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ROUNDTABLE:

- Tracking Failure Curves of Early AMI Deployments
- Considerations for AMI 2.0
- System Obsolescence Considerations

TESCO's Meter School
TESCOOL
July 21-24, 2024

- July 24, 2024
- 8:45 AM -- 10:15 AM
- Glenn Pritchard

ICE BREAKER

Introductions

- What company are you representing and what is your role?
- Describe your AMI deployment and when was it installed?

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PECO's AMI Deployment

AMI at PECO

- PECO is located in Southeastern Pennsylvania, serving Philadelphia and the surrounding counties
- PECO installed a Sensus FlexNet AMI platform from 2011-2016
- The system serves:
  - 1.725M electric meters
  - 550k gas meters
  - 4,200+ Distribution Automation devices (Reclosers, Capacitors, FCI's, etc)
- Initial goals of the AMI deployment included:
  - Meeting Pa. Act 129 of 2008 required meter functionality, including
    - Hourly interval data (15 minute or faster as needed)
    - Remote disconnect & connect
    - Outage Alarming
  - Meeting and exceeding performance levels of the existing Ladis+Gyr CellNet AMR system
  - Creating opportunities to expand and deliver enhanced functions that leverage the network and meters

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AMI BACKGROUND

Advanced Grid/Meter Background

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- ✓ PA Act 129 (Oct. 2008) required electric distribution companies to provide all customers with new metering technology within 15 years
- ✓ In October 2009, PECO was awarded a $200M U.S. DOE Smart Grid Investment Grant – one of 6 companies maximum grant under the program - to project and reduce costs to customers
- ✓ In 2012, PECO initiated the AMI Gas in benefits of moving from an AMR third p private meter read system, in conjuncti
- ✓ In August 2013, the PA PUC approved deployment and complete this project b customers
- ✓ PECO has completed the AMI electric programs.
  - 1.7 million AMI electric meter instal
  - 529K AMI Gas module installs

Advanced Meter Functionality

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Act 129 Summary Requirements List
Bi-directional data communications
Remote disconnection and reconnection
15-minute or shorter interval data to customers, EGSs, 3rd parties and RTOs on daily basis
Record minimum hourly reads and deliver at least once per day
On-board meter storage of meter compliant with national, non-proprietary standards
Open standards and protocols compliant with national, non-proprietary standards
Ability to upgrade minimum capabilities as technology advances and becomes economically feasible
Ability to monitor voltage at each meter and report data
Remote programming
Communicate outages and restorations
Ability to support net metering of customer-generators
Support automatic load control by EDC, customer and 3rd parties with customer consent
Support time-of-use and real-time pricing programs
Provide customer direct access to consumption and pricing information (hourly consumption information)

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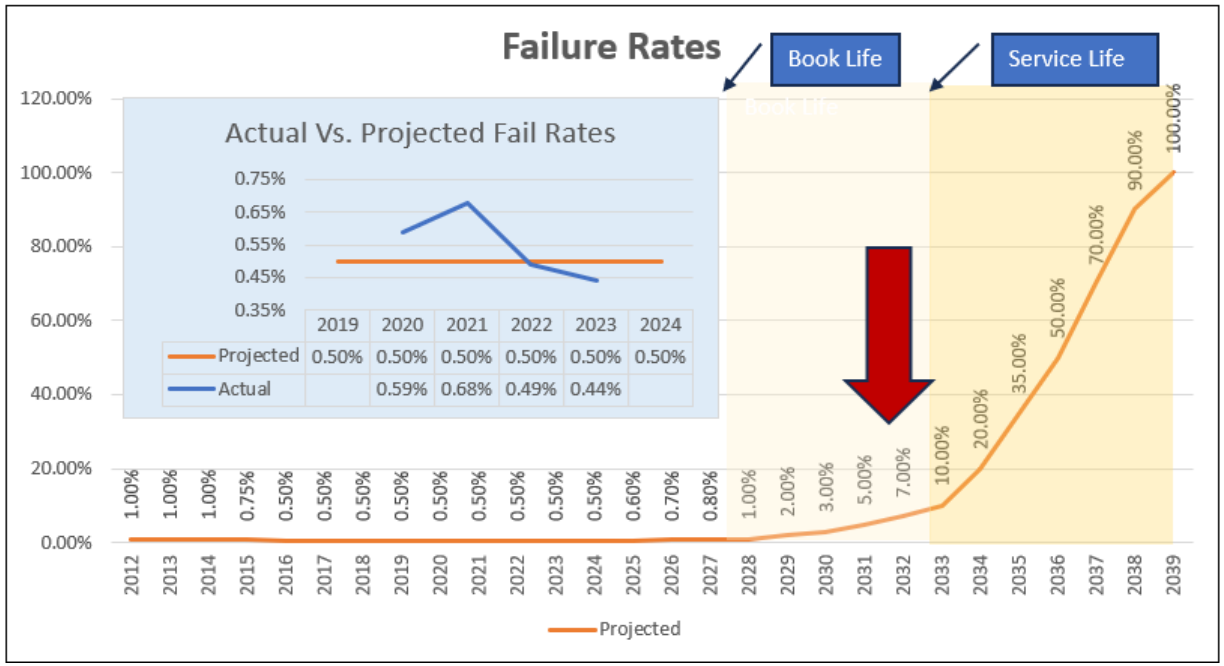
METER OBSOLESCENSE

