PQ Dashboard

2025 User Group

Project Manager:

Tom Cooke, EPRI

10 Sept 2025

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PS1B: PQ Data & Analytics

AGENDA

- Welcome and Introductions
- EPRI PQ Dashboard Service
- Developments
  - PQ Health Index
  - Waveform Clustering Tool
  - Compliance Reporting Initiative
  - Continuous Point on Wave
- Q&A

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Agenda

WEDNESDAY, SEPTEMBER 10, 2025 – PQ DASHBOARD USER'S GROUP- LIBERTY A&B		
TIME (CST)	**TOPIC**	**PRESENTER**
1:00pm	Introductions	Tom Cooke, EPRI
1:15pm	EPRI Review of Upcoming Contributions	Tom Cooke, EPRI
1:45pm	GPA Updates	Christoph Lackner, GPA
2:05pm	openXDA Suite Refresher	Erika Wills, GPA
2:30pm	openMIC at TVA	Tony Murphy, TVA
3:00pm	Break- Houston Ballroom – Pre-function Space (level 2)	
3:30pm	GPA Application Demonstration	Erika Wills, GPA
4:00pm	Roundtable Discussion	
5:00pm	Meeting Adjourned	

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EPRI Review: Agenda

- EPRI PQ Dashboard Service
- Developments
  - PQ Health Index
  - Waveform Clustering Tool
  - Considering a Compliance Reporting Initiative and Continuous Point on Wave research project.
- Q&A

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EPRI PQ Dashboard Online

PQ DASHBOARD ONLINE

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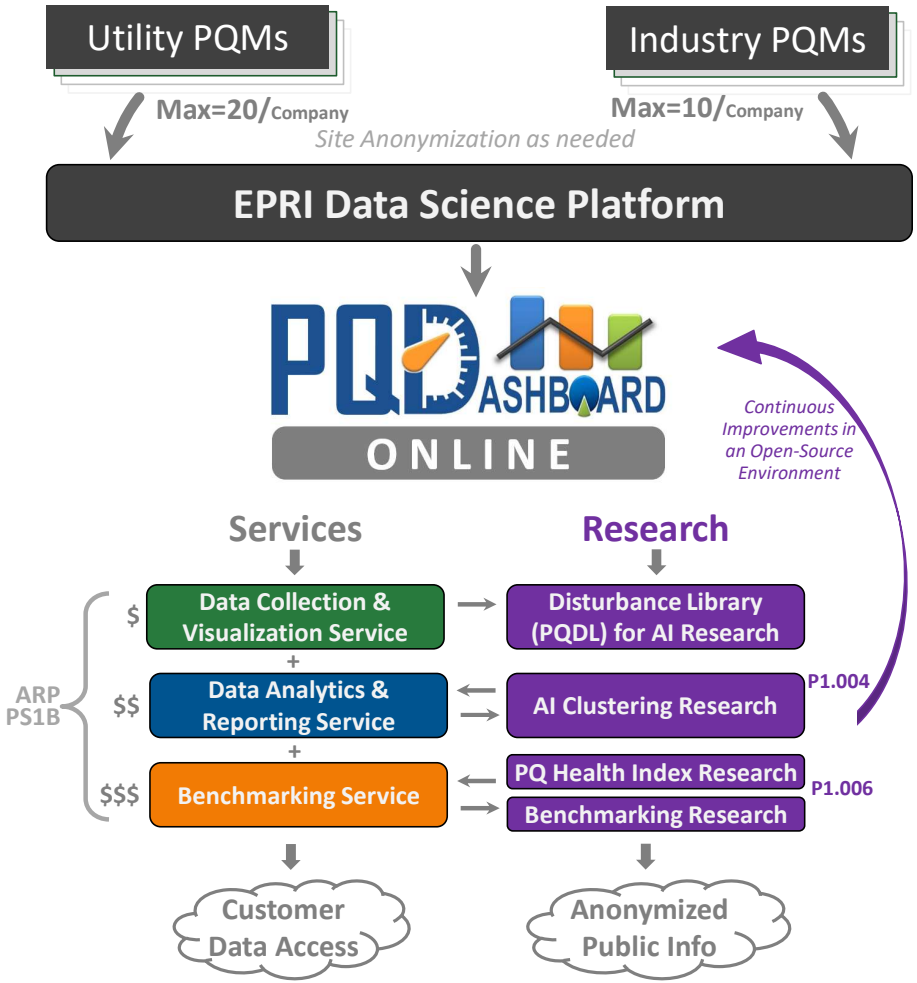
Scope



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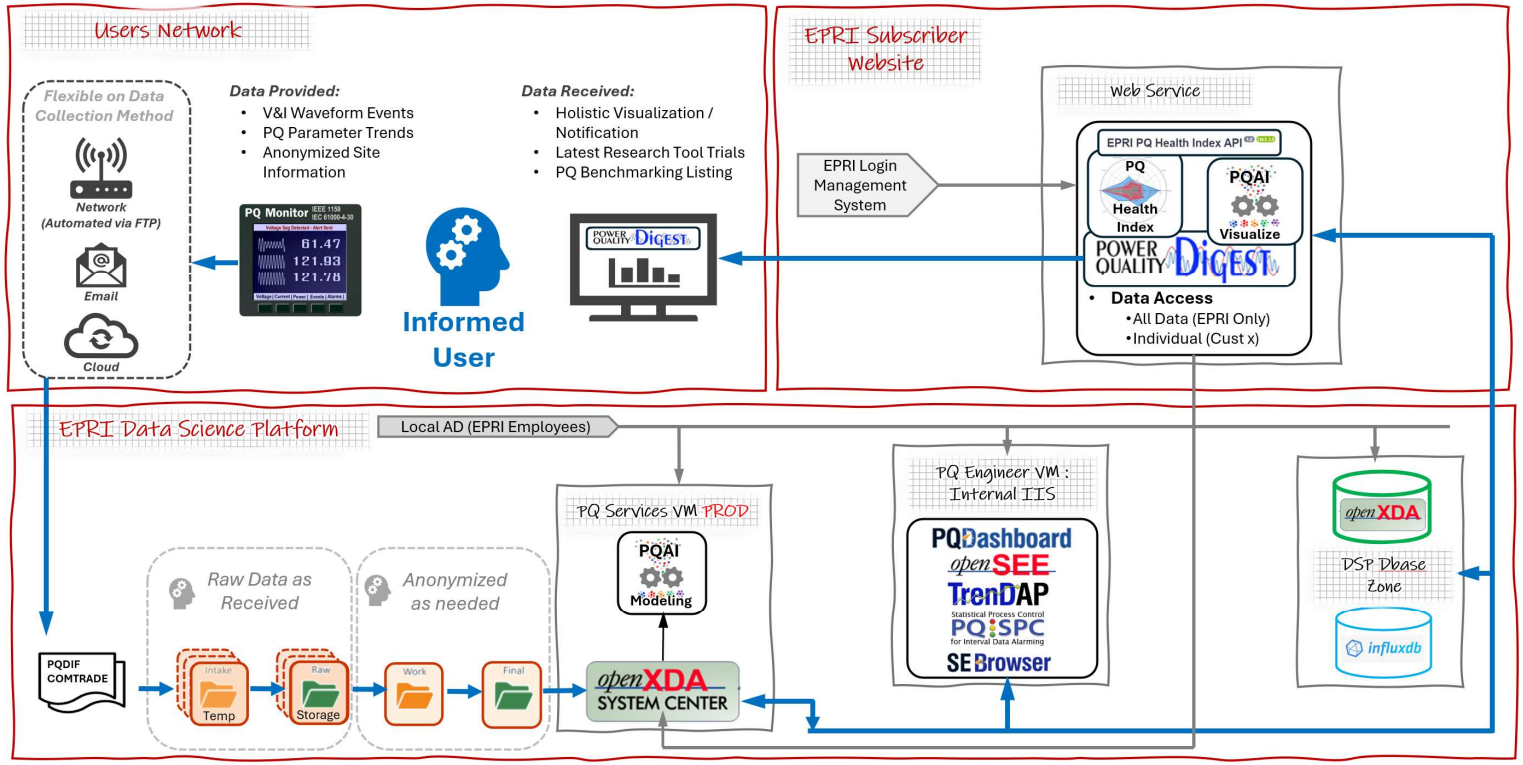
High-Level Network Flow Diagram

EPRI PQ Dashboard Service | A service for industry and utilities to pilot/demo the PQ dashboard and experience its value



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PQ Health Index

Automated PQ Benchmarking Service

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PQ Health Index Development

Normalize our Categories of PQ Data

- Event Data: IEEE 1564-2014
- Parameter Trends: Universal Limit = 1

Temporal Aggregation

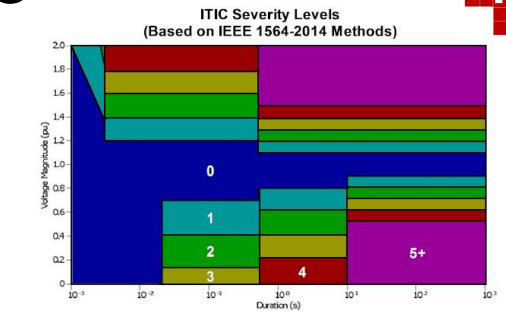
- Daily Statistical Values (Max, CP95, Avg, CP05, Min).
- Events per month multiplier for Temporal normalization.

