ComEd PMU Installation Status

- 148 PMUs going to PJM
- Prior to build-out starting in 2017:
  - ARRA Pilot Project
    - 7 substations
    - 12 PMUs
  - Substation PDCs
    - SEL 3573
    - Moving to SEL 3555 RTAC
  - 61 substations
    - 2 PMUs per substation for first installation is typical
    - As many as 6
    - Switching data center to C37.118.2 because of the number of PMUs
- Mixture of methods:
  - Planned installations
  - Opportunistic installations as part of reinforcement projects
ComEd PMU Installations - Future

• Possibly 200 PMUs going to PJM by the end of 2022

• Almost all 345kV substations will have PMUs
  - Exceptions have insufficient communications or relays
  - Starting to fill in 138kV

• Retrofitting old pilot-project sites

• Station Types
  - All nuclear plants will have PMUs
  - Remaining coal and some gas
  - Starting to pick up wind farms

• LRP funding ends after 2022
  - Need to figure out what to do to clean up a few sites
REACTS - ComEd Fiber Build-out

- Communications availability limits where PMUs can be deployed
- Fiber is always preferred
- At least one transmission site is WiMax
- ComEd has initiated a 15-year program to install optical fiber across the system
  - Running fiber to substations where there is no fiber today
  - Adding additional circuits to substations that already have it
- We are hoping to leverage the fiber installations to install more PMUs
PMU DNA

- We are inserting PMU DNA into the company
- Transmission Reinforcement Projects
  - ComEd Transmission Planning uses a checklist when developing project diagrams for reinforcement projects
  - PMU installations are now on the checklist with standard notes
    - Relays associated with upgrades get turned into PMUs
    - If the substation needs a PDC, it gets one if the cost of the project allows for it
  - Learning: It is important to word the notes on the project diagrams correctly
    - Project managers have been installing cabinets and then walking away without establishing the network connections
- Remote ends
  - It is often necessary to take a line out of service when updating relay firmware or updating settings
  - We have so many substations upgraded now with PDC cabinets that we are having to take more care to make sure that we do both ends of each line
    - For example, if a substation is getting a PDC and two or more PMUs, then the remote ends of the lines also get PMUs if a PDC has been installed.
Usage

• Post-event Analysis
  • Verification of correct relay operation
    – Was there really a fault?
• Oscillation Analysis
  – Midwest 0.72 Hz oscillation originates within ComEd
• New EMS is capable of consuming PMU data
• Planned
  – Load modeling and support of DER integration
• Future LSE
• Control room implementation
• Situational awareness during loss of SCADA
• EPRI Supplemental Project
  • “Data-Driven Real-time State Estimator Using Machine Learning for Transmission Systems”
    • Basically, how do you make a state estimator when you don’t have complete coverage of the system?
      – What is the best way to combine SCADA and PMU data and get a functional linear state estimator
Data Center Design – Quick Summary

- Redundant data centers
- Substation PDCs send data to both data centers
- Redundancy for PDCs, historian, and application servers
Exelon Mid-Atlantic Utilities

- Exelon’s mid-Atlantic utilities
  - PECO (Philadelphia)
  - BGE (Baltimore)
  - Pepco
    - Delmarva
    - Atlantic City Electric
- All of Exelon’s mid-Atlantic PMUs are from the ARRA days
- It’s time to fix that
Mid-Atlantic PMU Development

- If you think it is fun getting one utility to buy in, try five

- Primary points of interest
  - **PJM’s new requirements** have been a big help to get things moving
  - Situational awareness during loss of SCADA
    - Ultimate plan is for an LSE

- Data center design in mid-Atlantic will be identical to ComEd’s

- Improvements due to lessons learned

- The mid-Atlantic utilities now share data and control centers for EMS and SCADA
  - Two data centers
  - PMU data from each utility will go to the two mid-Atlantic data centers
Mid-Atlantic Development – In Progress

• Working with IT to develop placeholders and funding estimates for data center implementation in the mid-Atlantic
  – Part of larger effort to identify future needs for Transmission Operations
  – Essentially identical to ComEd but will implement lessons learned

• Work needed for communications assessment in the mid-Atlantic
  – How do we get PMU data from substations to new control centers?
  – How do differing practices at the OpCos impact the implementation of PMUs in the substations
  – There will be some differences in how CIP requirements will be handled

• Working to identify mid-Atlantic SMEs

• Mid-Atlantic data-center installation in 2025 for full effort
  • Working on a “boot strap” installation in the meantime
**Additional Integration**

- Will start training mid-Atlantic SMEs on the applications installed at ComEd
- Expect to see more Exelon people at SMWG and NASPI meetings
  - Be nice to them!
- Data sharing between Midwest (ComEd) and mid-Atlantic utilities
  - This might be an application for STTP
- Integration with OSI Monarch EMS
  - Sending PMU data has been tested
    - Issues with interpretation of C37.118 standard – working on it
- We will be on the hook for control-room deployment
  - 202x’ish?
The End

Any Questions?