EV Detection and Forecasting

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June 11, 2024

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My Profile

- Reza Dehghan – Solution Architect
- BS in Electrical engineering
- MS in computer science
- 22 years in industry
- 12 Years with Eaton

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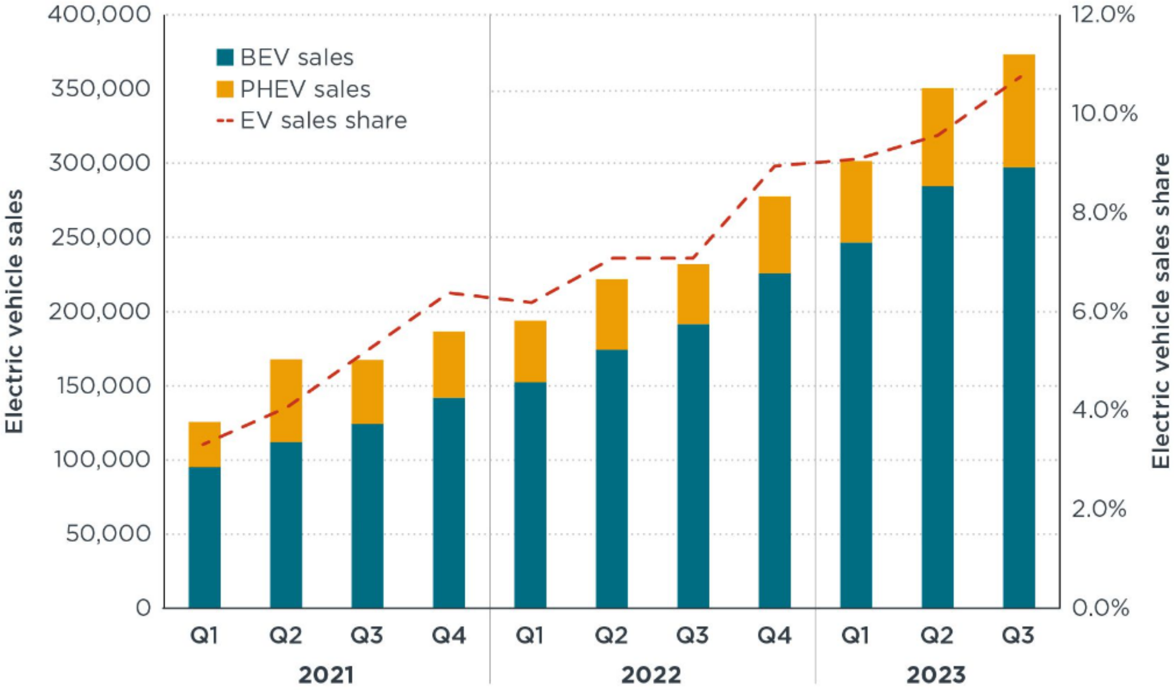
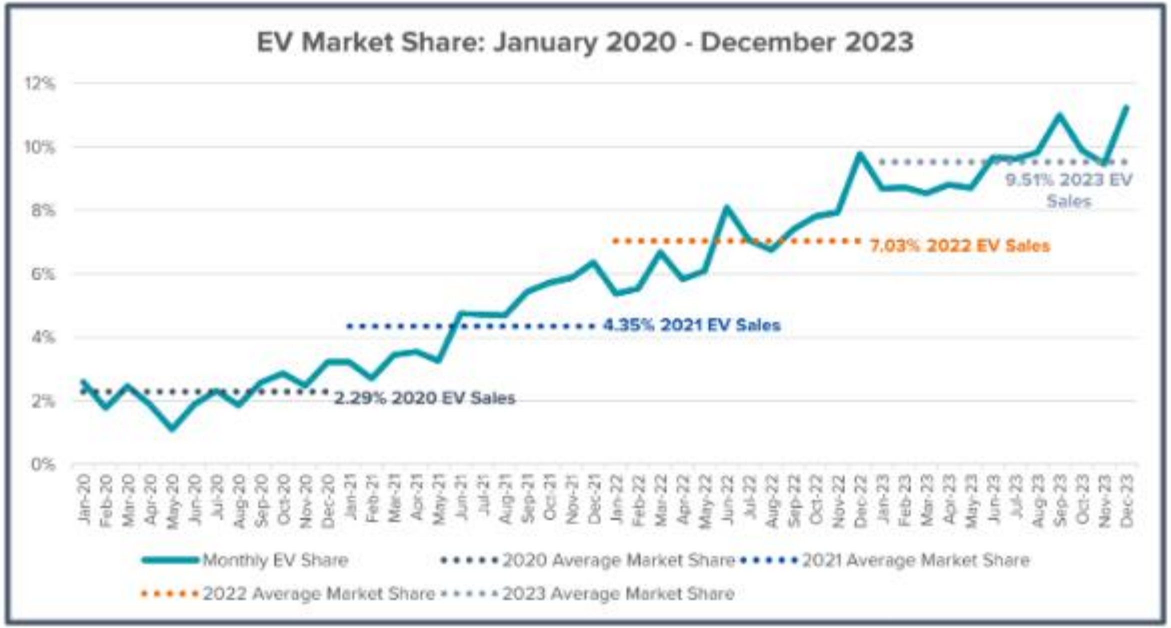
Growth of EVs

The Growth of EVs



International Council on Clean Transportation

Fast Facts about EV Growth



Alliance for Automotive Innovation

- 58% growth in sales of EVs from Q1, Q2 & Q3 2022 to 2023
- Market share is almost to 12%
- Growth is significantly faster for EVs than Hybrids