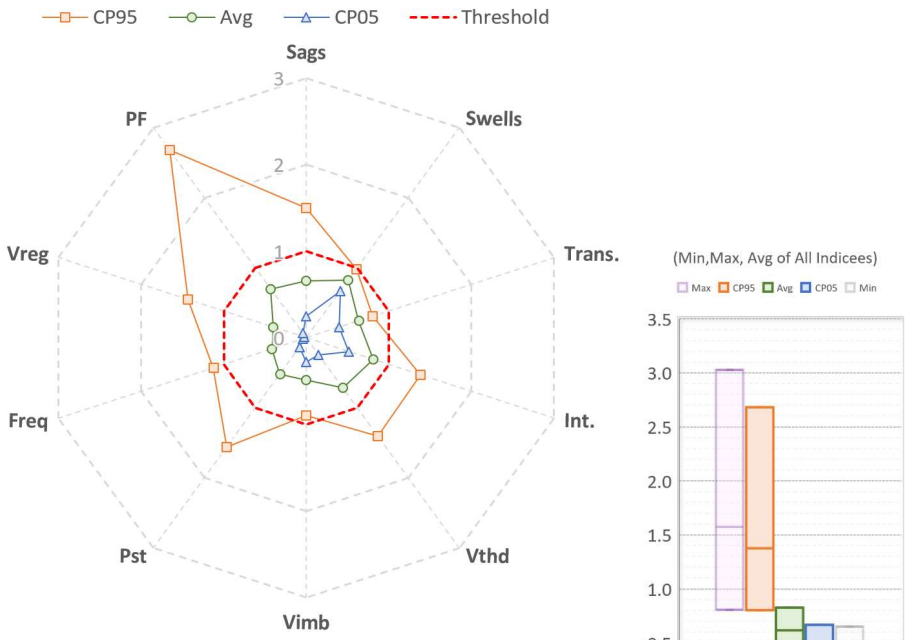
Phenomena Aggregation

Min, Max, Avg of All PQ Indices represents Single PQ Health spread.

4 Geospatial Aggregation

Average of Spider Diagram, Box and Whiskers, or the Index Average





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Normalize All PQ Phenomena Levels

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PQ Health Index Tool PoC

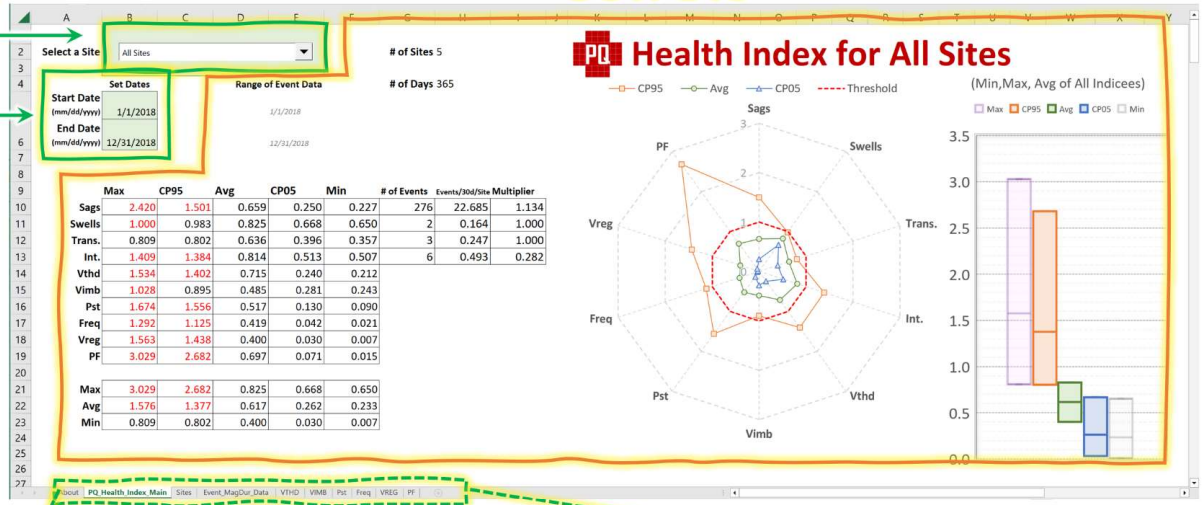
Excel Worksheet

INPUTS

Site Selection →

Date Range Selection →

OUTPUTS



	Max	CP95	Avg	CP05	Min	# of Events	Events/30d/Site	Multiplier
Sags	2.420	1.501	0.659	0.250	0.227	276	22.685	1.134
Swells	1.000	0.983	0.825	0.668	0.650	2	0.164	1.000
Trans.	0.809	0.802	0.636	0.396	0.357	3	0.247	1.000
Int.	1.409	1.384	0.814	0.513	0.507	6	0.493	0.282
Vthd	1.534	1.402	0.715	0.240	0.212			
Vimb	1.028	0.895	0.485	0.281	0.243			
Pst	1.674	1.556	0.517	0.130	0.090			
Freq	1.292	1.125	0.419	0.042	0.021			
Vreg	1.563	1.438	0.400	0.030	0.007			
PF	3.029	2.682	0.697	0.071	0.015			
Max	3.029	2.682	0.825	0.668	0.650			
Avg	1.576	1.377	0.617	0.262	0.233			
Min	0.809	0.802	0.400	0.030	0.007			

Sheet Selection →

Copyright and Disclaimer Information

Sheet for Viewing Results

Sheet for Populating Sites and Configuring Variables

Sheet for Populating Event Mag/Dur Data

Sheets for Populating Statistical Trend Data

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Data Formatting for the PQ Health Index Tool

Event Data Formatting

	A	B	C	D	E
1	Date	Site	Magnitude (%)	Duration (sec)	IEEE 1668 Type
2	1/1/18 1:51	Site 1	87	0.025	Type 2
3	1/10/18 13:27	Site 1	81	0.046	Type 2

Characterization Per IEEE Std 1668

Per IEEE Std 1159™-2009 [B14], duration of the voltage sag is defined as the time from when the rms voltage decreased below 90% of the nominal steady-state voltage to when it returned above 90% of the nominal steady-state voltage, measured in milliseconds, seconds, or cycles. An example of a voltage sag as an rms plot to 46% of nominal for 5.4 cycles (60 Hz) is shown in Figure 1.

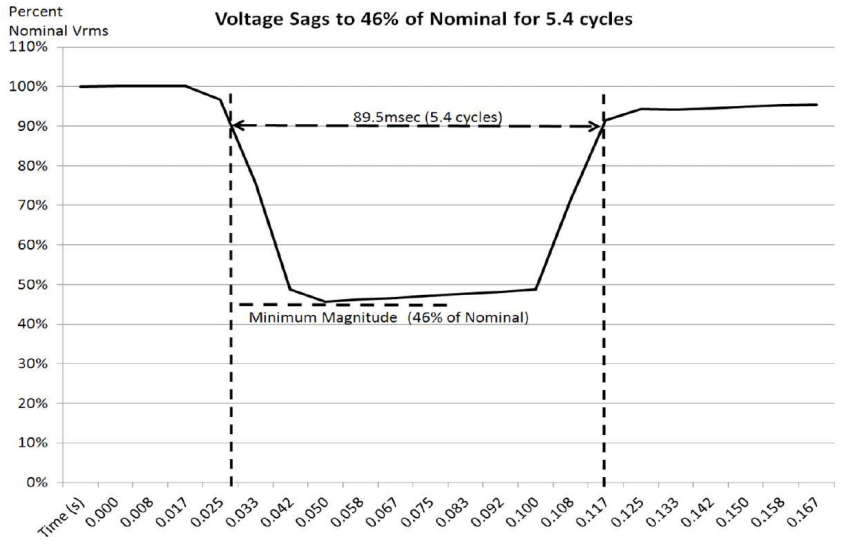
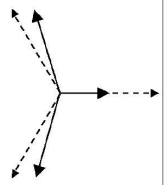
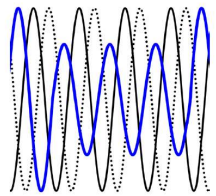
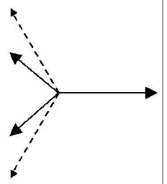
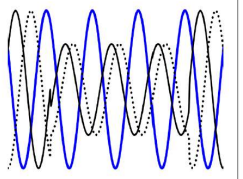
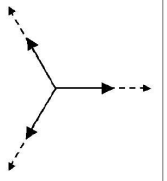
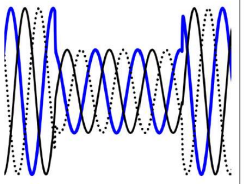


Figure 1—Single-phase voltage sag (instantaneous voltage rms plot)

Table 8—Recommended Type I, II, and III voltage-sag classifications [B1]

Voltage-sag type	Description[a]	Vector diagram	Waveform
Type I	This is a voltage sag in which a drop in voltage takes place mainly in one of the phase-to-ground voltages. $\overline{U}_a = \overline{V}$ $\overline{U}_b = -\frac{1}{2}\overline{V} - \frac{1}{2}j\overline{E}\sqrt{3}$ $\overline{U}_c = -\frac{1}{2}\overline{V} + \frac{1}{2}j\overline{E}\sqrt{3}$		
Type II	This is a voltage sag in which a drop in voltage magnitude takes place mainly in one of the phase-to-phase voltages. $\overline{U}_a = \overline{E}$ $\overline{U}_b = -\frac{1}{2}\overline{E} - \frac{1}{2}j\overline{V}\sqrt{3}$ $\overline{U}_c = -\frac{1}{2}\overline{E} + \frac{1}{2}j\overline{V}\sqrt{3}$		
Type III	This is a voltage sag in which there is a drop in voltage magnitude that is equal for the three voltages. $\overline{U}_a = \overline{V}$ $\overline{U}_b = -\frac{1}{2}\overline{V} - \frac{1}{2}j\overline{V}\sqrt{3}$ $\overline{U}_c = -\frac{1}{2}\overline{V} + \frac{1}{2}j\overline{V}\sqrt{3}$		

