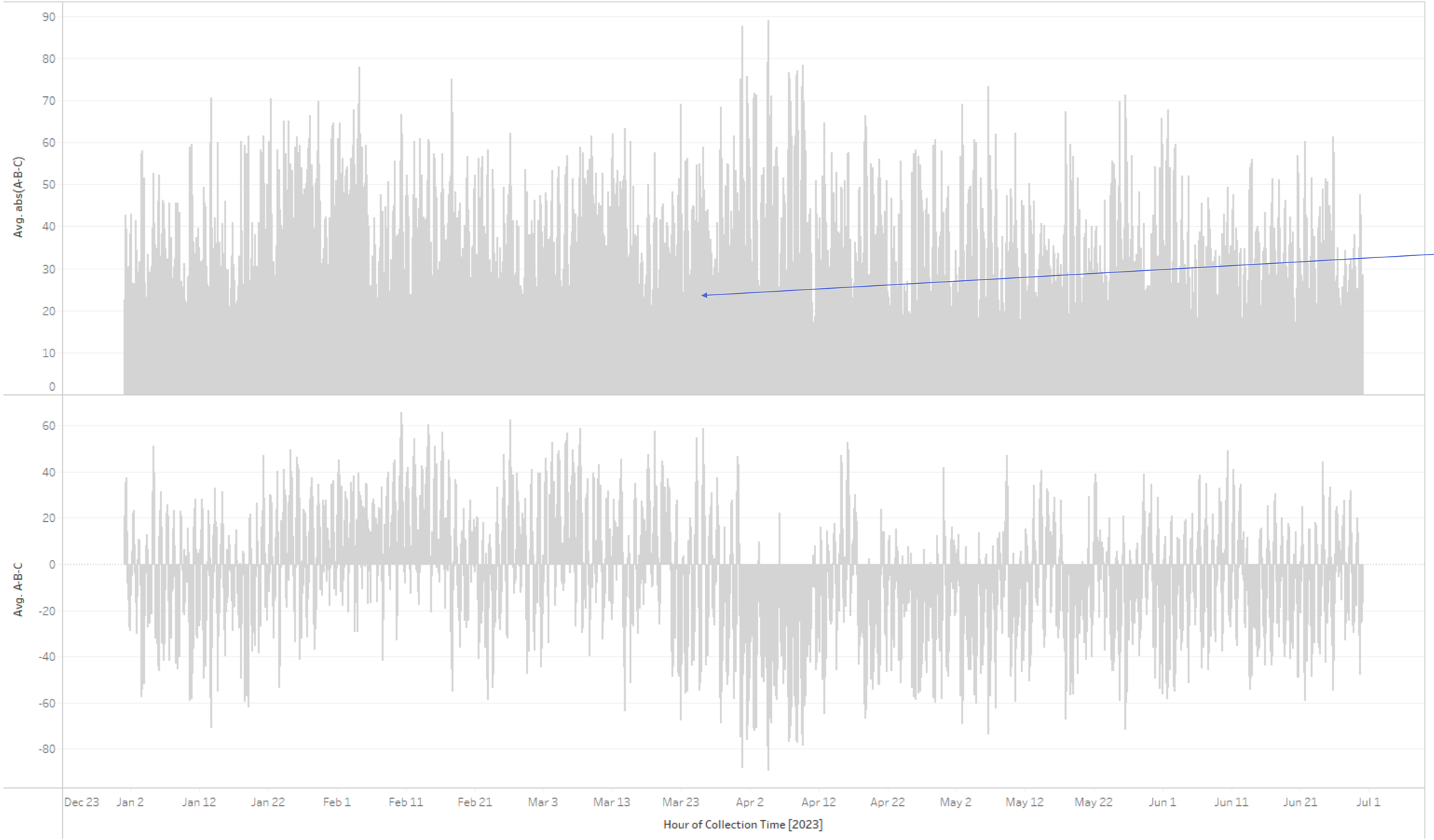


The plots of average of abs(A-B-C) and average of A-B -C for Collection Time Hour. The data is filtered on Collection Time Day, which ranges from January 1, 2023 to June 29, 2023. The view is filtered on Collection Time Hour, which includes everything.