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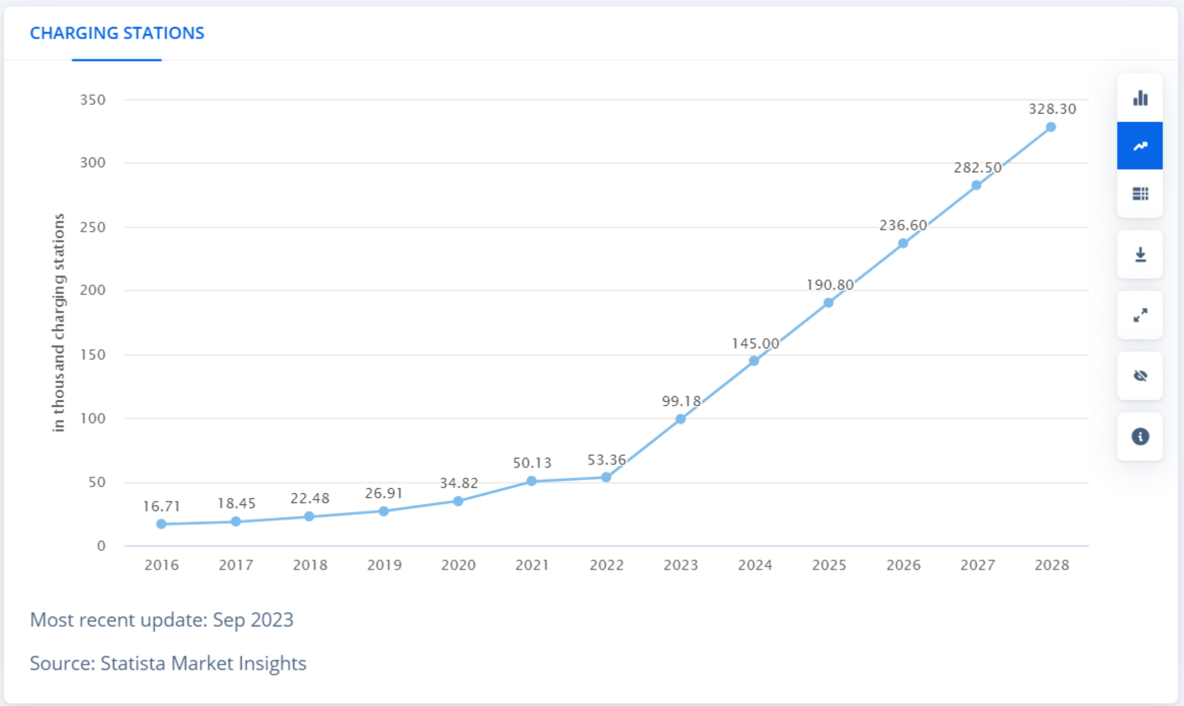
EV Charging Stations

- Charging Stations and EV sales have a positive correlation
- Growth of EV sales and charging station installations show the huge strain the infrastructure our electrical system will experience in coming years.



EV Detection

Problem Statement

The increased adoption of EVs is having a significant impact on the distribution grid, challenging utilities to better manage peak demand costs and address infrastructure upgrades.
In some areas, mandates are pushing for up to 100% EV adoption by a certain year. Unfortunately for utilities, there are no permitting requirements for EV like there are for PV, so utilities are not notified when an EV, which can consume as much load as an entire home, are added to the grid. In addition, EV adoption tends to occur faster in specific neighborhoods, which translates into significant load increases.

The impact of EV to the utility are:

- Higher pick demand
- Device aging
- Voltage sag

Utilities need to better understand where EVs are located and when they are being charged to fully realize the benefits of increased consumption caused by the electrification of transportation.

Methodology

We provide rankings that depend on amount of data that was available for the analytics as well as the confidence interval of the model itself. Currently we achieve confidence intervals up to 85% which depends on how many EV events were detected during that time interval and the pattern of the charging interval so the duration and the kW rating during the charging time duration.

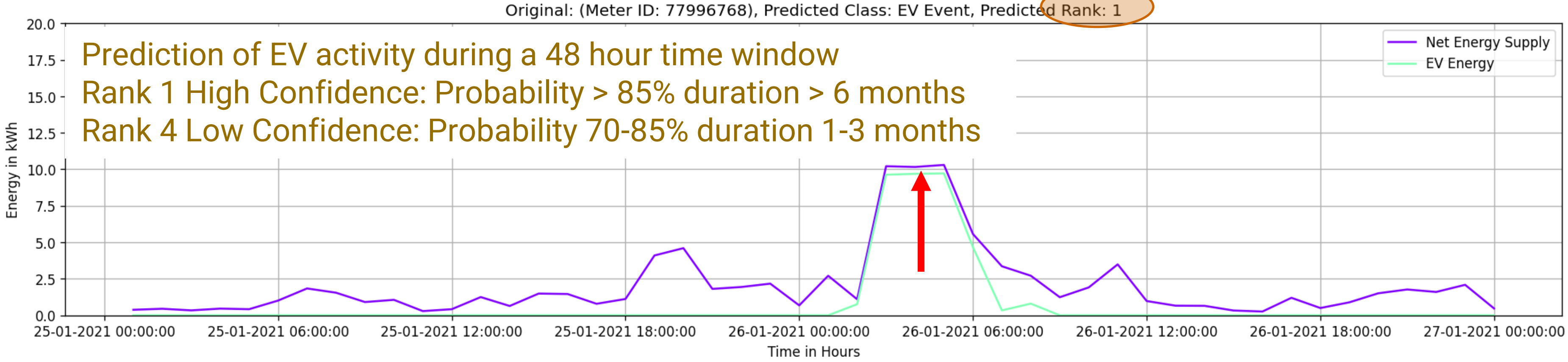
Following table summarizes defination of predicted ranks for EV owners.

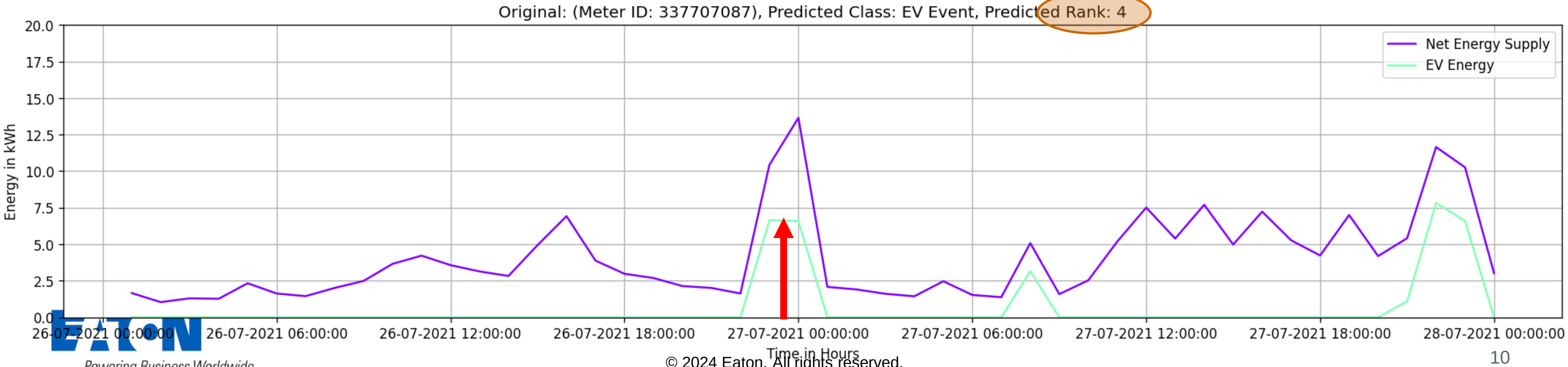
Label	Description
Rank 1	Consumer Meter IDs with prediction confidence of 85% or more and have 6 Months or more EV activity
Rank 2	Consumer Meter IDs with prediction confidence 85% or more and have 4 to 5 Months of EV activity or
	Consumer Meter IDs with prediction confidence between 70% to 85% and have 6 Months or more EV activity
Rank 3	Consumer Meter IDs with prediction confidence between 70% to 85% and have 4 to 5 Months of EV activity or
	Consumer Meter IDs with prediction confidence more than 85% and have 1 to 3 Months of EV activity
Rank 4	Consumer Meter IDs with prediction confidence between 70% to 85% and have 1 to 3 Months of EV activity