[a]Where: V – characteristic voltage, E – pre-sag voltage, and Ua, Ub, Uc – phase-to-neutral voltages.
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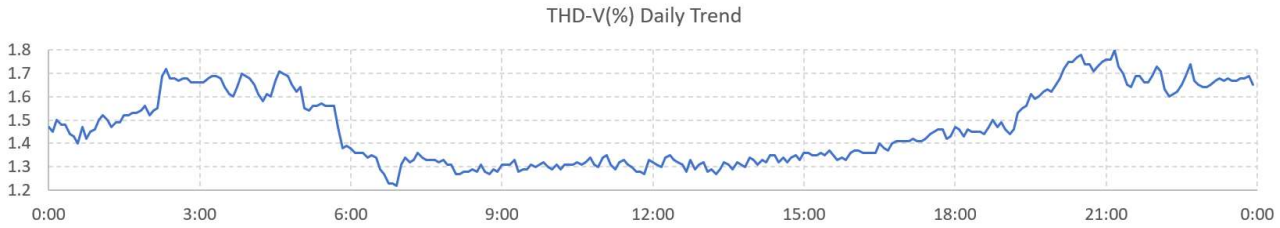
Data Formatting for the PQ Health Index Tool

Trend Data Formatting

	A	B	C	D	E	F	G
1	Site	Date	Max	CP95	Avg	CP05	Min
2	Site 1	1/1/2018	1.82	1.64	1.43	1.25	1.09
3	Site 1	1/2/2018	1.79	1.68	1.47	1.22	1.12
4	Site 1	1/3/2018	1.81	1.69	1.41	1.26	1.11
5	Site 1	1/4/2018	1.77	1.72	1.47	1.19	1.13
6	Site 1	1/5/2018	1.84	1.71	1.45	1.22	1.11



F2 =PERCENTILE.INC(B2:B289,0.95)

	A	B	C	D	E	F	G	H	I
1	Start Date and Time	THD-V Avg(%)			Max	CP95	Avg	CP05	Min
2	6/12/2023 0:00	1.47		6/12/2023	1.800	1.720	1.466	1.280	1.220
3	6/12/2023 0:05	1.45		6/13/2023	1.860	1.757	1.480	1.280	1.260
4	6/12/2023 0:10	1.5		6/14/2023	1.790	1.770	1.496	1.300	1.260
5	6/12/2023 0:15	1.48		6/15/2023	1.860	1.810	1.517	1.300	1.230
6	6/12/2023 0:20	1.48		6/16/2023	1.800	1.757	1.506	1.290	1.250
7	6/12/2023 0:25	1.44		6/17/2023	1.770	1.700	1.487	1.280	1.250
8	6/12/2023 0:30	1.43		6/18/2023	1.780	1.717	1.490	1.290	1.250

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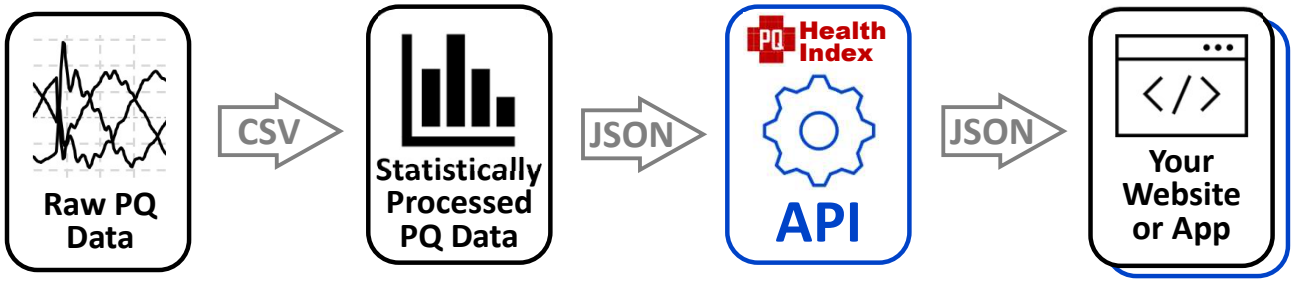
PQ Health Index API



Theo Laughner
Director of Engineering, Lifescale Analytics

3. Installation

3.1 System Requirements

- This system is designed to run on windows based servers using Python 3.11.9.
- The backed uses MS SQL server or SQL Express.
- The API layer has a FLASK Server built in which is sufficient for testing, but for production a WSGI should be installed. (This will be covered more in the API Section)
- The web front end uses Streamlit v 1.38.0

3.2 Database

The database folder has two SQL files in it.

File	Description
epriwhit_final.sql	This file has the schema only and can be used to set up a fresh installation of the database.
epriwhit_final_w_sampledata.sql	This file has the schema and sample data and can be used to evaluate the system.

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PQ Dashboard Integration

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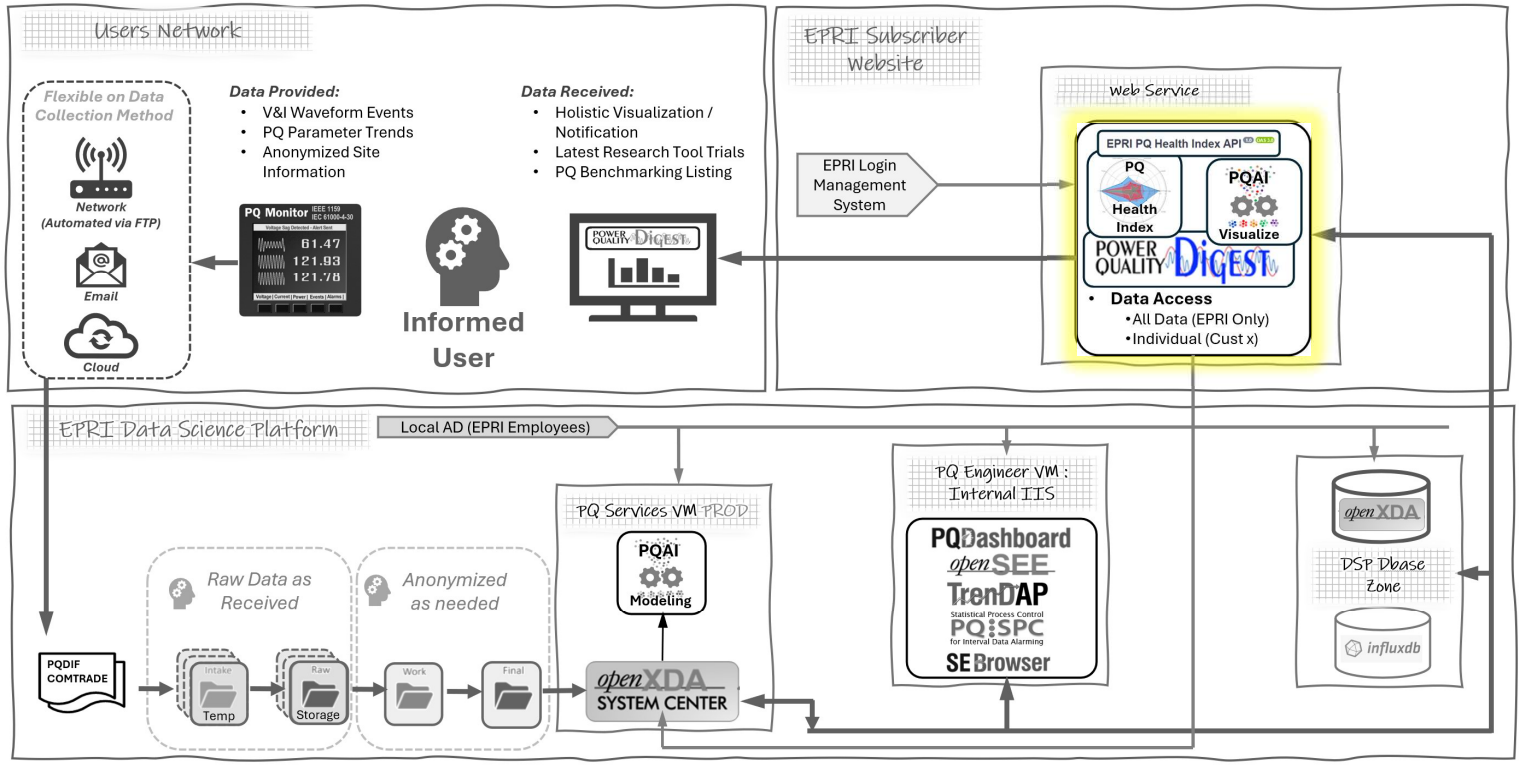

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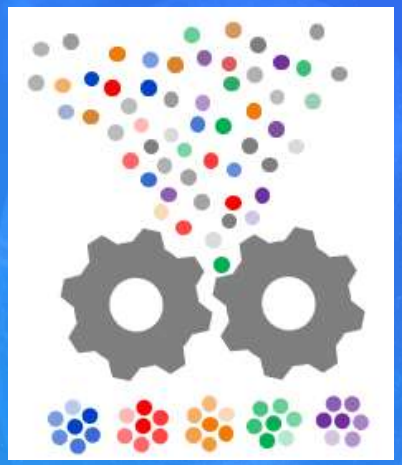
AI/ML Clustering Tool