Meter Lifecycle

- New Smart Meters have a finite useful life (15-20yrs)
- It is important to recognize that there will be a future need to replace both the meters and the networks
- Is a future full redeployment an option?
- What about a future annual replacement plan?

It pays to plan for this now, account for it in your Long-Range Financial Plans
It is also advisable to include your regulators and stakeholders

Projected Meter Failures



- Analysis of failure rates over the past 3 years confirms current failure rate curve projections
- Recommend beginning replacement in earnest by 2027 to stay ahead of the expected failure rates
- Meter failure rates will quickly increase by 2029, exceeding meter shop capacity to adequately respond without significant additional support
  - ~50% deployment needed by 2031 to stay ahead of failure curve

Impacts from the Pandemic

How did COVID change AMI?

- Material Supply Constraints
- Premature Material Obsolescence
- Technology Evolution
- New Customer Expectations

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AMI 2.0?

AMI 2.0

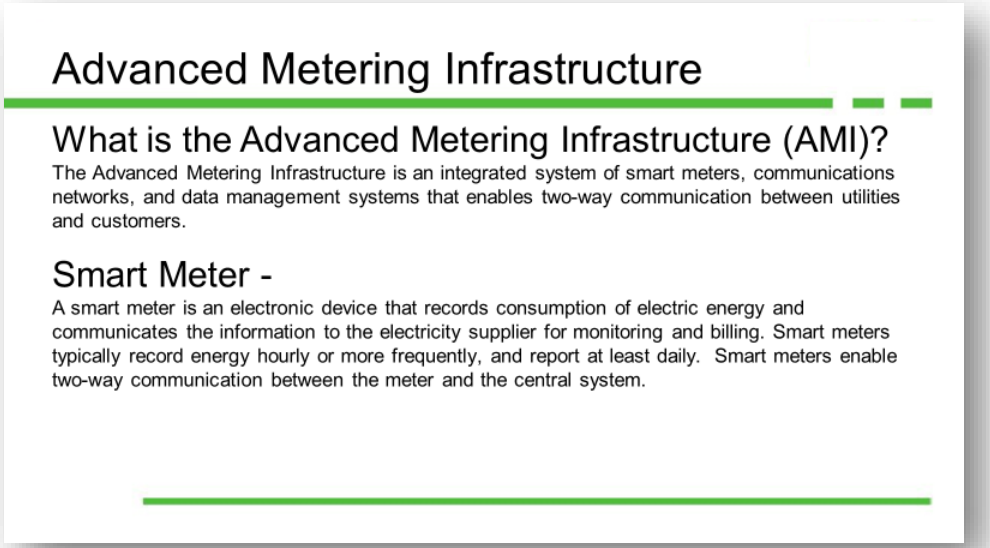
- What is AMI 2.0?
- What is changing?

AMI 2.0

AMI 2.0 is a system upgrade that results in increased network reliability and more reliable exchanges of data

The functions build upon AMI 1.0, which set the foundation for the future

"Many of the end user/customer advantages promised by AMI 1.0 did not materialize."



More Data & New Functions

- Increased Sample Rates
  - 60-, 15-, 5- & 1-minute samples are possible
- Multiple Recording Channels
  - Some vendors are claiming up to 32 independent channels are available
- Distributed Intelligence and Decision Making local to the meter

Question – *Has the network and head-end kept pace with the new meter capabilities?*

New Functions

- On-Board Decision Making
  - EV Management
  - Voltage Regulation
- Analytics
  - Non-intrusive load monitoring & Load Disaggregation
- New Communications Methods for FAN and HAN
  - WiFi Enabled Meters