Table 1. Definition of Ranks

Detection of EV with different Confidence Levels

Prediction of EV activity during a 48 hour time window
Rank 1 High Confidence: Probability > 85% duration > 6 months
Rank 4 Low Confidence: Probability 70-85% duration 1-3 months





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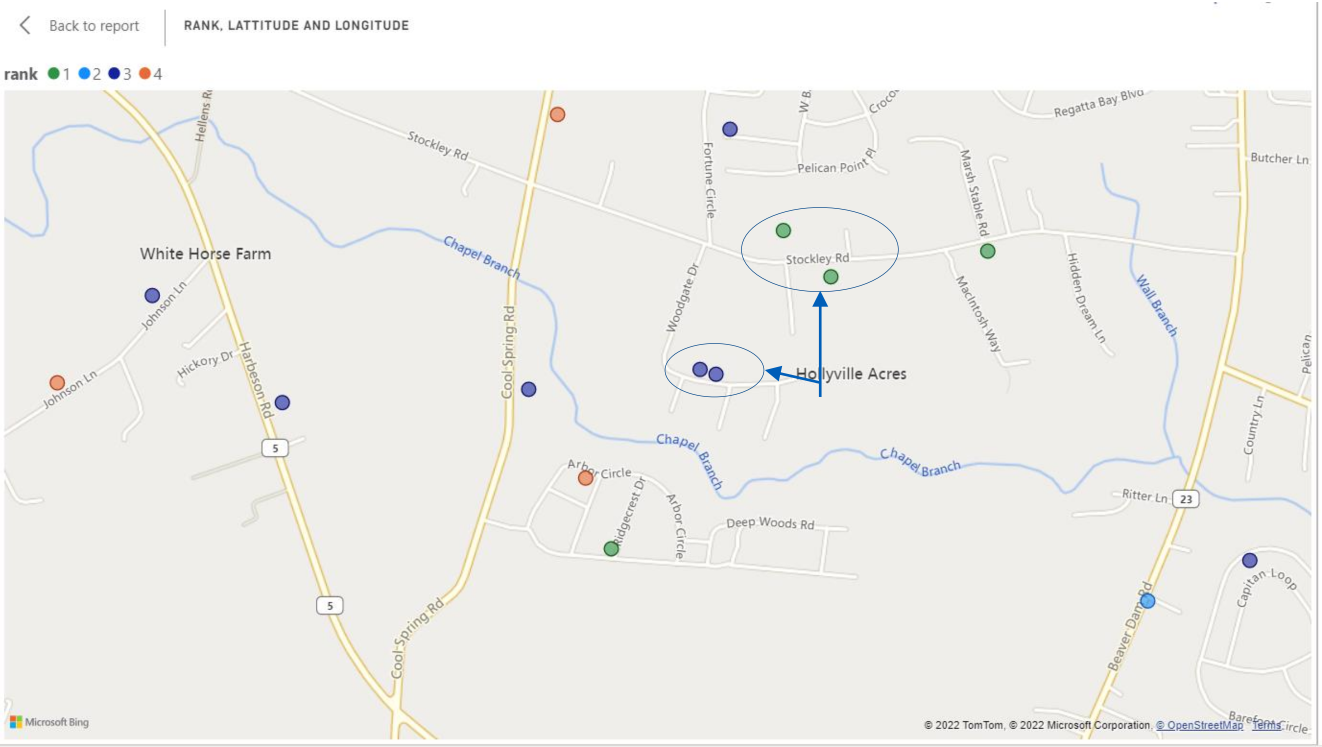
Visualization of Data can Help Detect EV Clusters

Displaying the EV on a map can help identify if there are clusters in the service territory that could cause network issues such as overloading.



Result to Customer Report and File Export

Result from EV study is a report with information regarding the EV accounts detected in the territory with confidence ranking, geographical visualization and a csv file that can be important to other 3rd party products e.g. work-order management application

2.1 EV ranks

3,021 EV homes were identified in the network. This represents 3.5% of the total analyzed distribution network. To help prioritize the investigation of these EV homes, they were organized into 6 distinct ranks based on a confidence value and the duration data available. The confidence value is based on complex logic from two machine learning prediction models.

Rank	Confidence	% of reporting period with EV activity	# of EV homes	% of total EV homes
1	>=85%	>=50%	475	15.7%
2	70-85%	>=50%	308	10.2%
3	>=85%	30-50%	213	7.1%
4	70-85%	30-50%	383	12.7%
5	>=85%	8-30%	423	14.0%
6	70-85%	8-30%	1,217	40.3%

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Benefits of EV Detection

Knowing where EVs charge and how they are distributed in the network has many benefits such as:

1. Improving DR program
2. Better asset management
3. Improving system planning
4. Customer engaging

EV Forecasting

What about future ?!

- Predicting the future EV penetration is not easy
- Socioeconomic data
- Stochastic algorithms

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What is CYME and how does it help with reducing the impact of EVs on the electrical network?