Data Analysis

1) DTE 1 showing significant Phase Imbalance in February and large Imbalance on March 13th

DTE4 Delta

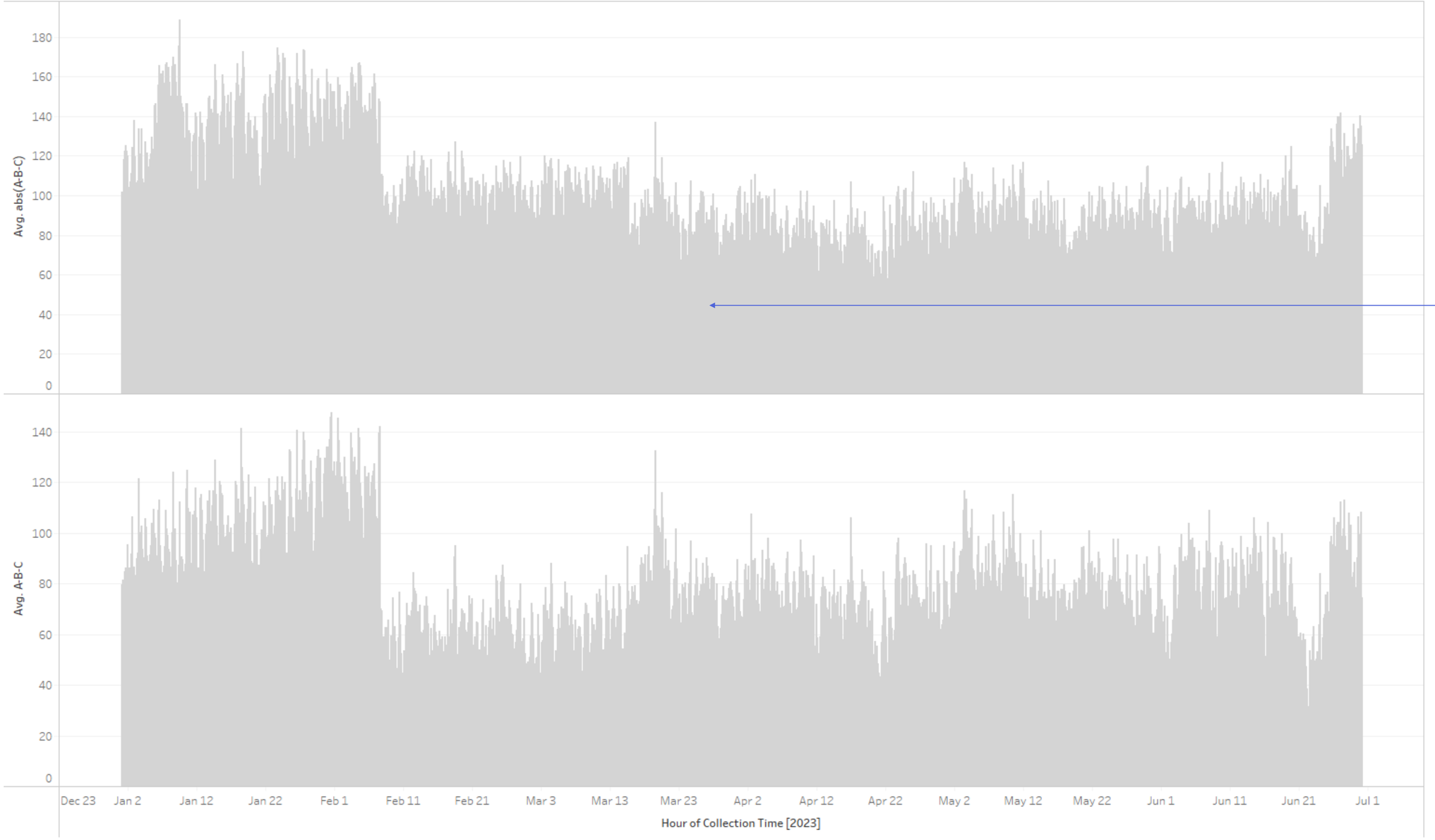


The plots of average of abs(A-B-C) (DTE 4) and average of A-B-C (DTE 4) for Collection Time Hour. The data is filtered on Collection Time Day, which ranges from January 1, 2023 to June 29, 2023.