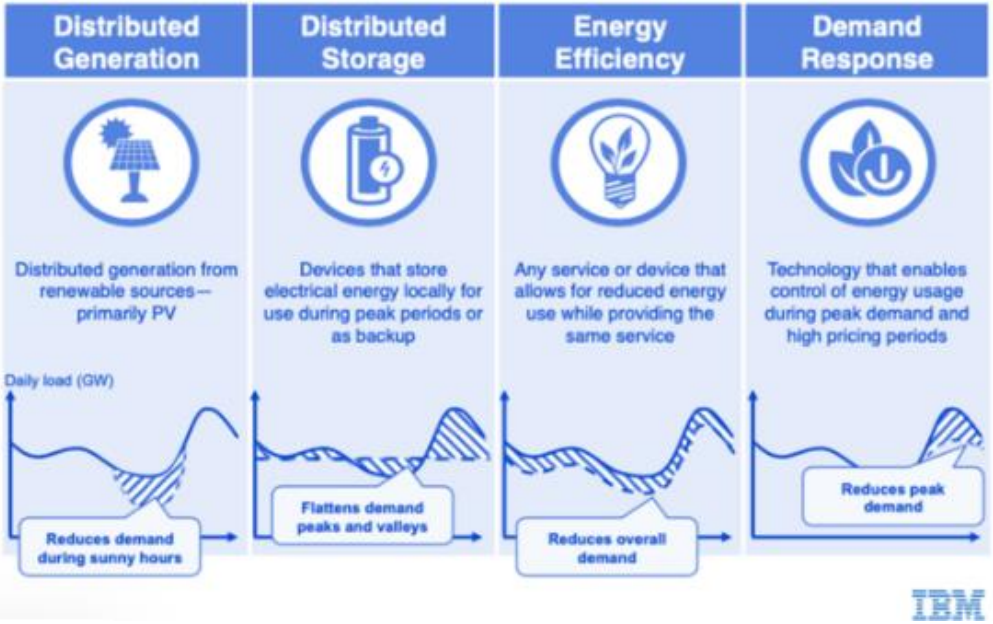
AMI 2.0 Use Cases

Grid optimization use cases

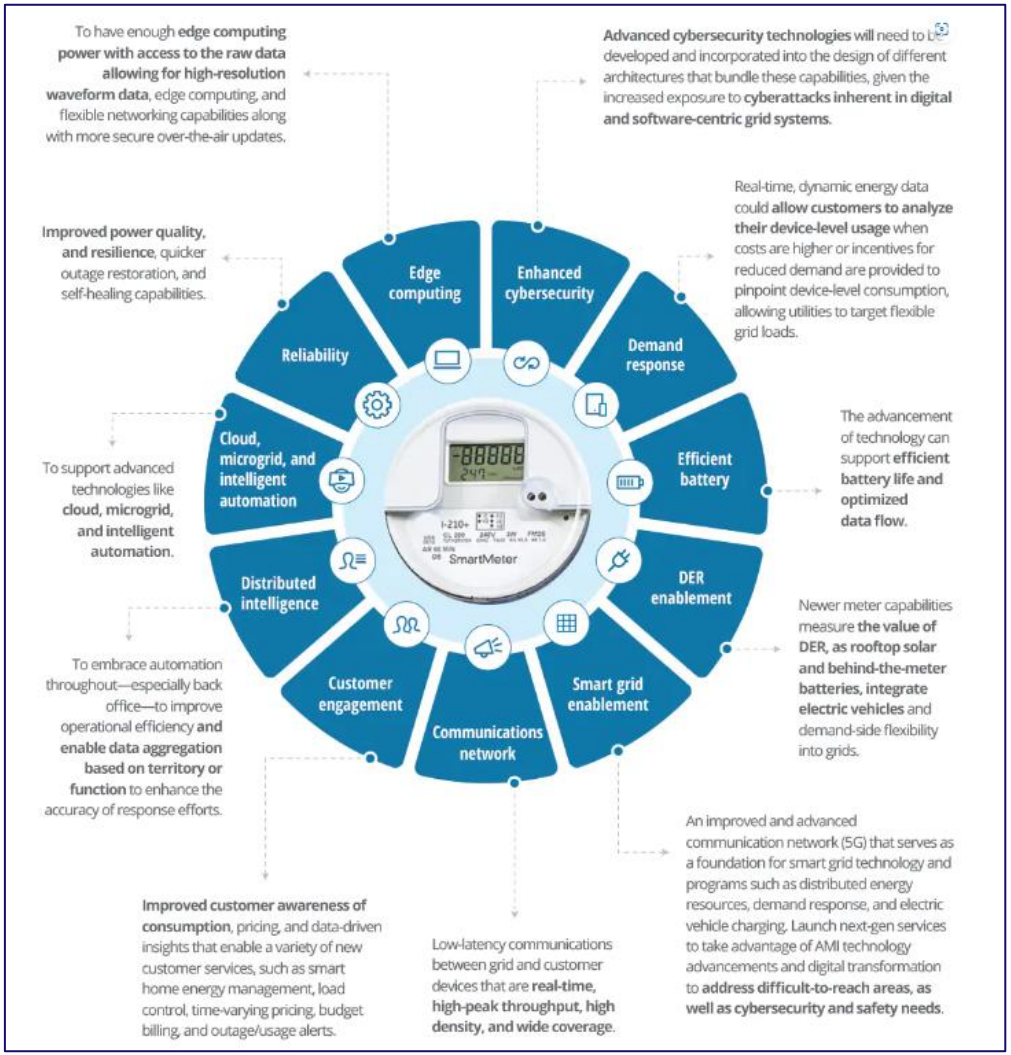
- Supply/Demand security on all voltage levels
- Manage Congestion management (dispatching)
- Keep Grid stable (frequency, voltage) despite renewable
- Optimize utilization of grid capacity