CYME – Advanced Distribution Planning Software

Power Engineering Software

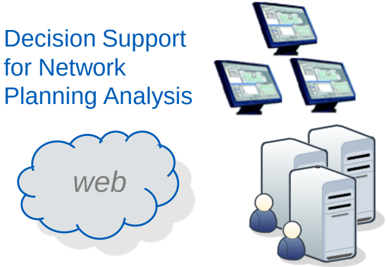
CYME Power System Analysis
Transmission
Distribution
Industrial

CYMCAP Cables

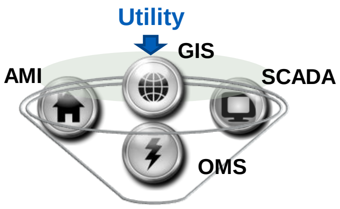
CYMTCC Protection

CYMGRD Substation Grounding

Decision Support
for Network
Planning Analysis



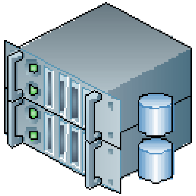
Integration Projects and Solutions



CYME Gateway

CYME
Network Model

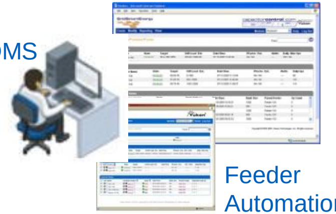
Operations Solutions



CYME Server

Volt/Var Control

DMS



Feeder
Automation

Decision Support
for Real-Time
Applications

State Estimator

Best-in-Class System Analysis Tools and Services From Transmission to Distribution to Industrial

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Behind-the-meter Scenario Analysis Module

- Add-on modules will add additional capabilities, analyses and modeling functions.
- Behind-the-Meter, or BTM, is an add-on module to CYMDIST that allows the user to assess network states
- BTM uses the Monte Carlo calculation method to analyze the selected network(s)
- Monte Carlo method is a "…mathematical technique that is used to estimate the possible outcomes of an uncertain event." (IBM)
- Because EVs are not required to be reported by homeowners, most utilities do not know which customers have EVs they charge at home and which they do not.
- People also change where they charge their EV because of work, weekend plans, etc.
- Where and when EVs are charging is considered an uncertain event.

CYME Modules

Modeling
- Enhanced Substation Modeling
- LV Secondary Distribution Modeling
- Secondary Grid Network Modeling
- Geographic Overlay
- Online Maps Service

Planning
- Advanced Project Manager
- Automated Network Forecast Analysis
- Techno-Economic Analysis

Operation
- Distribution State Estimator
- Contingency Assessment and Restoration
- Load Flow Contingency (N-p)
- Advanced Fault Locator

Protection
- Protective Device Analysis
- Arc Flash Hazards Analysis
- Distance Protection Analysis

DER
- Integration Capacity Analysis
- EPRI DRIVE™ Module
- DER Impact Evaluation
- Network Disturbance Assessment

Power Quality
- Reliability Assessment
- Harmonic Analysis
- Dynamic Motor Starting Analysis

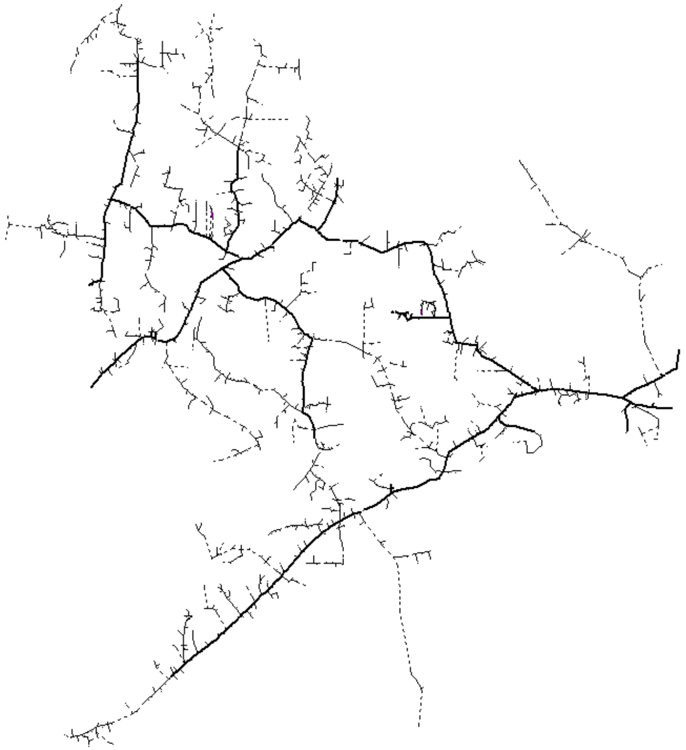
Optimization
- Network Configuration Analysis
- Volt/VAR Optimization
- Optimal Voltage Regulator Placement
- Optimal Recloser Placement

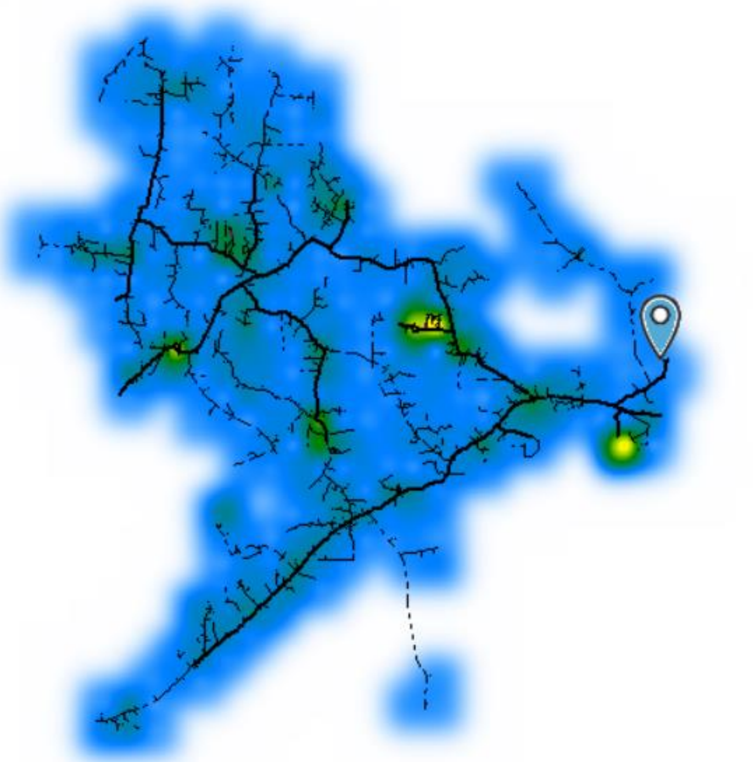
Time-Series
- Steady-State Analysis with Load Profiles
- Long-Term Dynamics Load Flow Analysis
- Transient Stability Analysis

