peco℠
AN EXELON COMPANY

April 2023

Impact of Recent Changes in Smart Grid / Metering Technologies on Reliability

Marc Bourrie
Manager, Smart Grid Distribution Automation

Exelon at a Glance

ABOUT EXELON

ATLANTIC CITY ELECTRIC, BGE, COMED, DELMARVA POWER DEL. AND PEPCO ACHIEVED BEST-EVER PERFORMANCE FOR RELIABILITY

8.9 MILLION ELECTRIC UTILITY CUSTOMERS

1.3 MILLION NATURAL GAS UTILITY CUSTOMERS

2 MILLION COMPETITIVE RETAIL CUSTOMERS

MORE THAN **1.7 MILLION** REMOTE OPERATIONS PERFORMED SINCE THE INSTALLATION OF SMART METERS

KEPT SERVICE ON FOR CUSTOMERS **99.988%** **OF THE TIME** WHICH RANKED IN THE TOP 25 PERCENT IN THE INDUSTRY NATIONWIDE

$33.5 BILLION IN OPERATING REVENUE

$116.7 BILLION IN ASSETS

$5.3 BILLION INVESTED IN UTILITIES IN 2017

34,621 EMPLOYEES

532 MW SOLAR GENERATION CAPACITY

961 MW WIND GENERATION CAPACITY IN 11 STATES

OUR UTILITIES WERE NATIONALLY RECOGNIZED FOR OUTSTANDING CUSTOMER SATISFACTION AND MOST TRUSTED BRANDS

PECO RECOGNIZED AS ONE OF THE TOP 10 UTILITIES FOR ECONOMIC DEVELOPMENT BY SITE SELECTION MAGAZINE

35,168 MW OWNED GENERATING CAPACITY

EXELON'S NUCLEAR FLEET PRODUCED A RECORD **157 MILLION MW HOURS**

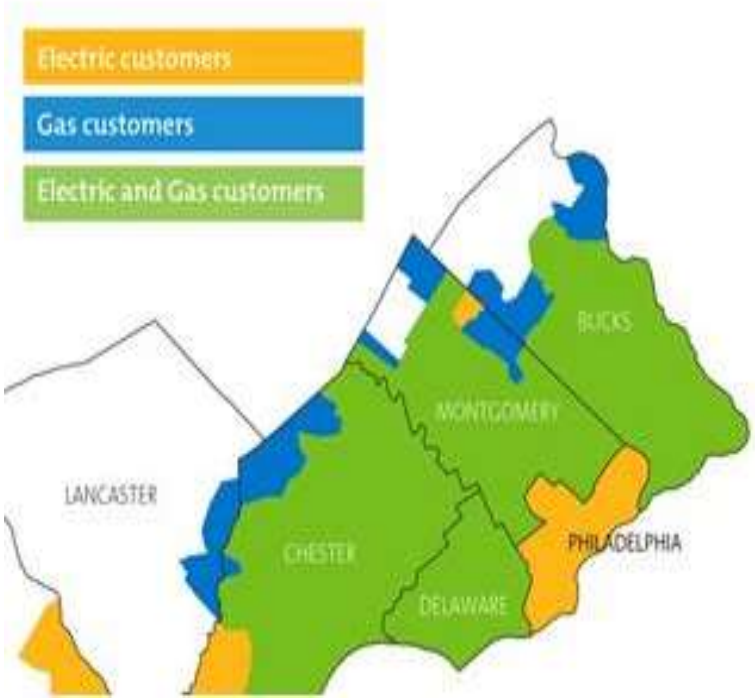