Distributed Energy Resources use cases

- Distributed generation
- Distributed storage
- Energy Efficiency
- Demand Response
- Load and Feed-in Management
- Microgrids & VPP (Virtual Power Plant) Mgmt.
- Ripple Control (heating, heat pumps)



AMI – Advanced Analytics Opportunities - Utility Analytics Institute



From Deloitte's AMI 2.0 Study

https://www2.deloitte.com/us/en/pages/energy-and-resources/articles/next-gen-advanced-metering-infrastructure.html

Distributed Intelligence

- Recently, several meter manufacturers have begun to develop Distributed Intelligent models and applications for their AMI meters
- This is seen as a new means to add future functions to the meters
- The concept mimics the “Apple iStore” concept where apps are available to be downloaded into meters as needed
- Apps are often targeted on Real-Time decision making and control solutions

DI is often associated with Mesh Network based systems where latency in communications may be a factor

Distributed Intelligence

Sample Use Cases:

- Hot Socket Monitoring & Action
- Smart Inverter Interface – Autonomous control
- Solar and Battery Support – Load Coordination
- Power Quality Analysis

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ALTERNATIVE PERSPECTIVES

Sensus FlexNet V2 – *"Crowded Highways Presentation"**

Summary

- PECO's Smart Grid has enabled many capabilities leading to +1 customer experiences. There is great potential to continue to expand and improve with some investment.
- Our network highways are crowded, and this will continue to increase due to more messages, more frequently, with more devices
- First generation AMI meters are limited in their capability to expand their functionality to meet evolving customer needs:
  - Next generation (NextGen) meters deliver these capabilities & functionality
- Flexnet V2 communications protocol provides the means to fully leverage these NextGen devices & their capabilities
- This evolution will require operational investment and capital
  - Configuration changes to transceivers, RF spectrum and the RNI
  - NextGen meters such as StratusIQ, SonixIQ (Gas), Aclara i210+c w/DT-105
- We cannot afford to be on the sidelines!

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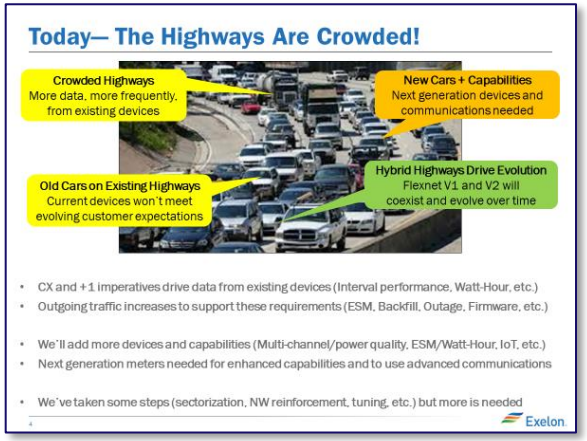

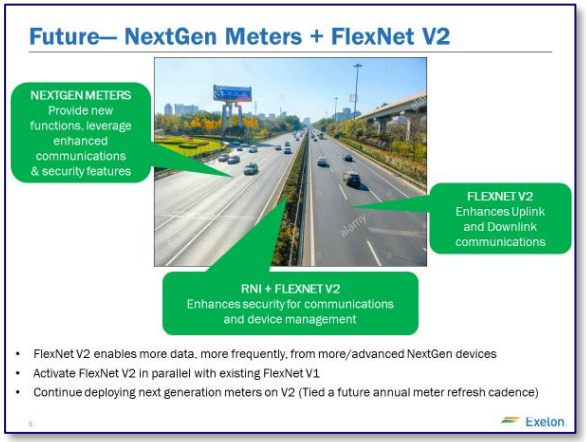

* - Full slides in Appendix

The FlexNet V2 Protocol enable more efficient use of the RF Channels, delivering higher speed, higher capacity and more secure communications

Sensus V2 Protocol

- What is V2?
  - The V2 protocol is a new method to communicate to our meters
  - It easily coexists with the legacy V1 protocol, using the same RF spectrum
  - V2 is built upon higher speed messages and more efficient data packets
- Why do we need it?
  - Performance Improvements
  - Improved Security
  - Enables new functionality on NextGeneration Electric and Gas Meters
- When is V2 available?
  - NOW, All eligible transceivers are configured to support V2 communications
- Do we have any devices on the V2 Protocol?
  - YES, more than 25,000 meters using the V2 Protocol today

What is a *NextGen* Meter?