Integration
- Dynamic Data Pull
- CIM Import / Export
- MultiSpeak® Import
- Data Push Publishing

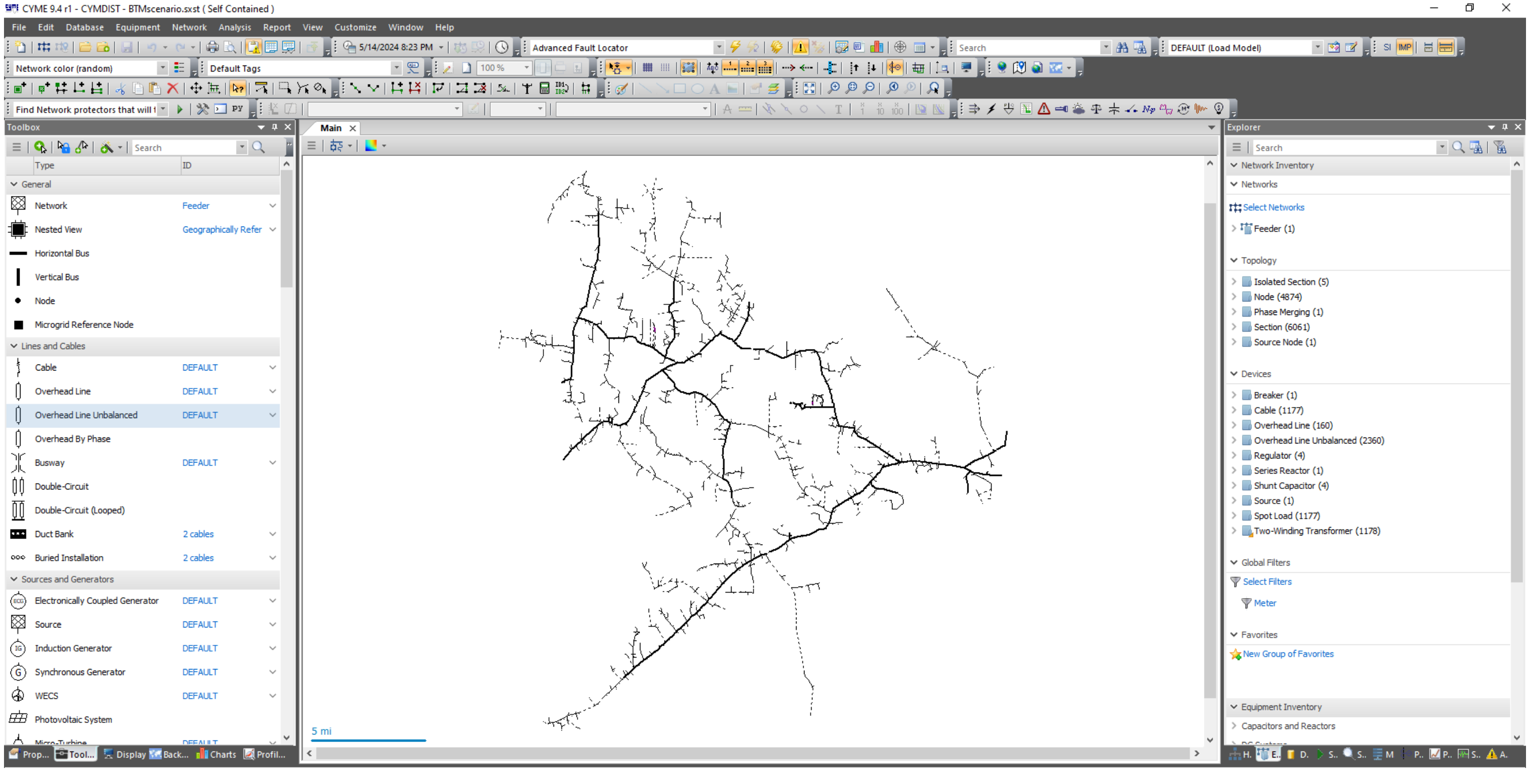
Scripting
- Scripting Tool with Python®

What to expect?

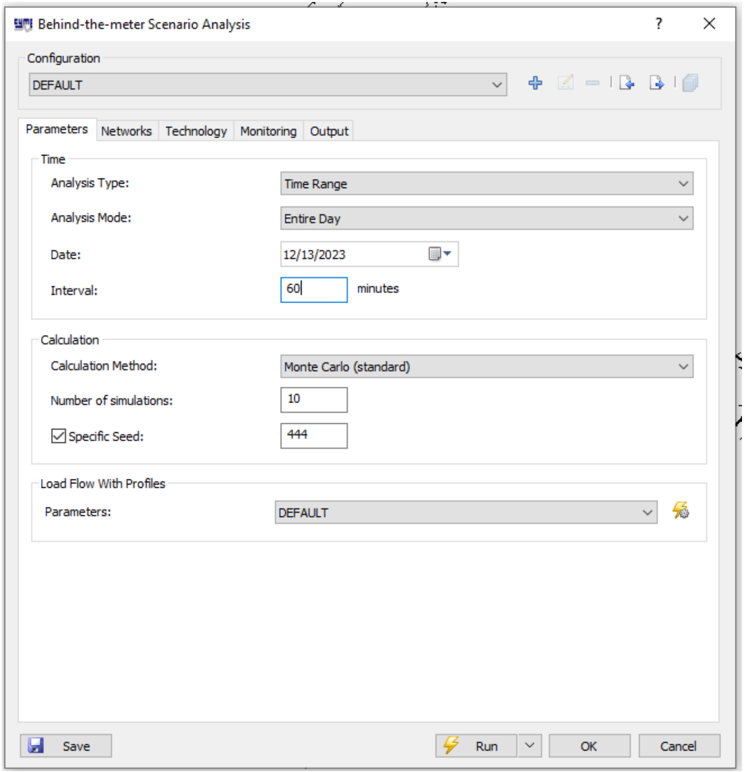




Behind-the-meter Scenario Analysis - Network



Behind-the-meter Scenario Analysis - Parameters



- BTM uses CYME's Steady State Analysis with Load Profiles (LFwP) to use AMI data in running an analysis of a full day.
- 60 minute intervals over 24 hours is 24 analyses run for each of the 10 simulations.