Data Analysis

1) DTE 4 shows constant Phase Imbalances throughout the year

DTE5 Delta

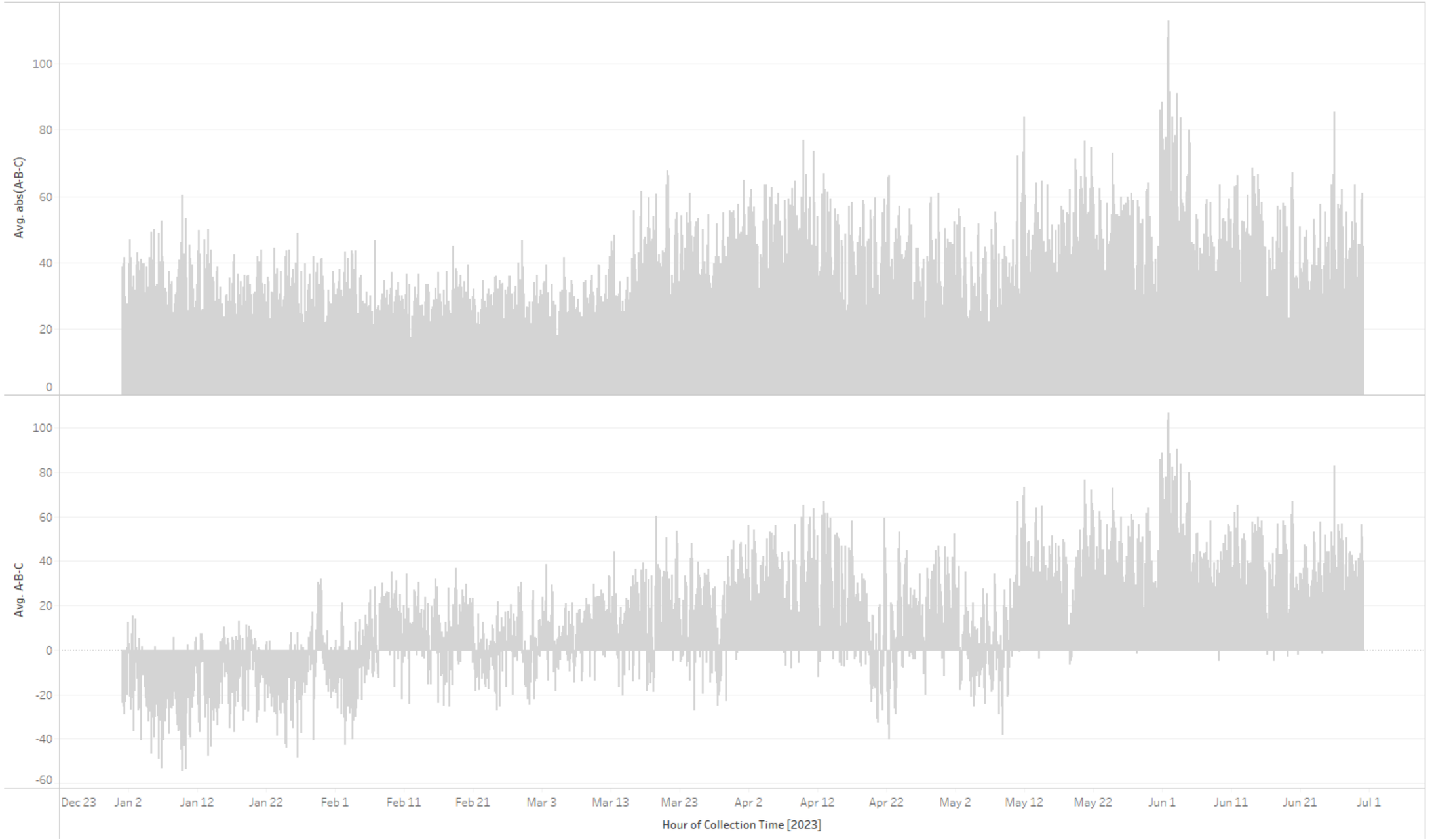


The plots of average of abs(A-B-C) and average of A-B-C for Collection Time Hour. The data is filtered on Collection Time (DTE 1) Day, which ranges from January 1, 2023 to June 29, 2023.

Data Analysis

1) DTE 5 shows constant Phase Imbalances throughout the year

DTE6 Delta



The plots of average of abs(A-B-C) (DTE 6) and average of A-B-C (DTE 6) for Collection Time Hour. The data is filtered on Collection Time (DTE 1) Day, which ranges from January 1, 2023 to June 29, 2023.