Aclara i210+c/DT-105

Sensus Stratus IQ/DT-96

Meters Continue to Evolve

- PECO's initial AMI meters were installed in 2012-2016
- Sensus has introduced new functions over the years
  - Enhanced Supervisory Messaging (ESM)
  - Snapshot Data
  - Firmware Upgrades/Enhancements
- Changes driven by both the comms module and the meter

Communications

- V2 – More efficient utilization of infrastructure leading to higher capacity and speed
- Security / Encryption – mandatory, enhanced security measures
- New Network hardware – improved software and contemporary hardware

Functionality

- Multiple Independent Channels – beyond usage, including voltage, power quality, etc.
- Firmware improvements / speed to upgrade
- More flexible remote configuration

A NextGen Meter is the newest type meter available for use at PECO. A key characteristic is its ability to support the V2 communications and its enhanced security measures.

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NEXT GEN AMI

1. New Meter Functions
   - –V2 Protocol
   - –More Data / Multiple Channels
   - –New Functions
     - –Distributed Intelligence / Grid Edge
     - –Loss of Neutral Detection
     - –Enhanced Temperature Sensing and Action
   - –Ultrasonic Gas Metering
     - –Remote Disconnect
     - –Pressure Sensing
2. Distributed Energy Resources – Solar, Batteries, etc
3. Electric Vehicles
   - –Load Disaggregation
   - –Charging Management

Next Generation Meters— The Future Needs New Cars

NextGen ELECTRIC (Sensus StratusIQ, Aclara i210+c DT-105, etc.)

- **Multiple energies**, demands, load profiles on multiple channels
- **Power Quality / Four quadrant metering**
- Tamper detection
- Persistent real-time clock maintains time for 24 hours following outage
- C&I features in residential meter
- **Software defined metrology** for future flexibility

Functionality	Customer Pain	Outcome
Power Quality with Alarms Measures beyond Usage	Data Access – Additional Insight to Data Power Quality – Effects	More customer-oriented information from next generation meters Enable personalized customer experiences tailored to needs Empower self-service and control over usage, energy costs, environmental Enable participation in energy efficiency and demand response
Software-defined metrology Local clock Residential Meter + C&I Power	Resilient to grid conditions Functionality can be configured quickly, remotely	Flexible, expandable platform reduces meter changes, interruption
Increased security	Protect customers' usage choices, cost info, privacy	Tamper detection, privacy

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Next Generation Meters— The Future Needs New Cars

NextGen GAS (Sensus SonixIQ, etc.)

- Solid-state design, **compact footprint**
- Dual-class metrology: 250 CFH or 425 CFH
- **Pressure Monitoring and Remote Disconnect**
- 90-day hourly data logs, Built-in theft and tamper detection
- Available pulse output
- Continuous health checks through safety alerts and alarms

Functionality	Customer Pain	Outcome
Increased memory - 90 day, hourly data logs	Provides more granular usage data for Billing, customer control, energy efficiency and other initiatives	More customer-oriented information from next generation meters Enable personalized customer experiences tailored to needs Empower self-service and control over usage, energy costs Enable participation in energy efficiency and demand response
Solid-state design; Compact footprint; Pulse output; Dual-class metrology; 20 yr Battery life	Resilient to grid conditions Functionality can be configured quickly, remotely	Flexible, expandable platform reduces meter changes, interruption
Built-in theft + tamper detection Health checks	Protect customers' usage choices, cost info, privacy	Tamper detection, privacy, safety

Advanced functionality is dependent on having V2 Network Functionality and RNI 4.8

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Sensus Stratus IQ+ – Residential

Features

- 6 energy and 6 demand registers
- kWh, kVAh, kVARh
- Bi-directional metering
- 8 channels load profile
  - 4 LP Data Sets (separate LP interval) = 32 Channels
- 7 TOU tiers, 8 seasons, CPP
- Outage and Restoration notifications
- Conservation Voltage Reduction
- Voltage and Temperature threshold alarms
- Industry leading sensors for high temperature monitoring and protection
- 4 Quadrant metering & separate phase metering
- Voltage, Current, and Demand Distortion measurements

Specifications

- UL 2735 and UL 61010-1
- C12.19 ANSI tables
- Exceeds industry standard accuracy - 0.2%

- Loss of Neutral
- Arc Detection
- Phase Detection
- Over the Air Configuration of metrology & radio
- AES 256-bit encryption
- Meter Tilt and Remote Auto-Disconnect
- Magnetic Tamper Attempt Alarm
- Scheduled Disconnect
- Extended Outage (8 Minutes)
  - Persistent Clock
- Harmonic Distortion (19th Harmonic)
- EV Charging Awareness

sensus
a xylem brand

CONCLUSION

- Meter systems continue to evolve and increase functionality
- NextGen Meters and AMI 2.0 are two similar manifestations of this evolution
- Many of the initial deployments are nearing their useful end of life, leading to significant decisions by the AMI Operators