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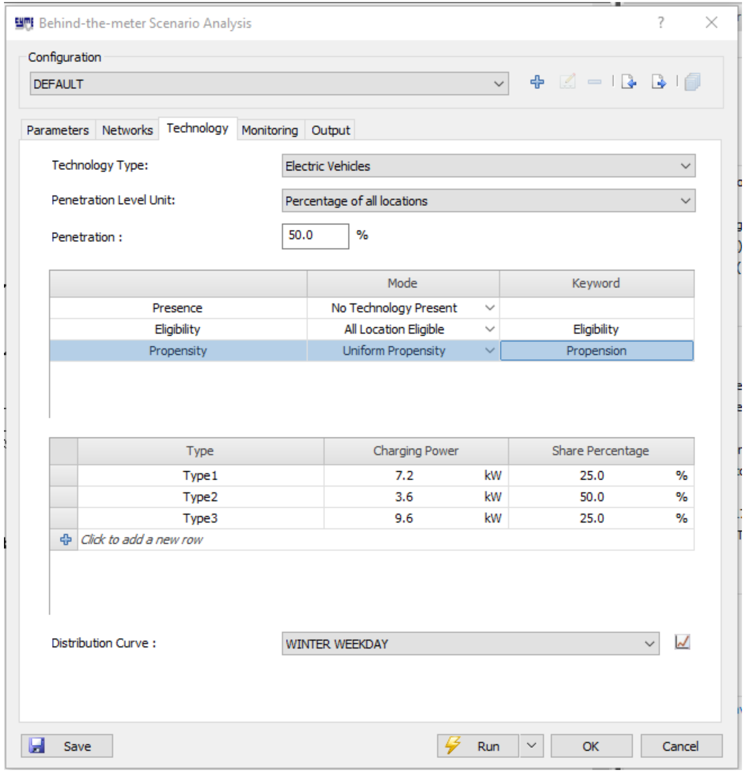
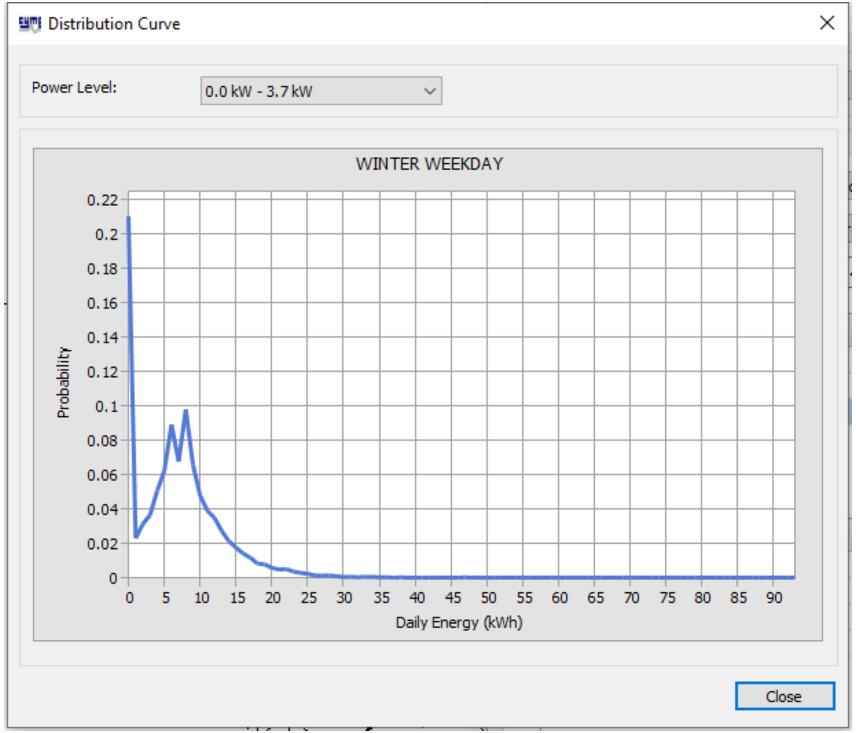
Behind-the-meter Scenario Analysis - Parameters





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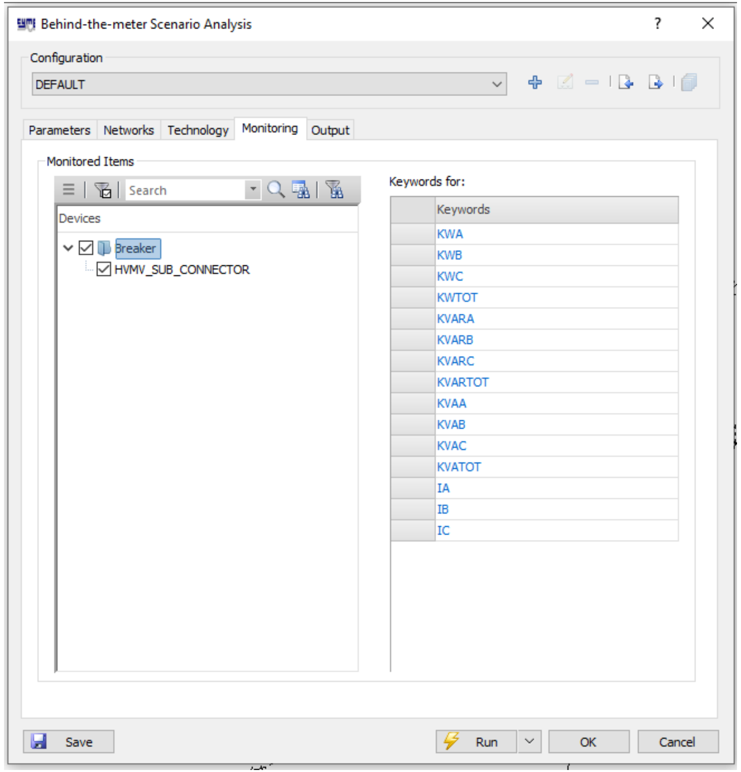
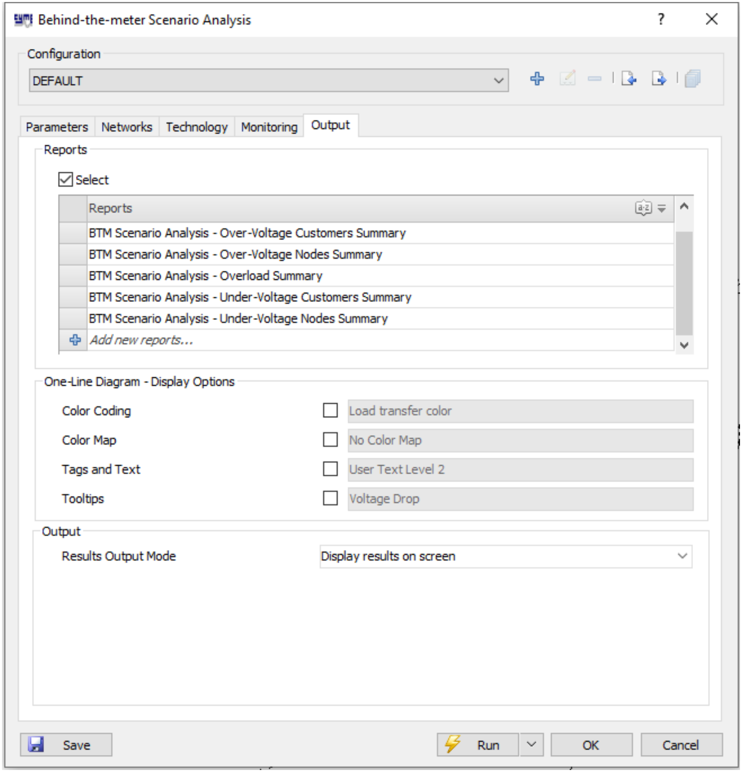
Behind-the-meter Scenario Analysis - Parameters