Waveform Clustering

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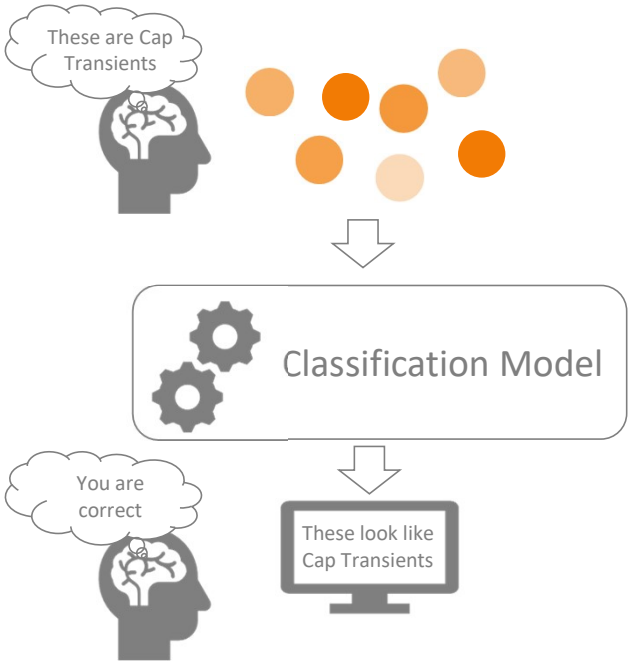
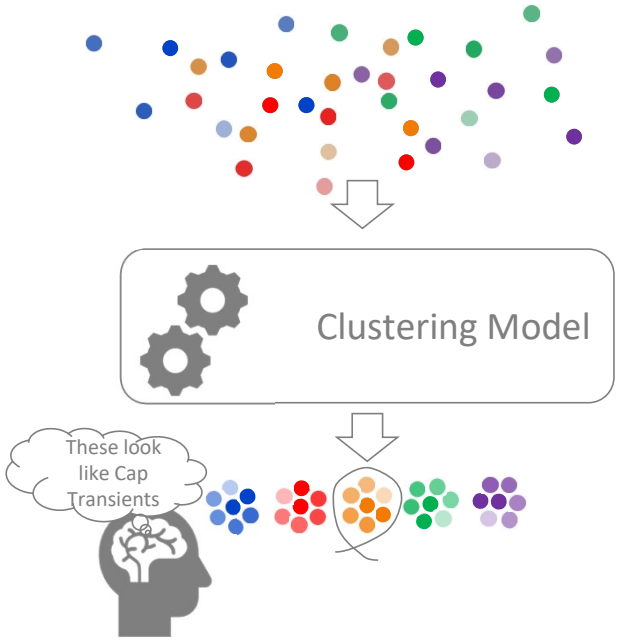
Two Approaches or Combination

- With Metadata
  - Classification
    - Human transfer of knowledge
  - Supervised Learning



- Without Metadata
  - Clustering
    - Looks for similarities
  - Unsupervised learning



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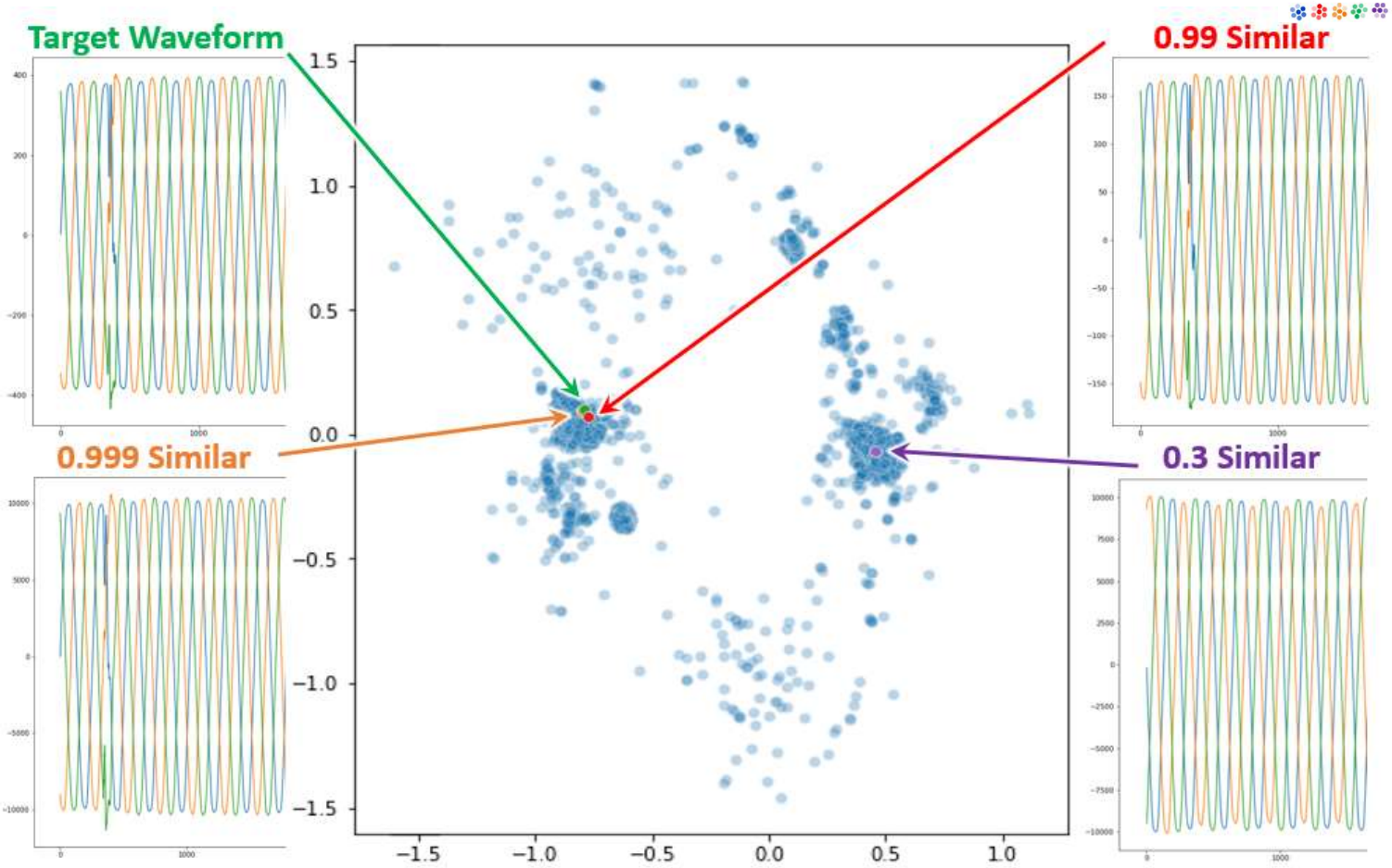
Clustering Similarity



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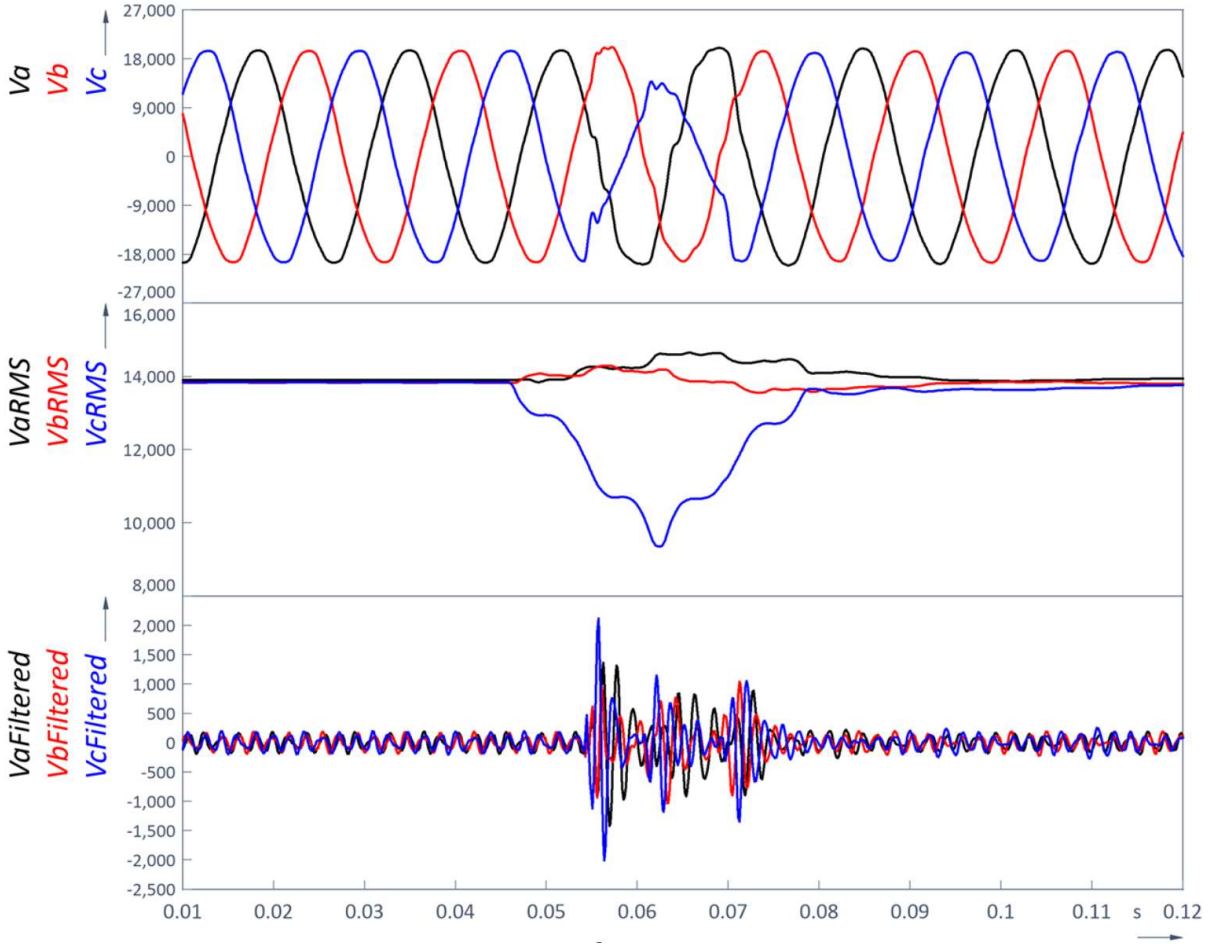
Event Characterization