Preliminary Findings

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Major Findings from Sensor Readings - 2023

All UFD Sensors provided rich data counts with minimal gaps in data generation and acquisition throughout 2023

Importance Hierarchy:

1) **Frequency Changes**
   - Very abnormal changes trending up and down (DTE 4 & 5)
   - This is likely a grid-side issue and not from the customer-side
   - Large black-outs have been associated with such drifts in Frequency

2) **Large Imbalances of Current**
   - Several days of large Imbalances with Current on DTE 1 with large spikes in Current
   - DTE 5 & 6 constantly had large Phase Imbalances

Additional Suggestions: Being able to read Power Factor would be helpful in further analysis. Voltage monitoring/sensors would be required to do this.

Additional Information

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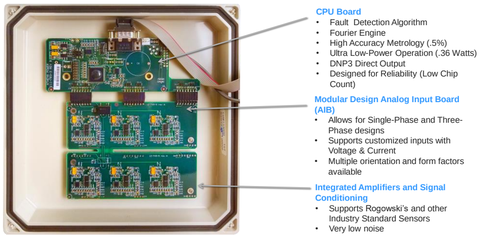
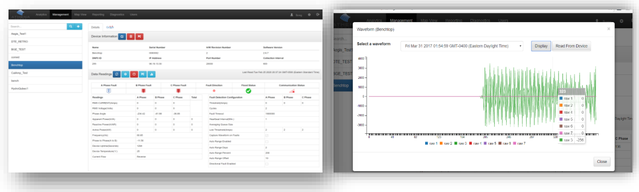
Pilot Overview

Detroit Edison (DTE) and Athena Power deployed UFD sensors throughout downtown Detroit. The sensors were primarily deployed on Netbanks and Switchgear to monitor and detect faults.

The sensors were custom developed for DTE and were primarily oriented for fault detection. The sensors are three-phase oriented with power harvesting technology and direct DNP3 output. Cellular connectivity (utilizing the Sierra Wireless RV 50) were equipped on each Athena UFD Sensor. Custom Antennas and cables were developed for the netbank asset class to demonstrate strong connectivity and uptime



The majority of the sensors were deployed in 2021 and 2022. The sensor management system from Athena, known as Aegis, was used to manage the sensor. Aegis was also used to manage the data and analyze trends and report the data findings



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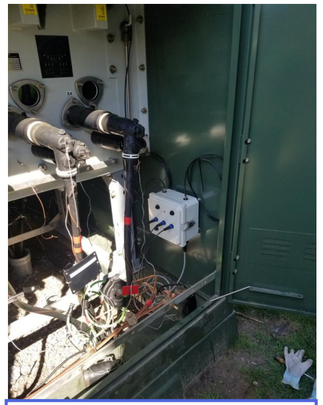
DTE Deployment Photos

Detroit Edison (DTE) and Athena Power deployed (7) UFD sensors throughout downtown Detroit. Below are photos of the installations that took place in 2021 and Q1 2022

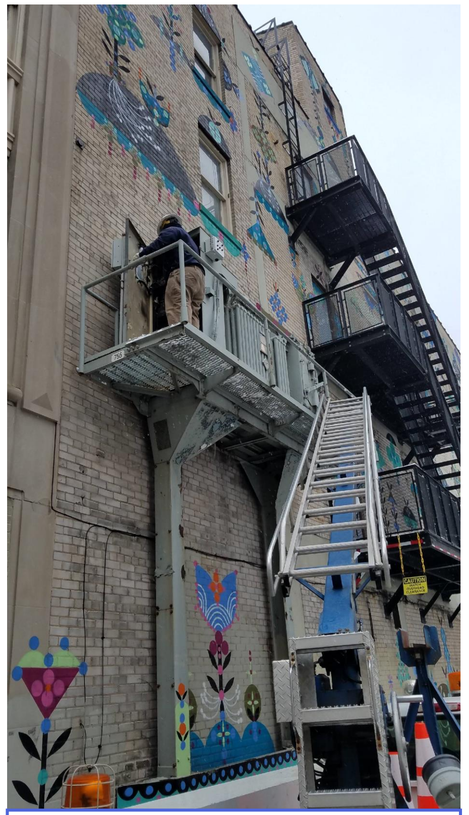
Netbank Installation

Three-phase Current + Neutral was installed on netbanks throughout downtown Detroit. Secondary Power was used to power the unit