ONLY UTILITY ON THE FORTUNE 100 LIST

DOW JONES SUSTAINABILITY NORTH AMERICA INDEX

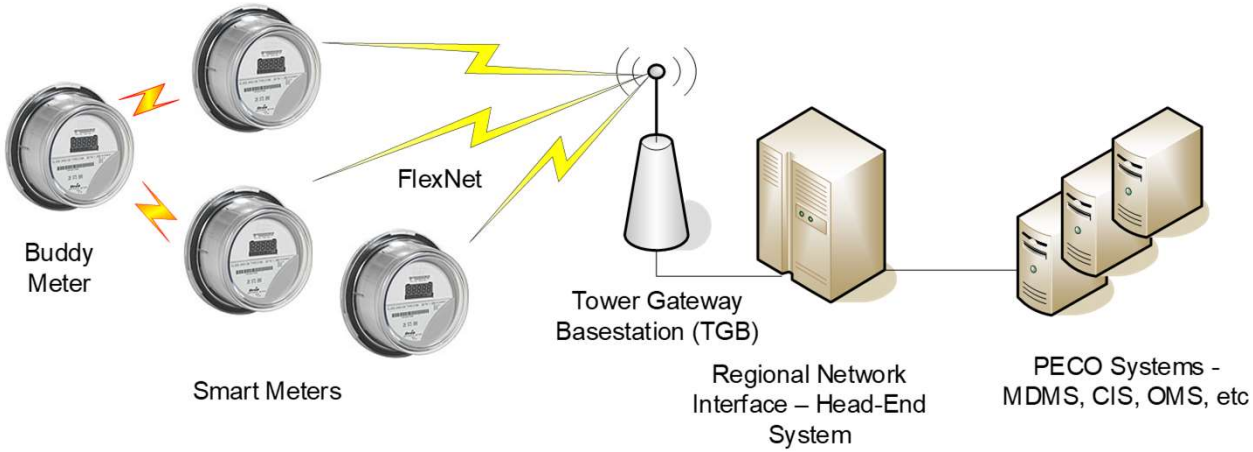
BEST EVER PERFORMANCE IN 2017 FOR CUSTOMER SATISFACTION AND CALL CENTER SATISFACTION

PECO – About Us

- The Largest Electric and Natural Gas Utility in Pennsylvania
  - More than 1.6M electric customers, 8,983 megawatt peak load
  - More than 530K natural gas customers
- Serving the greater Philadelphia area for more than 100 years
- 2,100 square miles (5,400 km2) service territory – 6 Counties
- 449 Primary and Unit Substations
- 2,242 Distribution Circuits covering 21,362 miles (34,378 km)
  - 4, 13, and 34 kV Distribution Lines



PECO's AMI System



- Sensus' FlexNet System is a point-to-point solution that leverages three key elements: Endpoints (meters), Tower Gateway Base station, and Regional Network Interface (RNI)
  - Meters are designed to directly communicate directly to the TGB's
  - The TGB Network is designed so that each meter can "see" between 3 and 7 TGB's
  - When a meter cannot directly reach a TGB, a buddy mode can be used to use near-by meters to relay the data back to a TGB
- FlexNet uses 2-watt transmitters on Federally licensed exclusive-use frequencies