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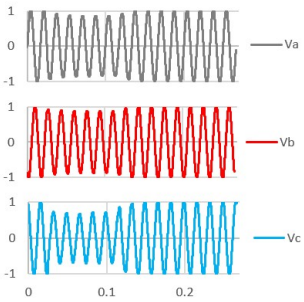
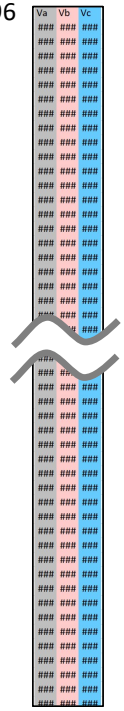
How Phases are Processed

Md Maidul Islam
EPRI
Engineer/Scientist

Data Prep

- 5,000 3-ph voltage recordings
- 256 SPC
- 3-ph Series Data length 4096
- Removed data < 2048 samples
- Padded Nominal to data < 4096 samples
- Scaled data to (-1 to 1) range

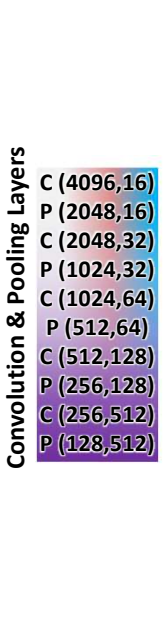




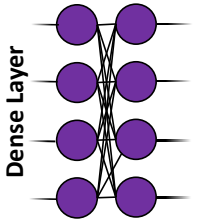
(4096,3)

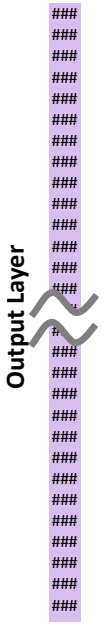
Feature Encoding

- Convolutional encoding
- Reducing the bottleneck size
- 60 seems to work best
- 50 or less than 50, data got distorted.



(65536,1)





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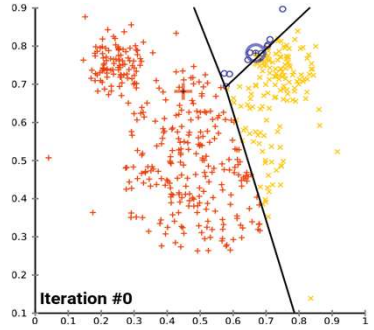
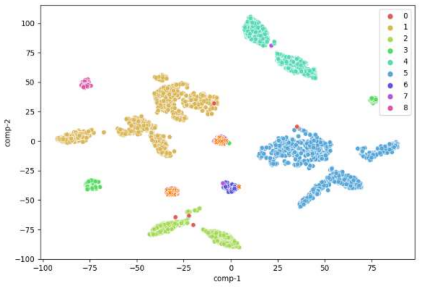
Clustering

- K-means Clustering
- Principal Component Analysis (PCA) Feature Extraction / Reduction
- t-SNE visualization





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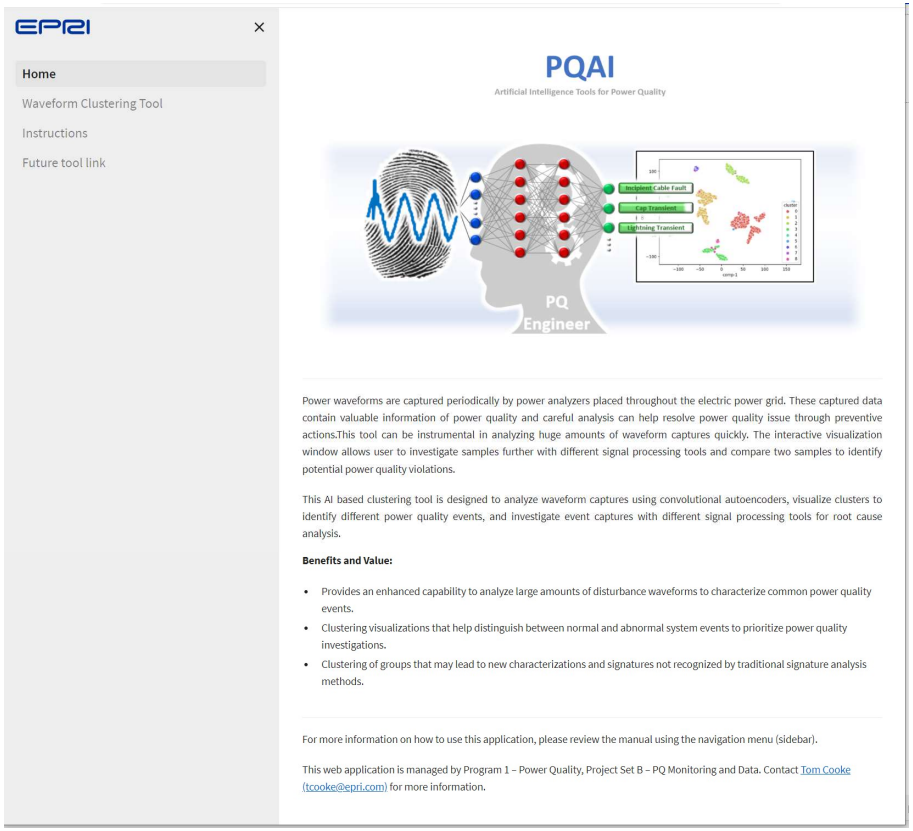
Web-based AI Clustering

Md Maidul Islam
EPRI
Engineer/Scientist

https://apps.epri.com/pqai/

Important: All lowercase



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Power Quality
PS1B: PQ Data & Analytics

AGENDA

- Welcome and Introductions
- EPRI PQ Dashboard Service
- Developments
  - PQ Health Index
  - Waveform Clustering Tool
  - Compliance Reporting Initiative
  - Continuous Point on Wave
- Q&A

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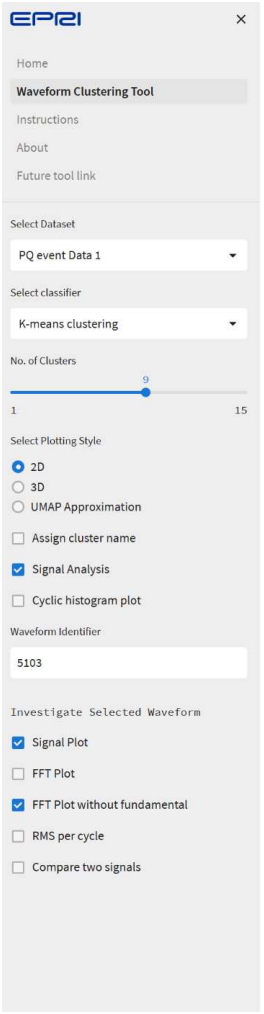
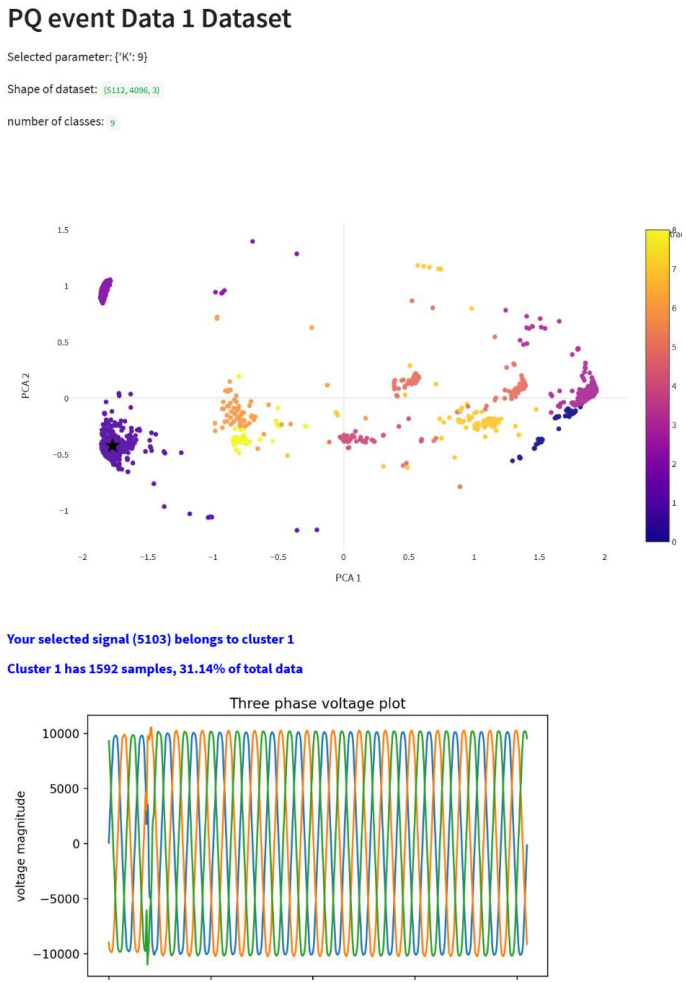
Web-based AI Clustering - Demo