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APPENDIX

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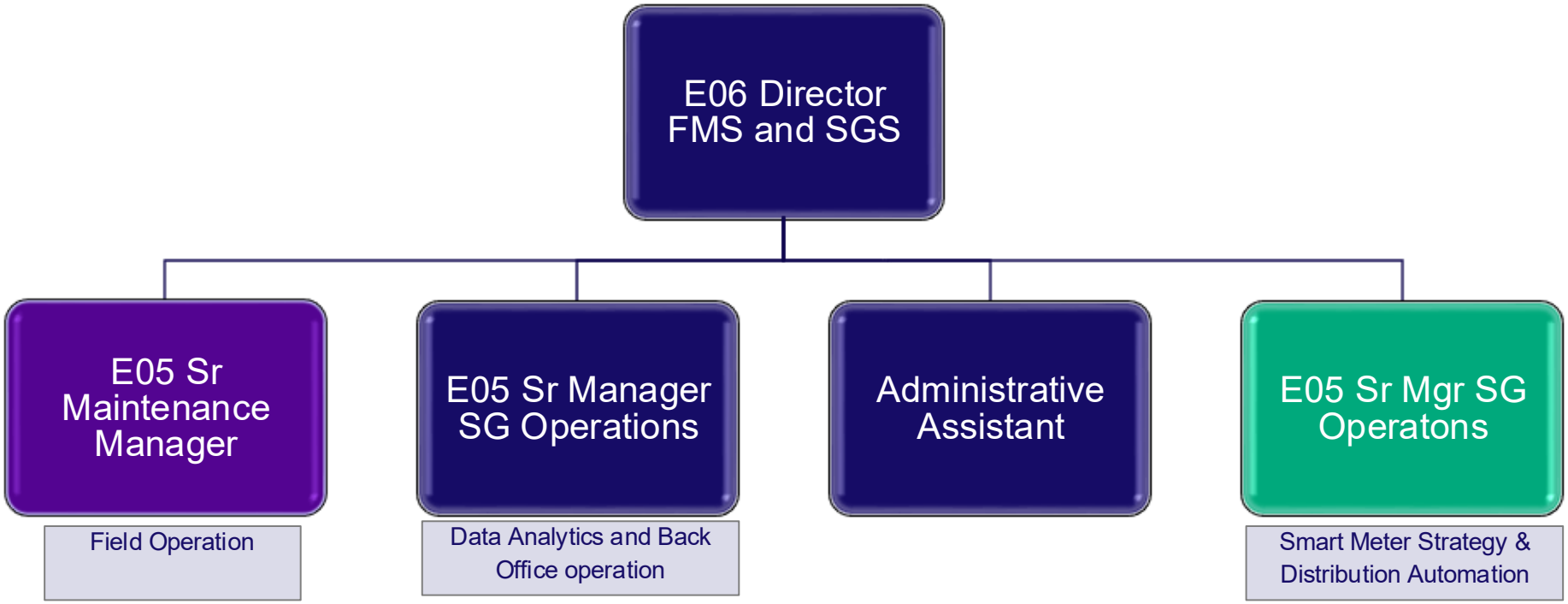
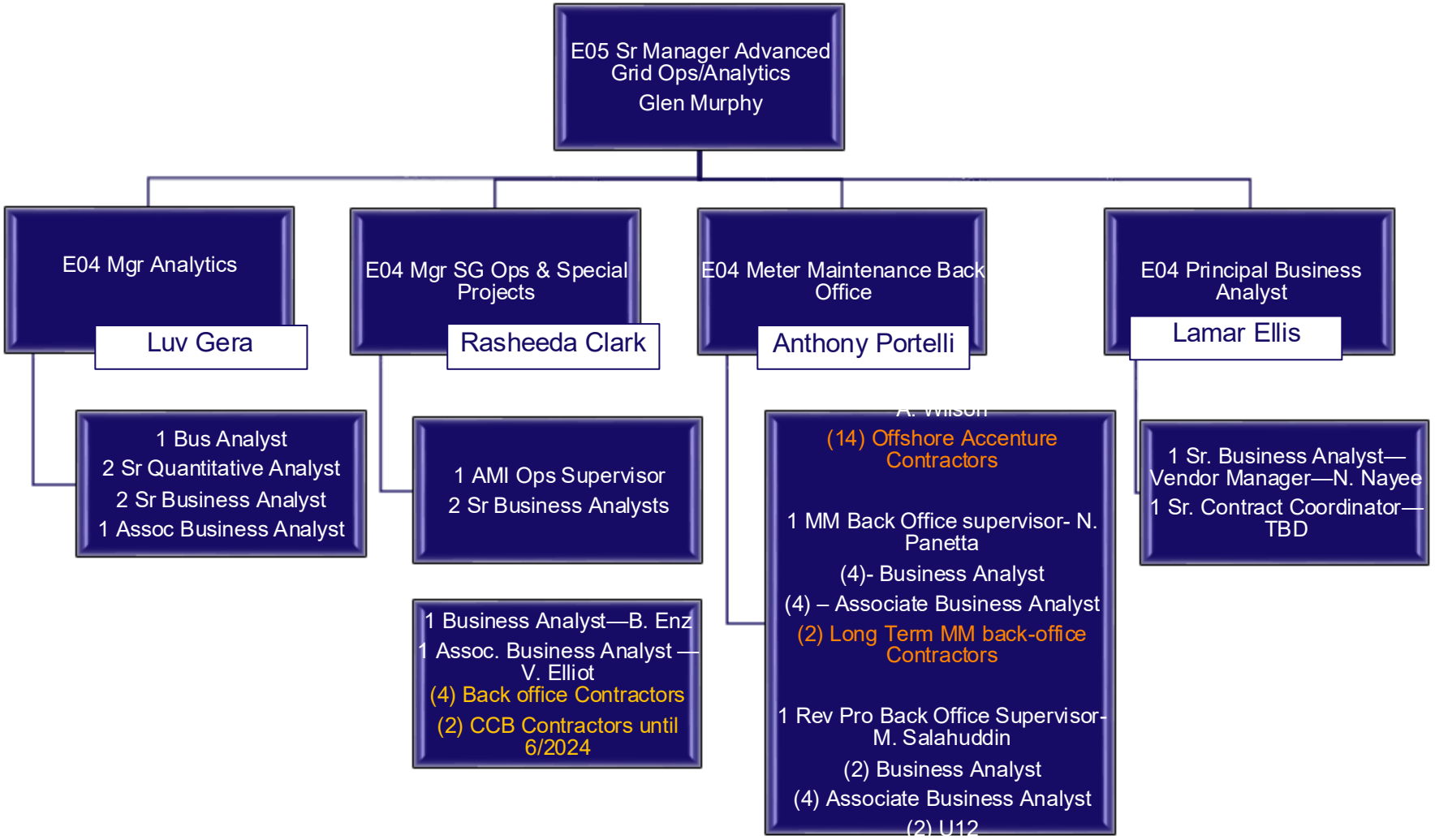
PECO's SGSM Team