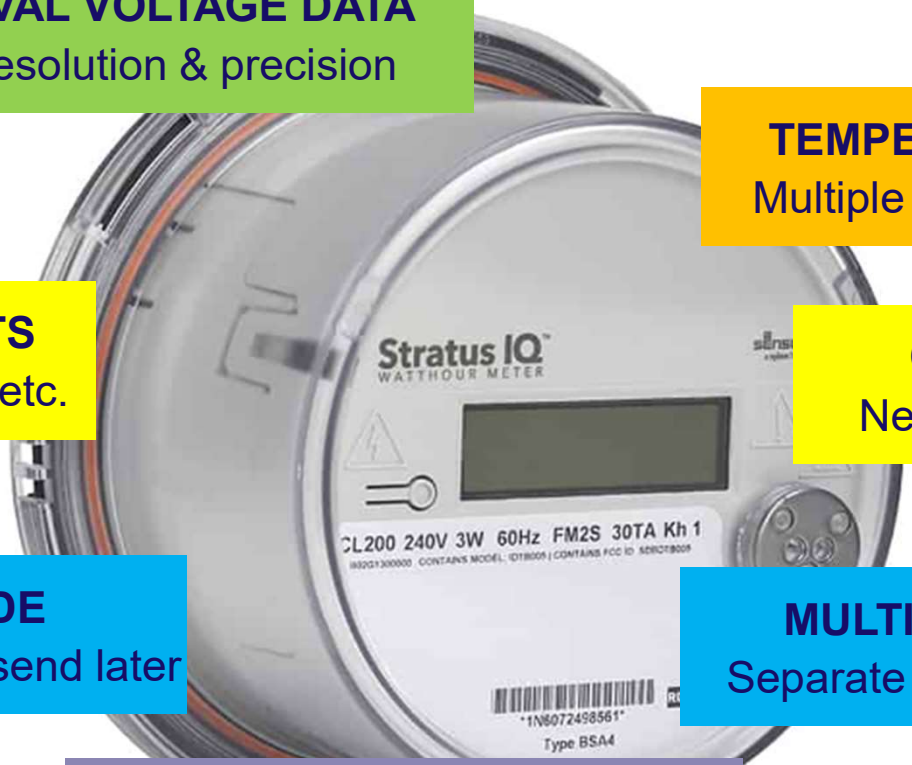
AMI Smart Meter Capabilities

INTERVAL VOLTAGE DATA
High resolution & precision

TEMPERATURE SENSING
Multiple sensors & thresholds

POWER QUALITY ALERTS
Voltage, Current, Brownout, etc.

OPERATING ALERTS
Neutral, Arcing, Tilt & others



RECORDER MODE
Metrology data capture, send later

MULTIPLE DATA SETS
Separate channels & intervals

DYNAMIC CONFIGURATION
Managed + deployed over the air

Voltage Importance & Measurement

A primary benefit of Smart Meters derives from their ability to monitor voltage at every delivery point, providing enhanced situational awareness & enabling myriad programs such as Power Quality

Why is Voltage important?

- Tariff requirement to maintain +/– 5% of nominal Voltage
- Direct and/or inferential indicator for power quality issues, DER, electrification, grid stability & other domains of concern

How is Voltage measured?

- Instantaneous = sampled at the time of data transmission
- RMS = averaged over time & usually at regular intervals
- **Precision & Resolution are important to maximize**

Voltage Measurement Design

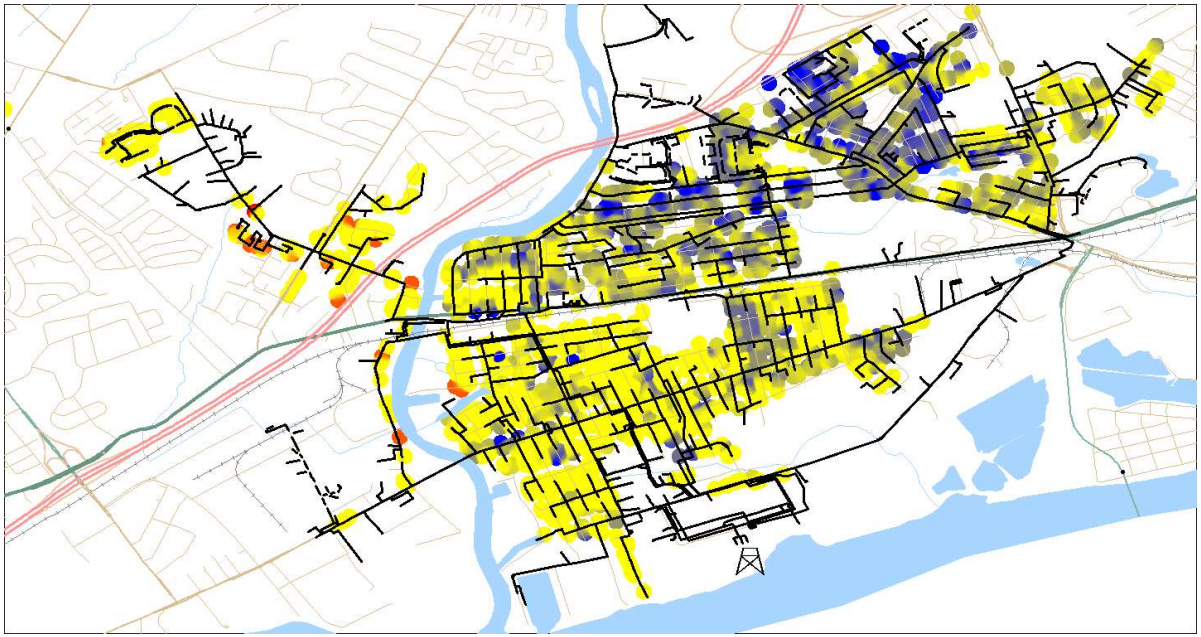
- AMI systems have many data delivery mechanisms
  - On-Demand Requests and Polling mechanisms
  - Automatic Alarms and Alert Messages
  - Regular meter reading transmissions, voltage may be included with the billing information
  - Specialty routines for delivering data on unique intervals
- Data format options
  - Resolution & Format - NNN.NN
  - Precision - +/- 0.02%
- Voltage is non–revenue data, available in head end system user interface & communicated in batches to downstream systems
- Voltage data consumed by Meter Data Repository, Data Lake, Analytics & potentially other systems in the future