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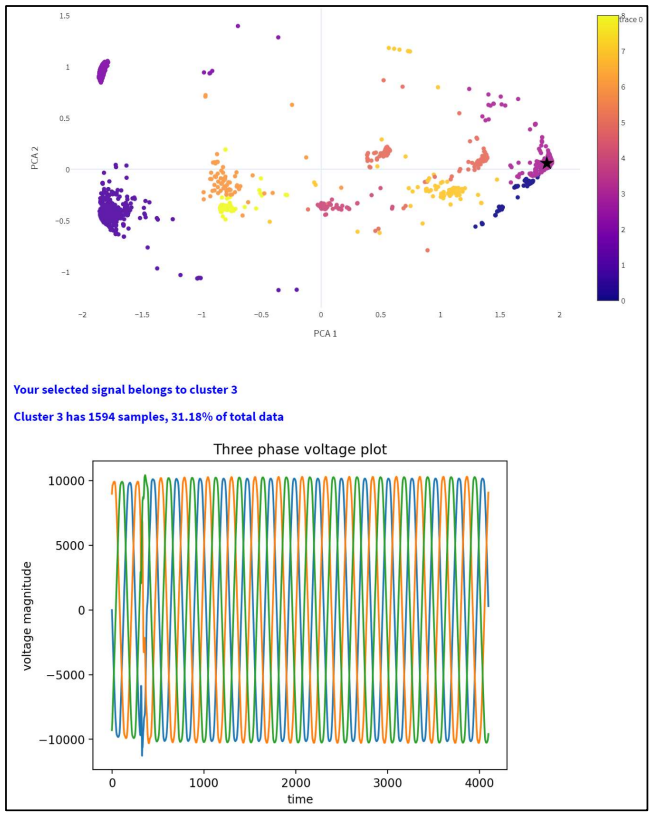

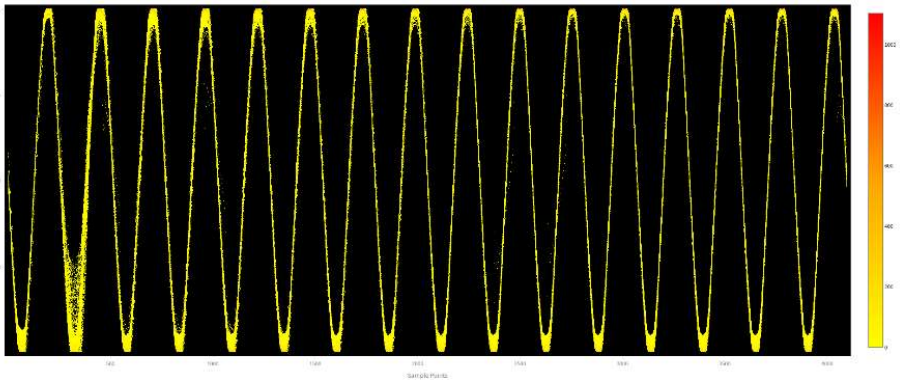

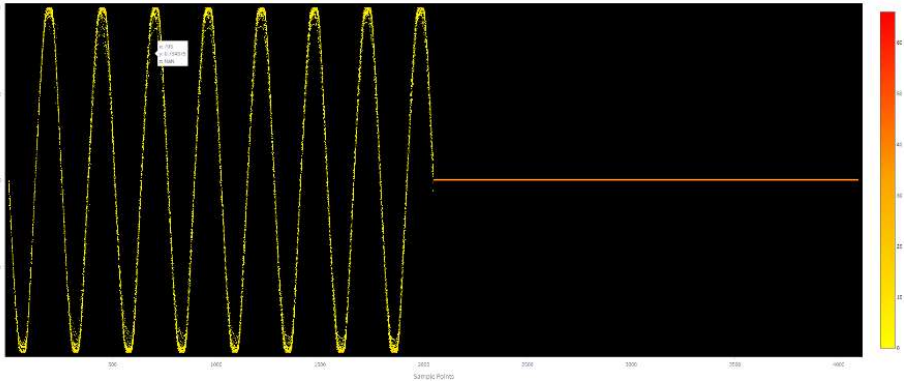

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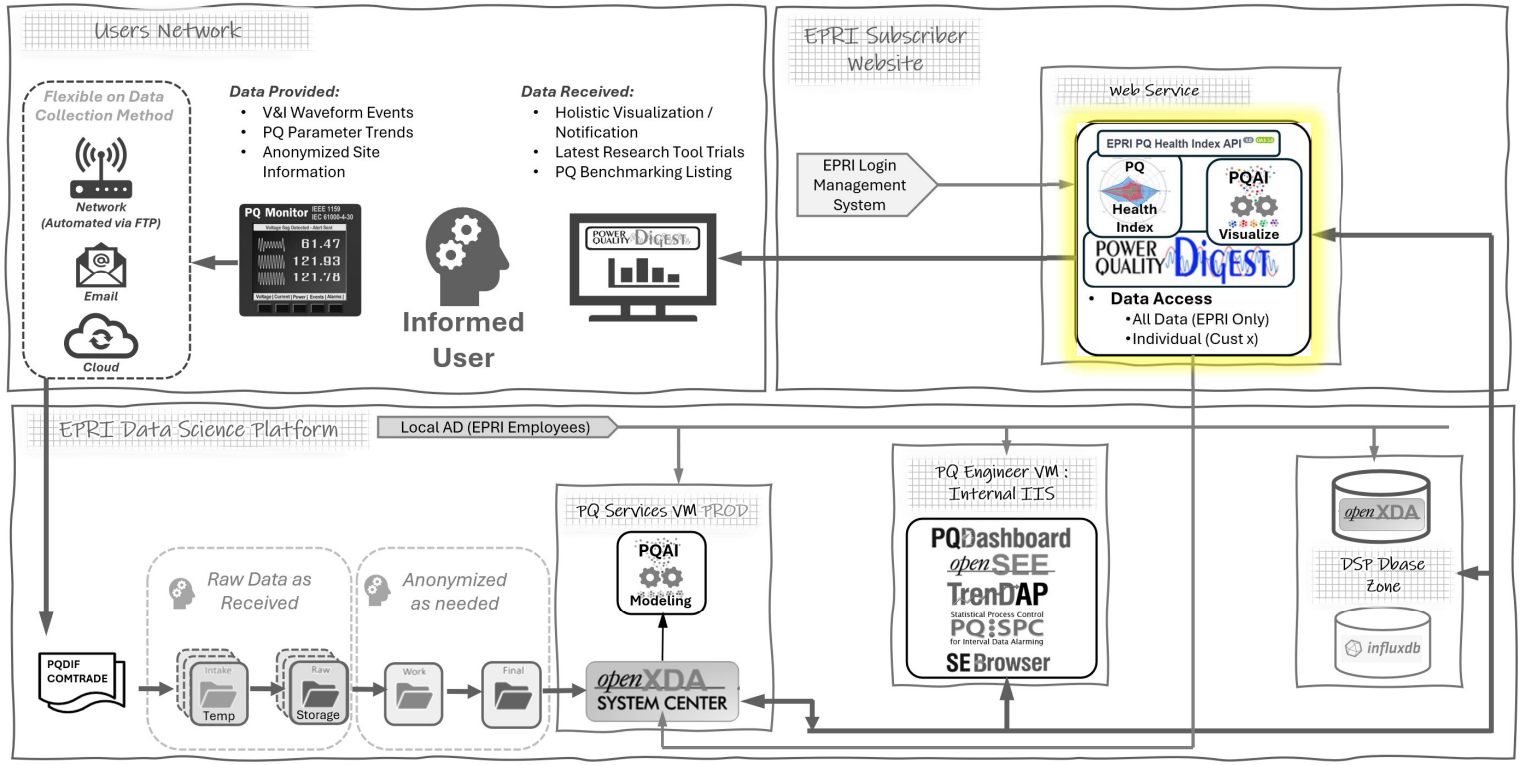
PQ Dashboard Integration

EPRI PQ Dashboard Service | A service for industry and utilities to pilot/demo the PQ dashboard and experience its value