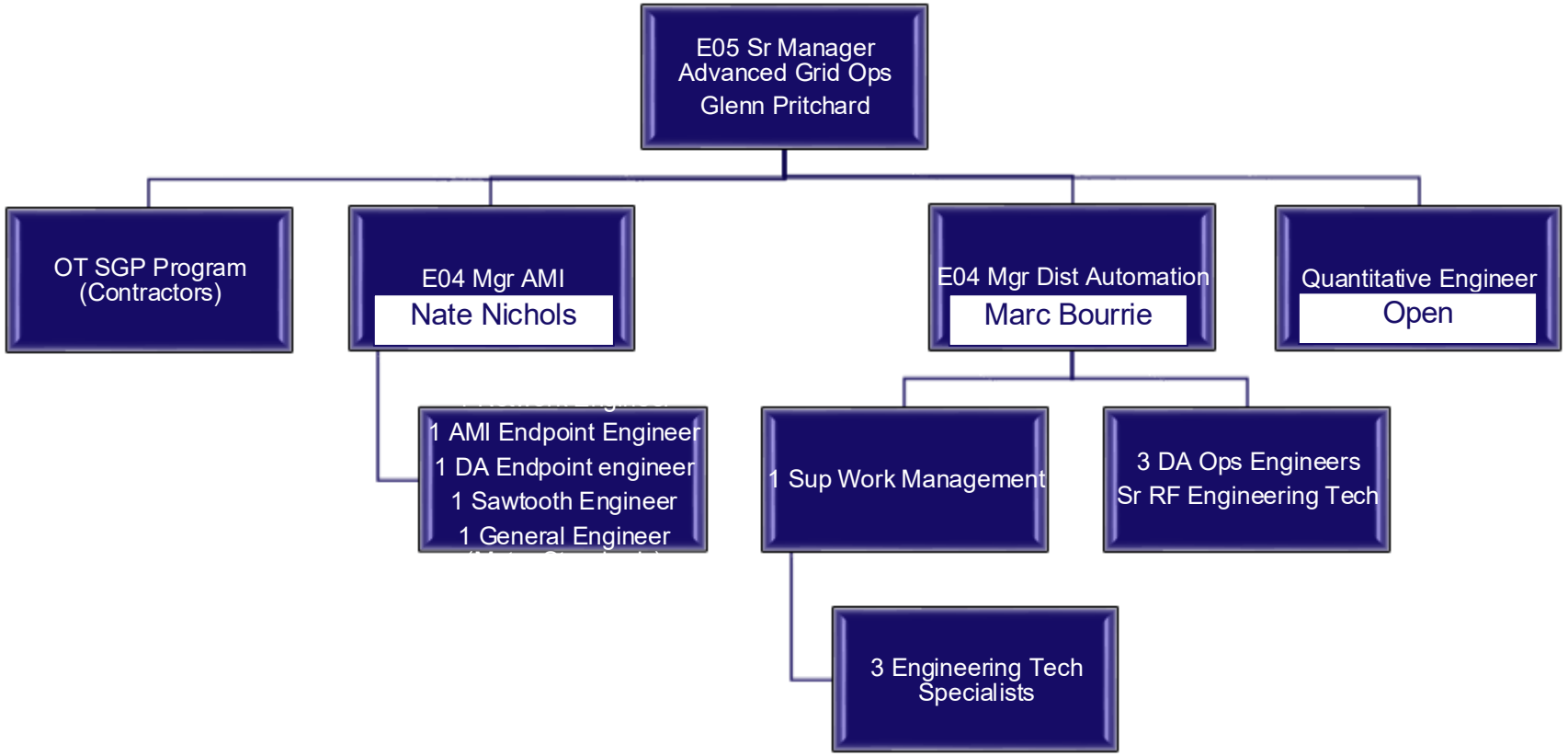
PECO F&MS and SGS



PECO F&MS and SGS – SG Ops



PECO F&MS and SGS – SG COE (Engineering)