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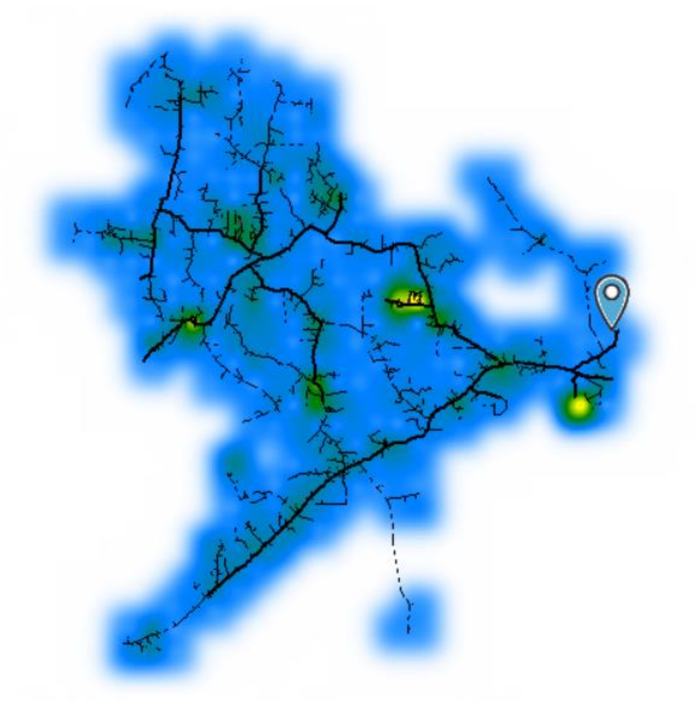
Behind-the-meter Scenario Analysis - Results



- This is a load density color map that shows the locations with the greatest load density that could cause strains on the electrical network.
- The more yellow and even slight red shows the densest locations.

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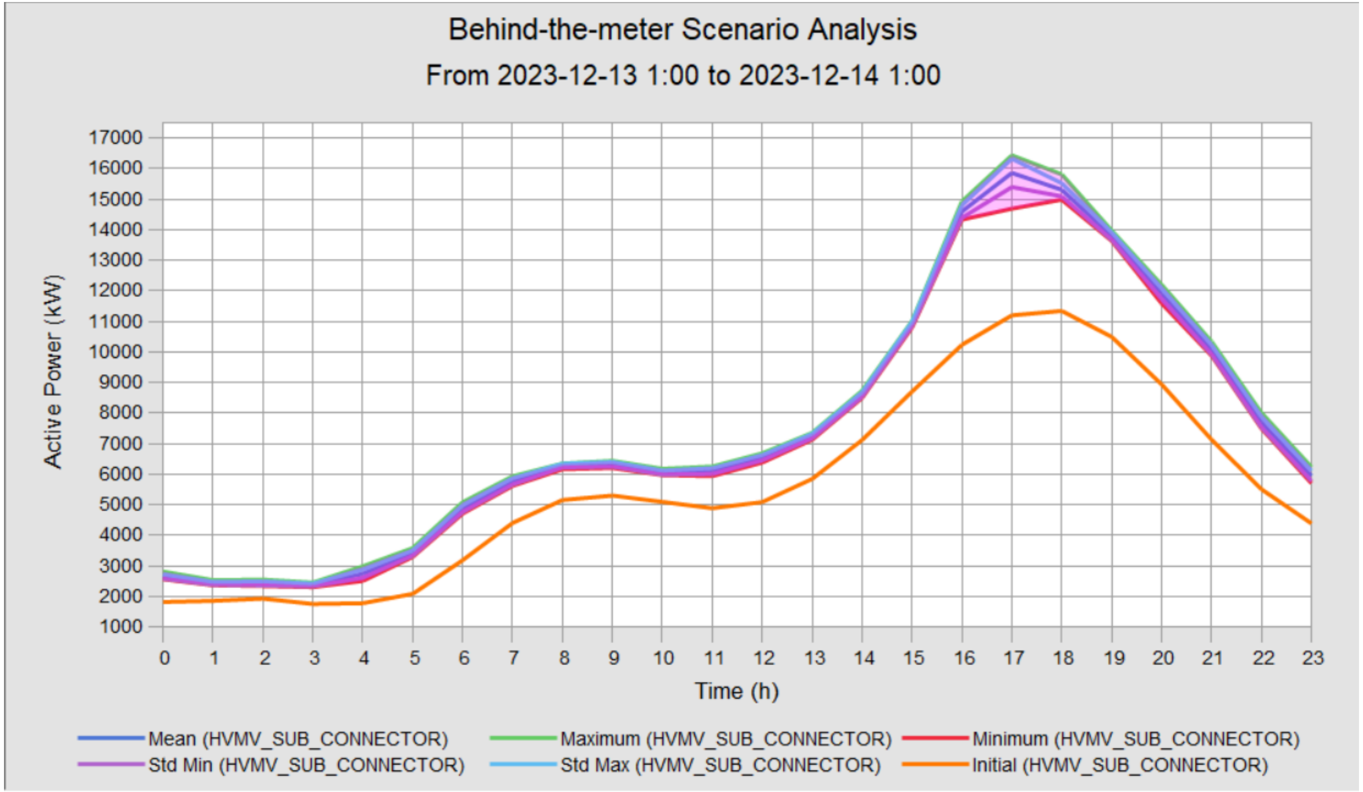
Behind-the-meter Scenario Analysis - Results