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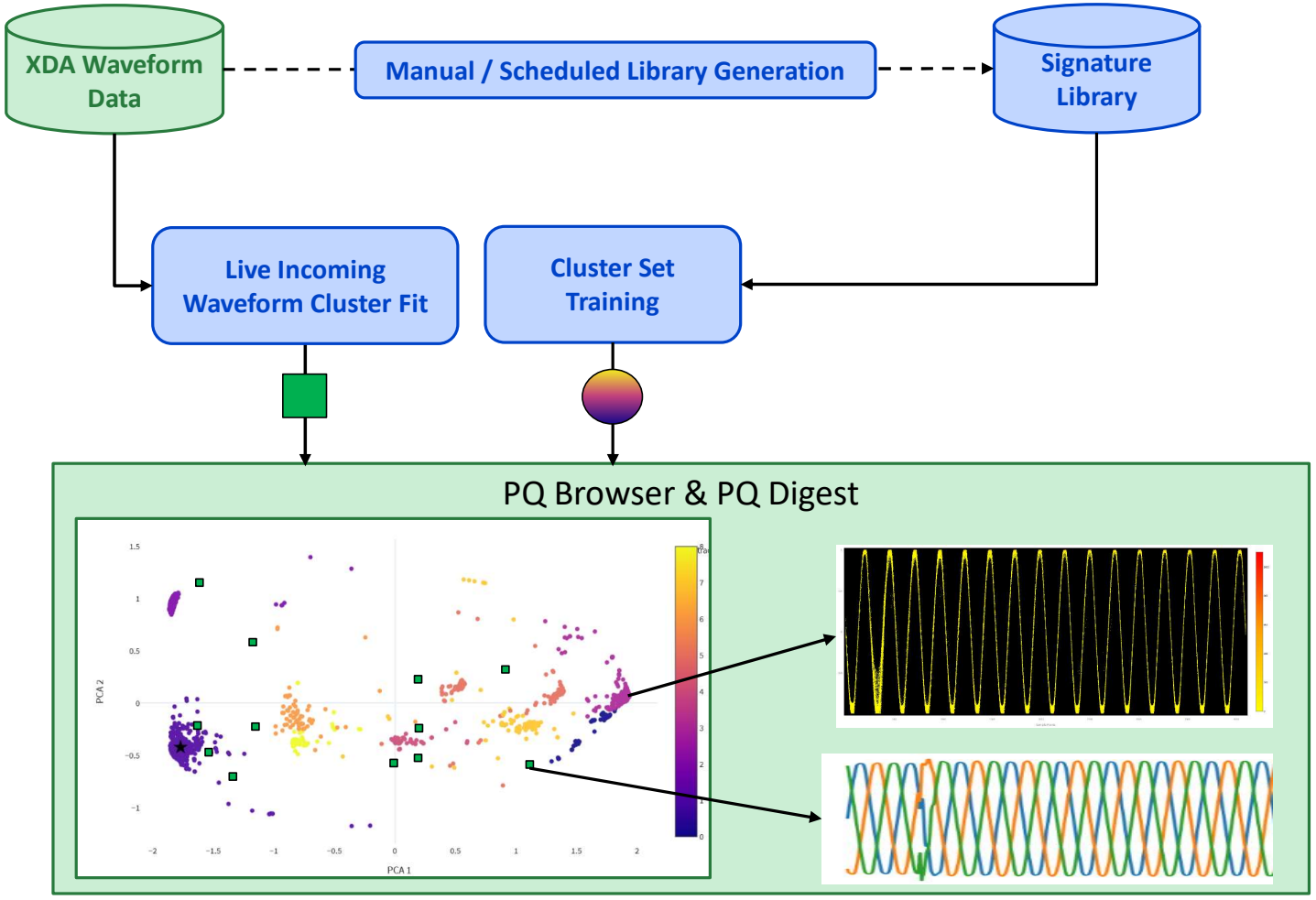
PQ Dashboard Integration Design



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IEEE 519 and Other Future Compliance Reporting

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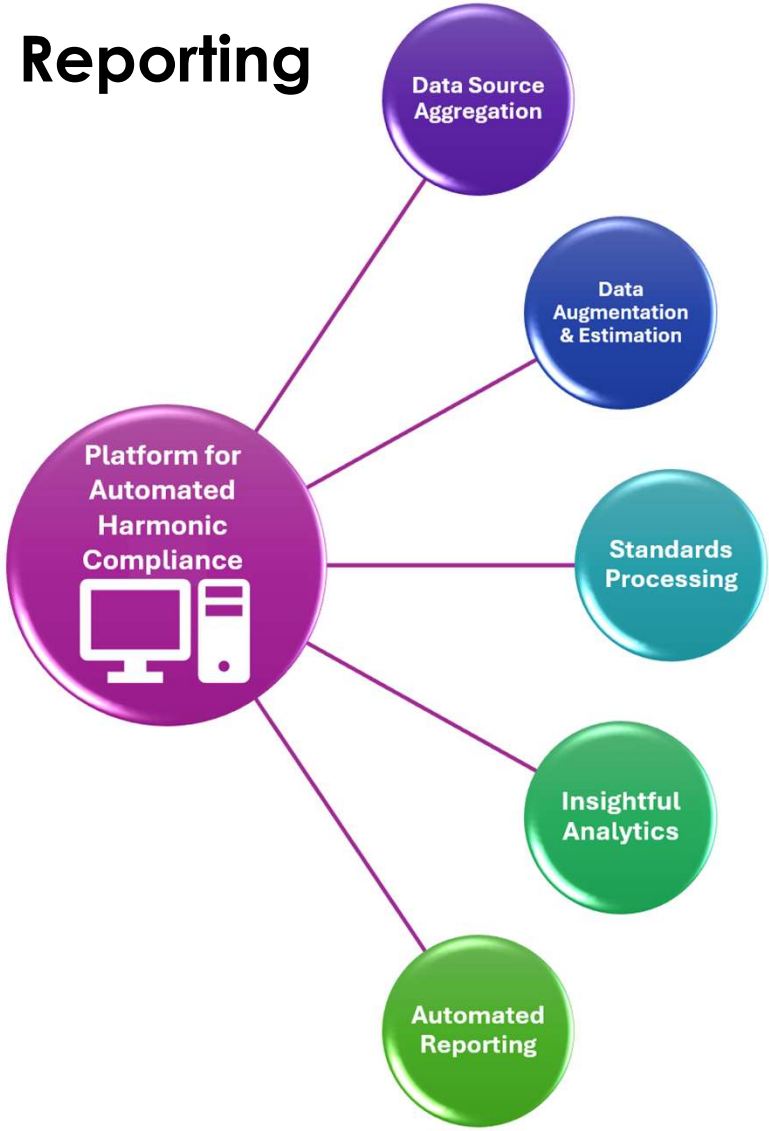
Platform for Compliance Reporting



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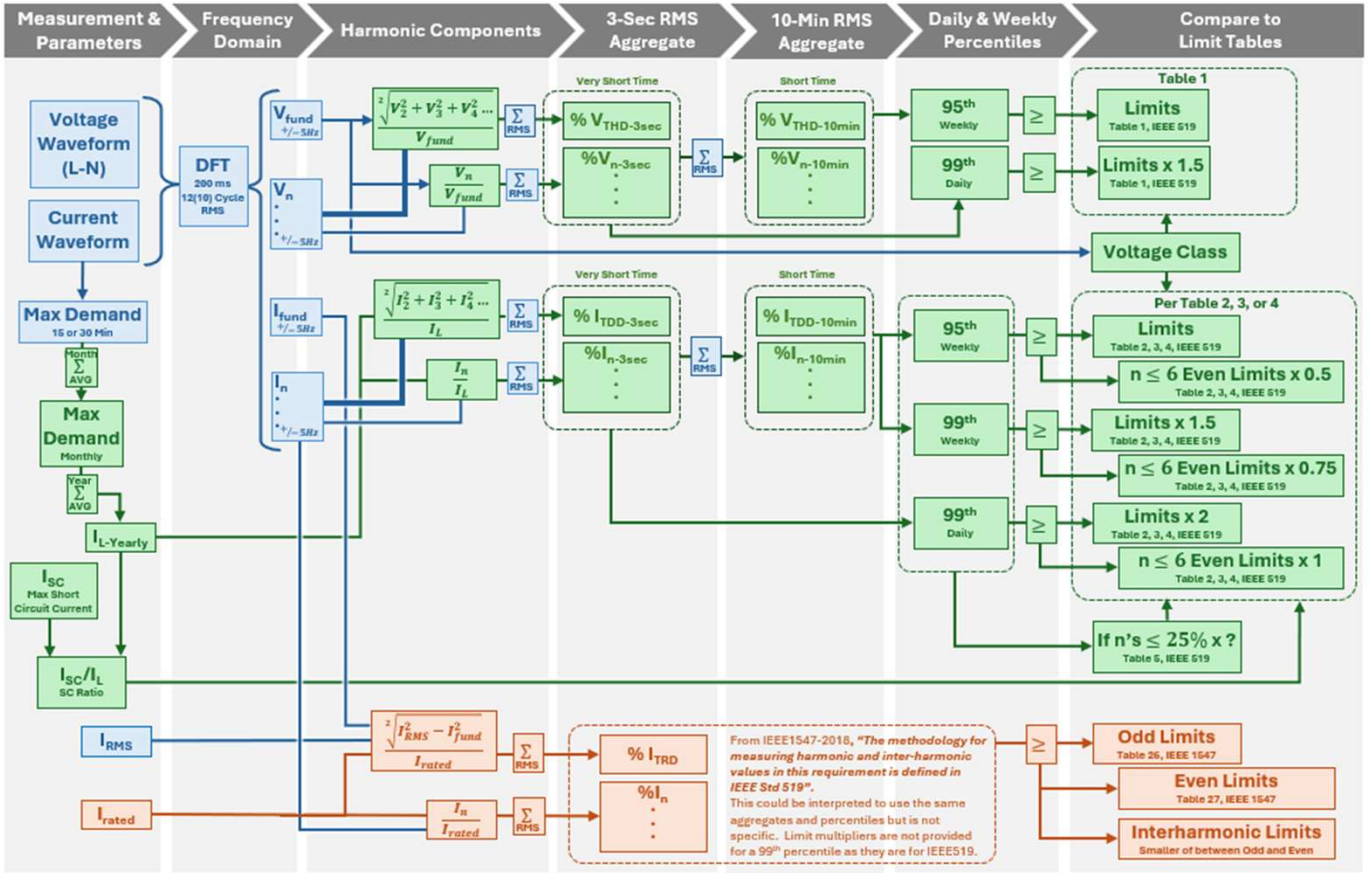
2026 PQ Dashboard BETA