Representative Use Cases for Voltage Data

- **Feeder Voltage Profiles** — Identifying high load/low voltage conditions at ends of a feeder & similar opportunities
- **Voltage Optimization** — Enabling instrumentation & data collection for these programs
- **Fault Prediction** — Voltage investigations from customer complaints & high/low voltage alarms
- **Generation Avoidance** — Construction scenarios that may include local outages & limited supply

Feeder Voltage Profiles

Distribution Circuits are designed to account for system losses to ensure that all customers on a circuit have acceptable voltage.



While the voltage profile is within the Tariff guidelines,
voltages range from red/orange = >240v to blue/gray = < 240v

Volt/VAR Optimization & Conservation Voltage Reduction

- Volt/VAR and Conservation Voltage Reduction programs are designed to help managing system voltage and introduce new means of energy efficiency programs
- Many such systems use voltage readings from existing SCADA endpoints as input into the analysis engine
- Smart Meters enable the voltage at each customer to be monitored to ensure the tariff requirements are met

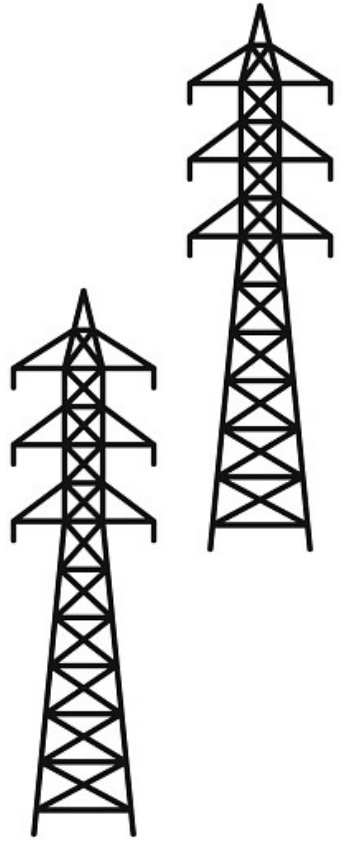
Fault Prediction

- Low voltage & flickering lights calls are often the first sign of trouble, especially on urban underground networks
- AMI Meters are able to actively monitor and alarm on adverse conditions, often before customers report trouble
  - High/Low Voltage Alarms
  - Momentary Outage Counters
- When such conditions are observed, crews can be quickly dispatched and addressed before significant damage is done. In many cases outages can be avoided
- Common events include:
  - Equipment Failure – Insulation breakdown
  - Vegetation ingrowth
  - Undersized equipment

Generation Avoidance

SCENARIO — Install a second transmission feed to connect two substations to increase capacity BM0

- A 25-day outage at both the source and destination subs was required with the temporary reconfiguration of over 50 distribution circuits affecting ~33,000 customers
- Engineering studies predicted low-voltage conditions during peak periods with hot weather. These areas needed to be closely monitored to ensure that voltage is maintained within the established tariff limits
- Standby generation was strategically placed at points of concern
- The AMI system was used to monitor voltage in these areas
- The AMI meter data actively measured the customer voltage to avoid running the standby generation, thereby saving over $1M (USD) in fuel costs



Slide 12

BM0 Was the transmission line operating over rated capacity? i.e. why was voltage being monitored during this work?
Bourrie, Marc:(PECO), 2023-04-21T14:48:49.975

PGA0 0 No, this was a capacity addition project, hence the new parallel line. The need for voltage monitoring was due to the extended outages at the source & destination subs, the reconfiguration of the existing circuits into very long 34kv lines and the potential hot weather during the work.
Pritchard, Glenn A:(PECO), 2023-04-23T17:52:49.327