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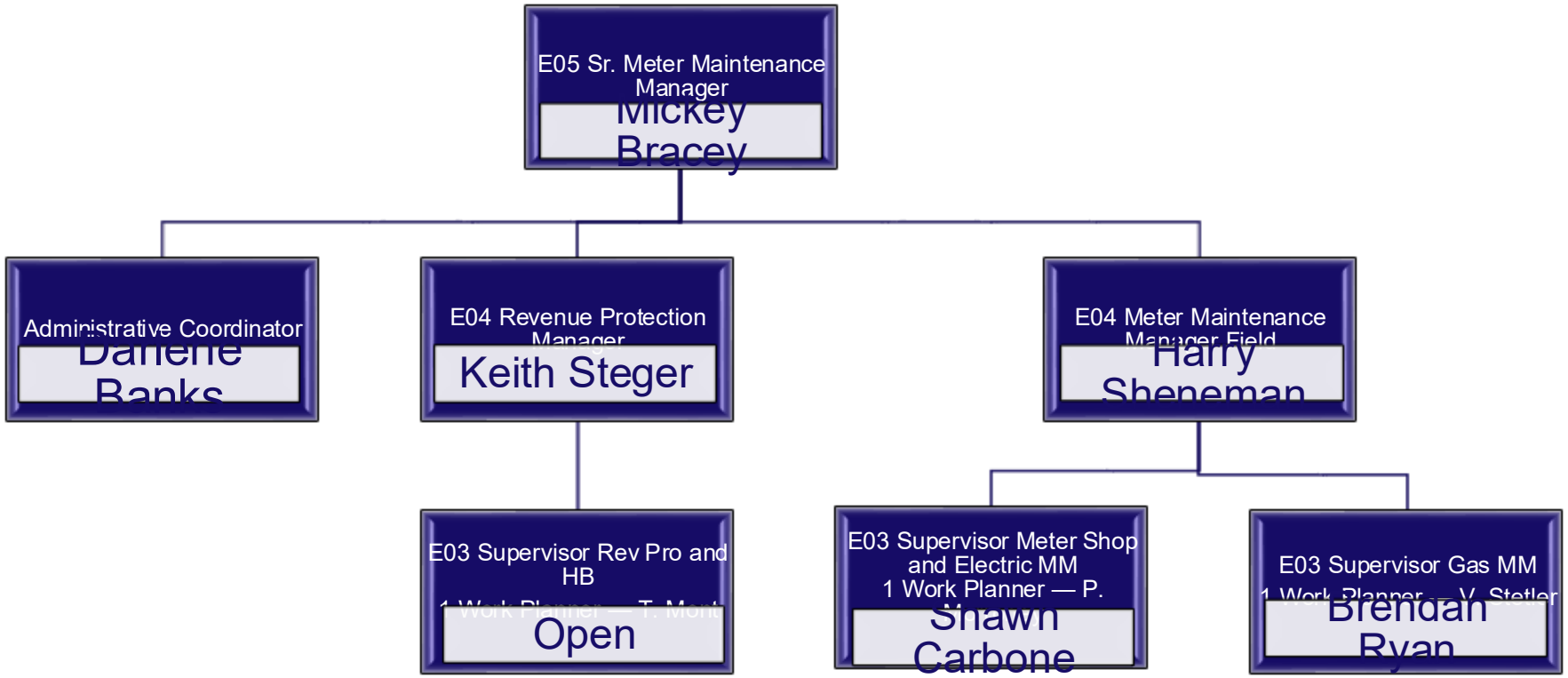
PECO F&MS and SGS – Meter Maint



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