IEEE 519 and 1547 Harmonic Analysis Flow

- IEC 61000-4-7 & 4-30
- IEEE-519-2022
- IEEE-1547-2018



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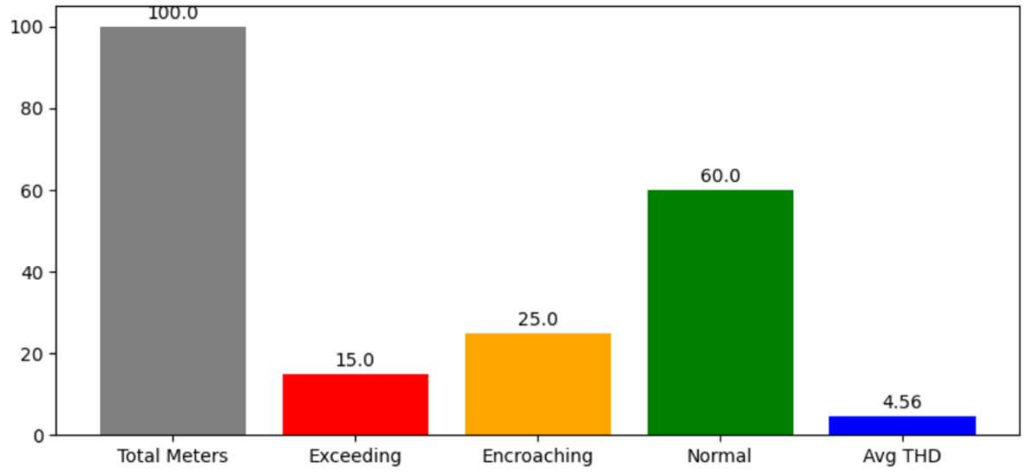
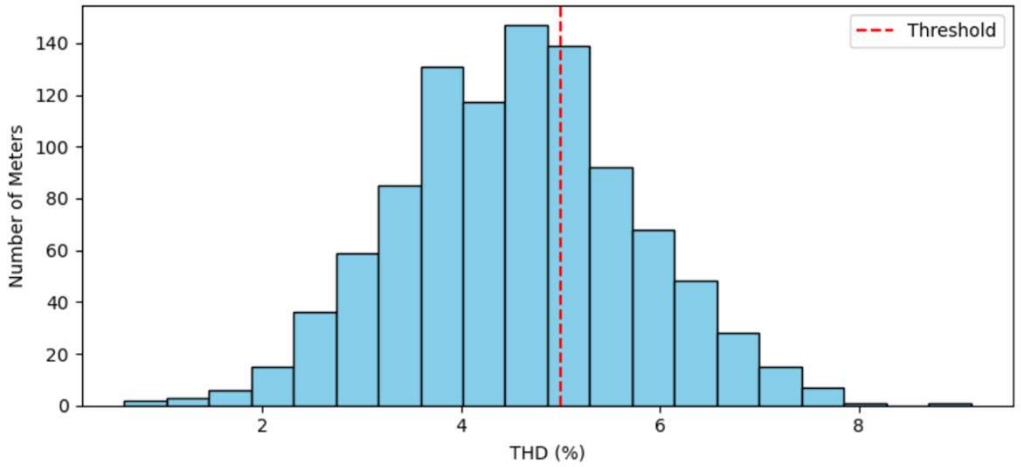
Insightful Analytics: Sites Quantitative Statistics





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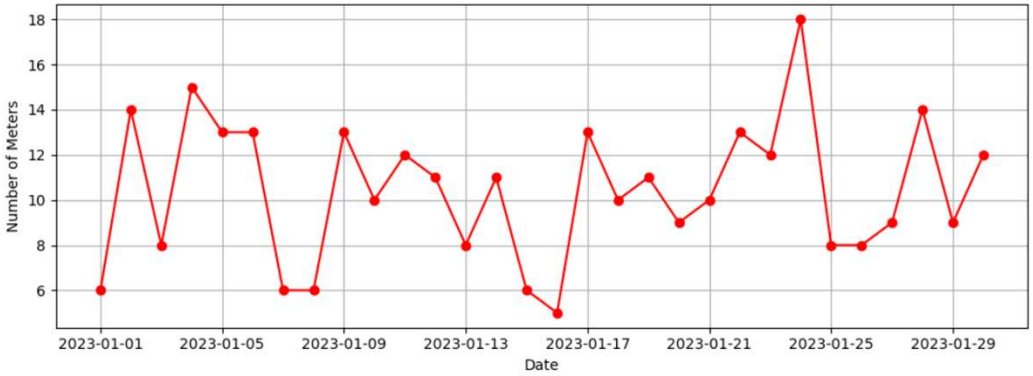
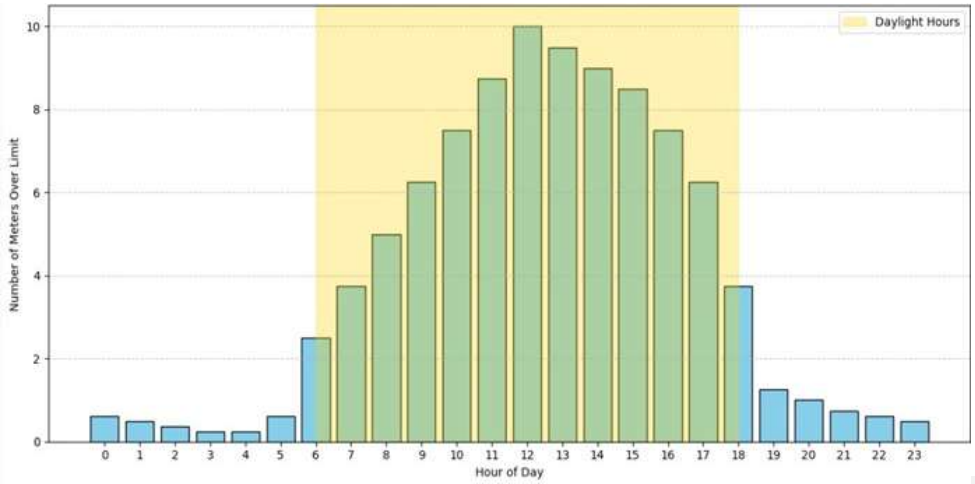
Insightful Analytics: Sites Temporal Statistics





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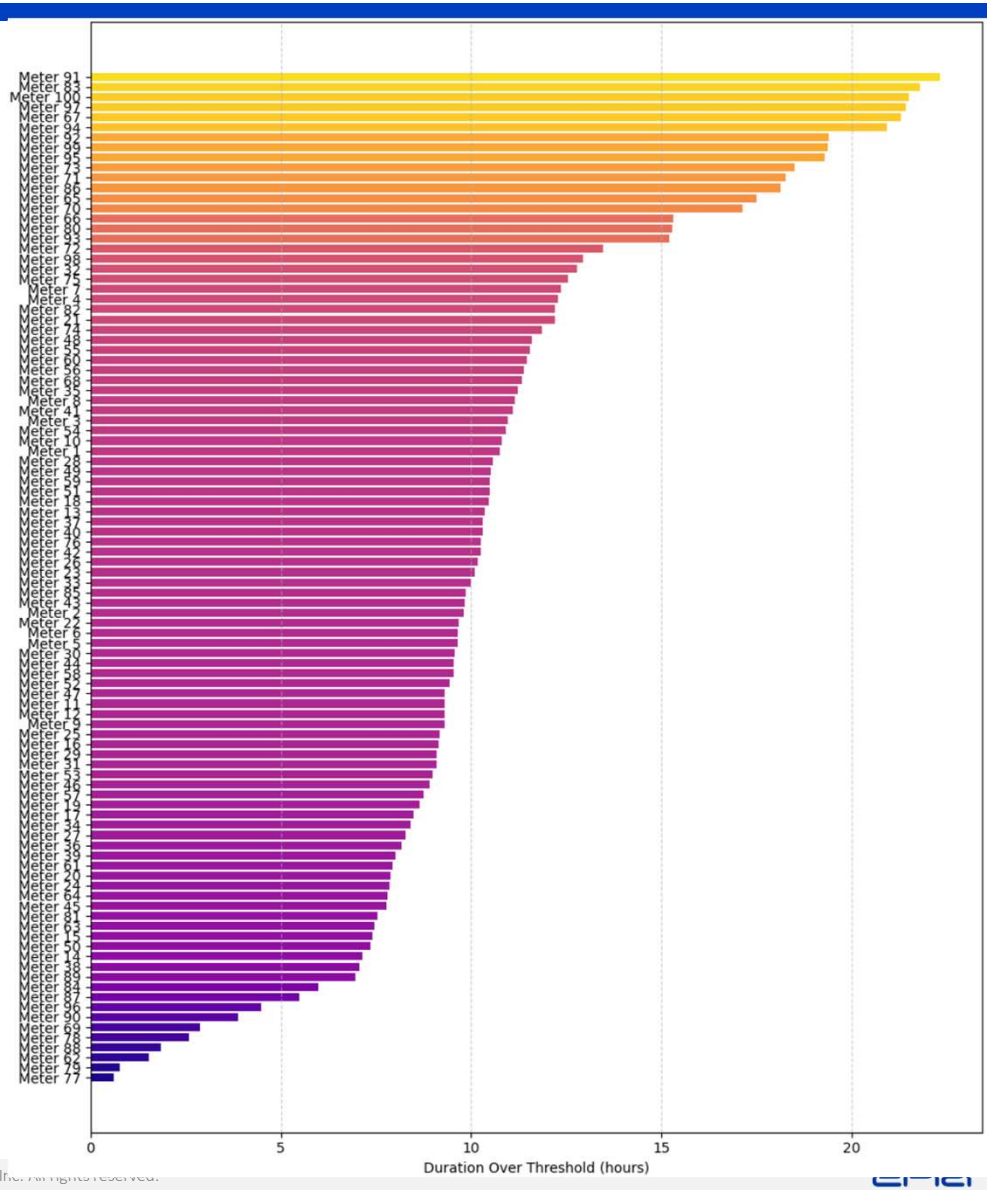
Insightful Analytics:

Site Duration over Threshold



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Proposing for 2026

CPOW for Incipient Fault Analysis and Asset Health.

CPOW PQ Assessment

- Data Requirements
  - How to manage CPOW data flow and reporting.
- Developments
  - Work with prototypes and interested manufactures (SELs, APP, OZM)
- Support P37 T&S Asset Health Testing
- Demonstrations

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