PGA0 1 By the engineering studies predicted low voltage at several locations. Stand-by generators were ordered for voltage support. The voltage monitoring led us to avoid starting up the generators, thereby saving huge fuel amounts/costs.
Pritchard, Glenn A:(PECO), 2023-04-23T17:54:32.130

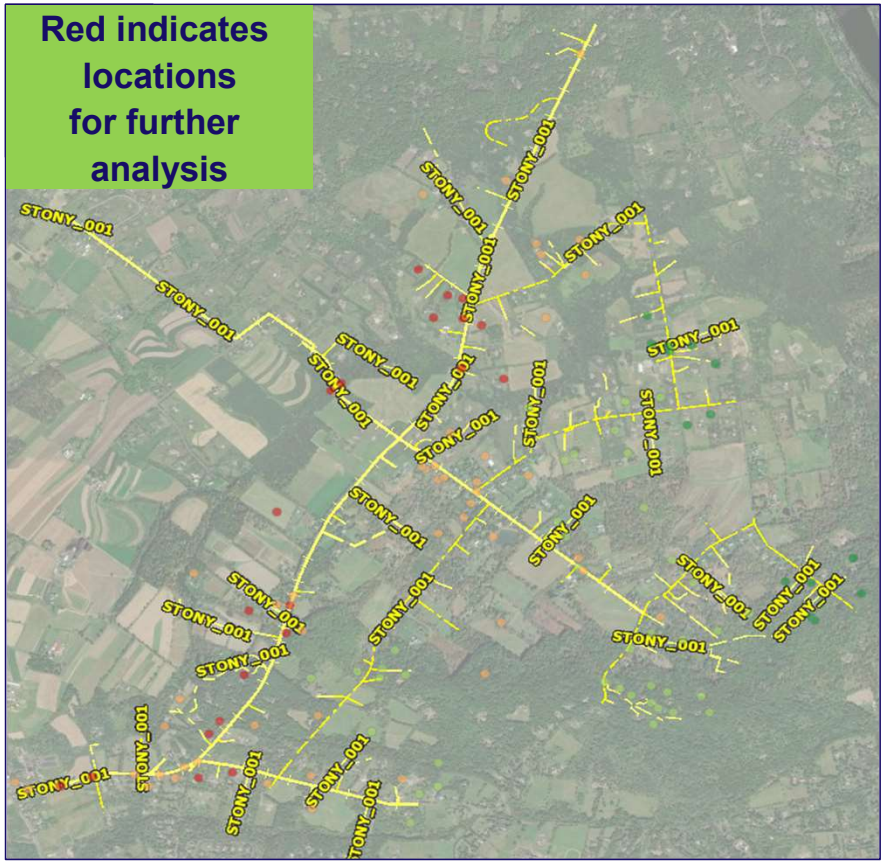
Other Potential Use Cases for Voltage Data

- **Solar Variance Impact** — Voltage dips due to output variations from clouds and other intermittent shadows

- **DER Planning** — Constraints on expanding DER due to voltage conditions requiring circuit modification or voltage management

Example PECO Voltage Measurement Deployment

- Targeted service points with known EV usage, solar generation, and grid segments with voltage alerts
- Provided direct monitoring at EV/solar service points as well as strategic circuit locations (e.g., beginning & ending)
- Supplemented with instantaneous voltage from other locations as comparison to interval voltage & acting as control groups



Initial Findings

- Identified grid locations for further monitoring & analysis
- Identified changes to IT integrations & systems to handle additional data
- Developing analytics to support trending analysis & correlate voltage data with sources such as Transformers, Distribution Automation devices
- Established foundation for additional rich data capture & utilization such as Temperature, Current & others

Conclusions

- Interval Voltage data can provide significant value to grid operations & CX
- AMI smart meters are viable grid instrumentation assets
- Meters can act as complements or replacements for traditional recorders
- Requires configuration management for different instrumentation scenarios

Thank You

Glenn A. Pritchard, PE
Sr Mgr, Advanced Grid Operations & Technology
PECO – SGSM Project
2301 Market St, S21
Philadelphia, PA 19101 USA
☎ (215) 841-6977
glen.pritchard@exeloncorp.com