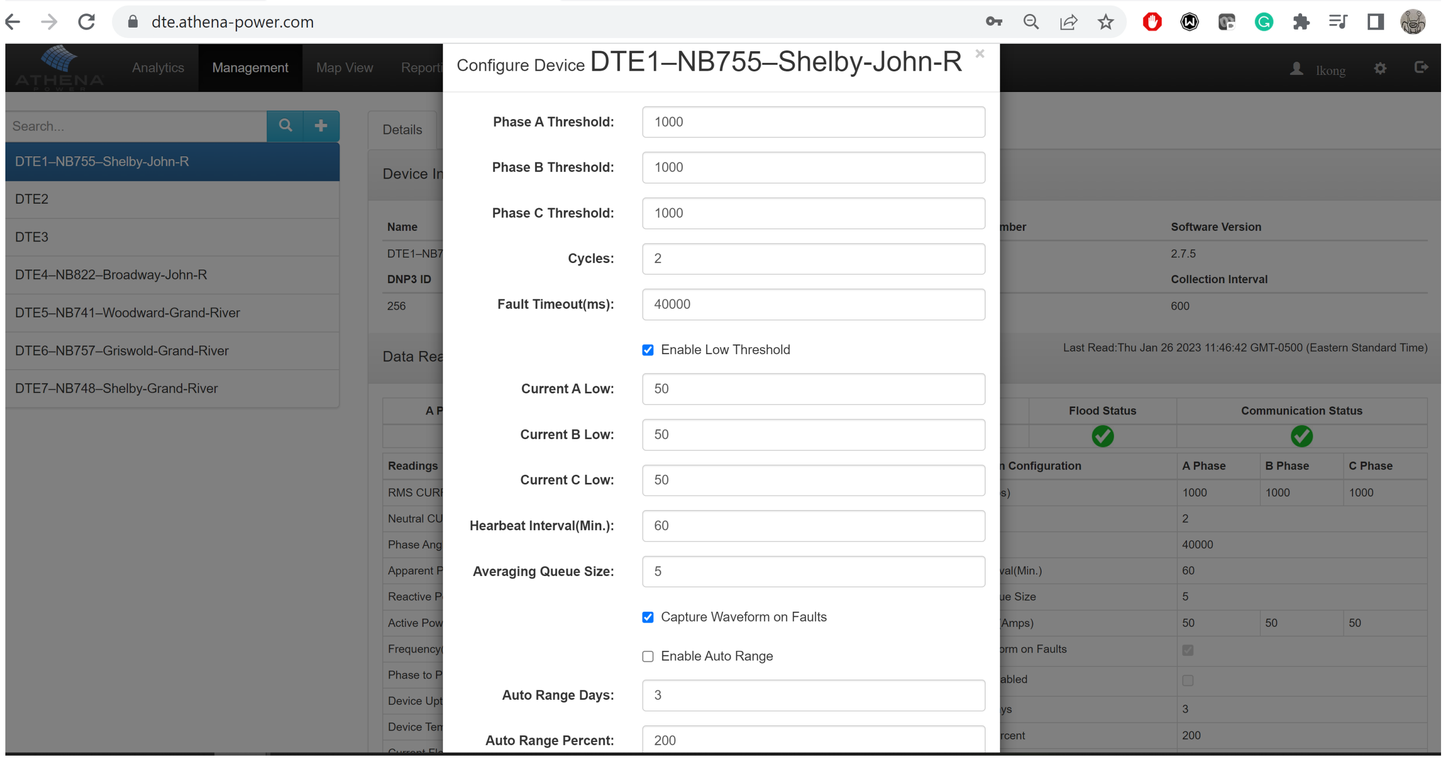
Switchgear Installation

Athena sensors were also installed on switchgear at the Detroit Institute of Art. The sensors were utilizing power harvesting technology



Netbank Installation at John R and Broadway

DTE Pilot Settings



Average Device Uptime: **13,686 Hours / 228 Days**

Monitoring Highlights

Resolution

- Resolution capture of 1200Hz and 20 samples per cycle
- Scanning/Intervals at every 15min
- Three Phase Current-Only Monitoring

Fault Detection Settings

- High Current threshold set at 1000amps
- 2 Cycles
- Low Current threshold at 50amps

Communications

- 4G Verizon Cellular
- Sierra Wireless RV 50/55 low power radio

Additional Information

- Netbanks powered through secondary power
- Switchgear powered through power-harvesting