Behind-the-meter Scenario Analysis - Results

Reports

Search

	Device Number	Device Type	Phase	Sample with abnormal conditions (%)	Minimum overload duration (minutes)	Maximum overload duration (minutes)	Average overload duration (minutes)	Minimum overload (%)	Maximum overload (%)	Average overload (%)
1	T5302809C	Two-Winding Transformer	C	80.0 %	15	135	51.0	105.31523	177.36658	125.31149
2	LN5561442-2	Overhead Line Unbalanced	A	10.0 %	15	15	15.0	100.06482	100.06482	100.06482
3	LN5561442-2	Overhead Line Unbalanced	B	50.0 %	15	90	40.0	100.75131	109.08577	103.65746
4	T225571871B	Two-Winding Transformer	B	30.0 %	15	105	35.0	100.68532	127.53734	109.68272
5	T5356791C	Two-Winding Transformer	C	10.0 %	15	15	15.0	112.01455	112.01455	112.01455
6	T5294786C	Two-Winding Transformer	C	70.0 %	15	135	54.375	105.31639	169.34608	117.6481
7	T2224387019A	Two-Winding Transformer	A	30.0 %	15	75	37.5	103.31641	112.91943	107.74862
8	LN5513564-1	Overhead Line Unbalanced	A	100.0 %	30	1440	625.22727	100.5009	139.50042	119.56211
9	LN5513564-1	Overhead Line Unbalanced	B	100.0 %	15	1125	270.35714	100.17914	144.24841	111.92486
10	LN5513564-1	Overhead Line Unbalanced	C	100.0 %	15	465	277.5	100.19309	126.03111	114.45935
11	T5138412C	Two-Winding Transformer	C	20.0 %	75	90	82.5	105.31482	105.31553	105.31517
12	T5293655B	Two-Winding Transformer	B	40.0 %	15	60	30.0	106.82686	116.4363	111.63592
13	T5260573C	Two-Winding Transformer	C	40.0 %	15	90	39.375	105.31494	113.31063	108.31325
14	T28150189A	Two-Winding Transformer	A	30.0 %	15	75	32.5	102.02309	144.32394	119.58016
15	LN5860423-4	Overhead Line Unbalanced	A	100.0 %	15	690	145.29412	100.13332	125.83133	108.32201
16	LN5860423-4	Overhead Line Unbalanced	B	100.0 %	15	285	134.16667	100.16948	125.1499	108.63033
17	T5138371C	Two-Winding Transformer	C	30.0 %	15	165	80.0	105.3153	153.31456	121.31493
18	T5339019A	Two-Winding Transformer	A	70.0 %	15	105	42.0	100.01295	148.26259	113.80592
19	T226193170A	Two-Winding Transformer	A	40.0 %	15	45	22.5	100.10865	112.96812	107.59919
20	T225918936C	Two-Winding Transformer	C	50.0 %	15	90	48.75	105.31898	129.31049	109.3211
21	T28120786A	Two-Winding Transformer	A	10.0 %	15	30	22.5	112.96976	119.16794	116.06885
22	T5356063C	Two-Winding Transformer	C	50.0 %	15	75	45.0	105.31544	201.44714	129.64279
23	T5302733B	Two-Winding Transformer	B	10.0 %	30	30	30.0	100.61479	100.61479	100.61479
24	T226195333C	Two-Winding Transformer	C	50.0 %	15	210	88.63636	113.27115	185.25929	128.5314
25	T5337672B	Two-Winding Transformer	B	80.0 %	15	330	78.125	101.13972	211.24587	123.08196
26	T21393486C	Two-Winding Transformer	C	80.0 %	15	105	49.41176	105.31673	161.34398	118.9678
27	T5138755B	Two-Winding Transformer	B	90.0 %	15	135	53.14286	111.44531	219.62278	131.56501
28	T5355591B	Two-Winding Transformer	B	10.0 %	15	15	15.0	116.44742	116.44742	116.44742
29	T5338995B	Two-Winding Transformer	B	90.0 %	15	345	74.14286	103.12011	207.58332	130.1843
30	T5138264B	Two-Winding Transformer	B	30.0 %	30	60	50.0	106.88495	126.20964	113.33629
31	T5338972B	Two-Winding Transformer	B	30.0 %	15	60	35.0	106.83618	116.49109	110.69571
32	T5337713C	Two-Winding Transformer	C	40.0 %	15	90	36.42857	105.31507	113.30249	106.45745
33	T5293422C	Two-Winding Transformer	C	20.0 %	30	120	60.0	105.31506	153.31372	123.97717
34	LN6380817-1	Overhead Line Unbalanced	A	100.0 %	15	1230	362.91667	100.30147	138.41435	114.11678
35	LN6380817-1	Overhead Line Unbalanced	B	100.0 %	15	435	231.17647	100.17581	138.07702	116.31962
36	T5251857C	Two-Winding Transformer	C	90.0 %	15	195	51.75	105.31678	233.60735	124.52155
37	T5293521B	Two-Winding Transformer	B	100.0 %	15	240	74.02174	100.76157	400.63498	155.43984
38	T21396959A	Two-Winding Transformer	A	10.0 %	90	90	90.0	141.90704	141.90704	141.90704

BTM Scenario Overloading Summary | BTM Scenario Under Voltage Nodes Summary | Breaker - HVMV_SUB_CONNECTOR | BTM Scenario Over Voltage Customers Summary | BTM Scenario Over Voltage Nodes Summary | BTM Scenario Under Voltage Customers Summary

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