



PJM Interconnection Smart Grid Investment Grant Update

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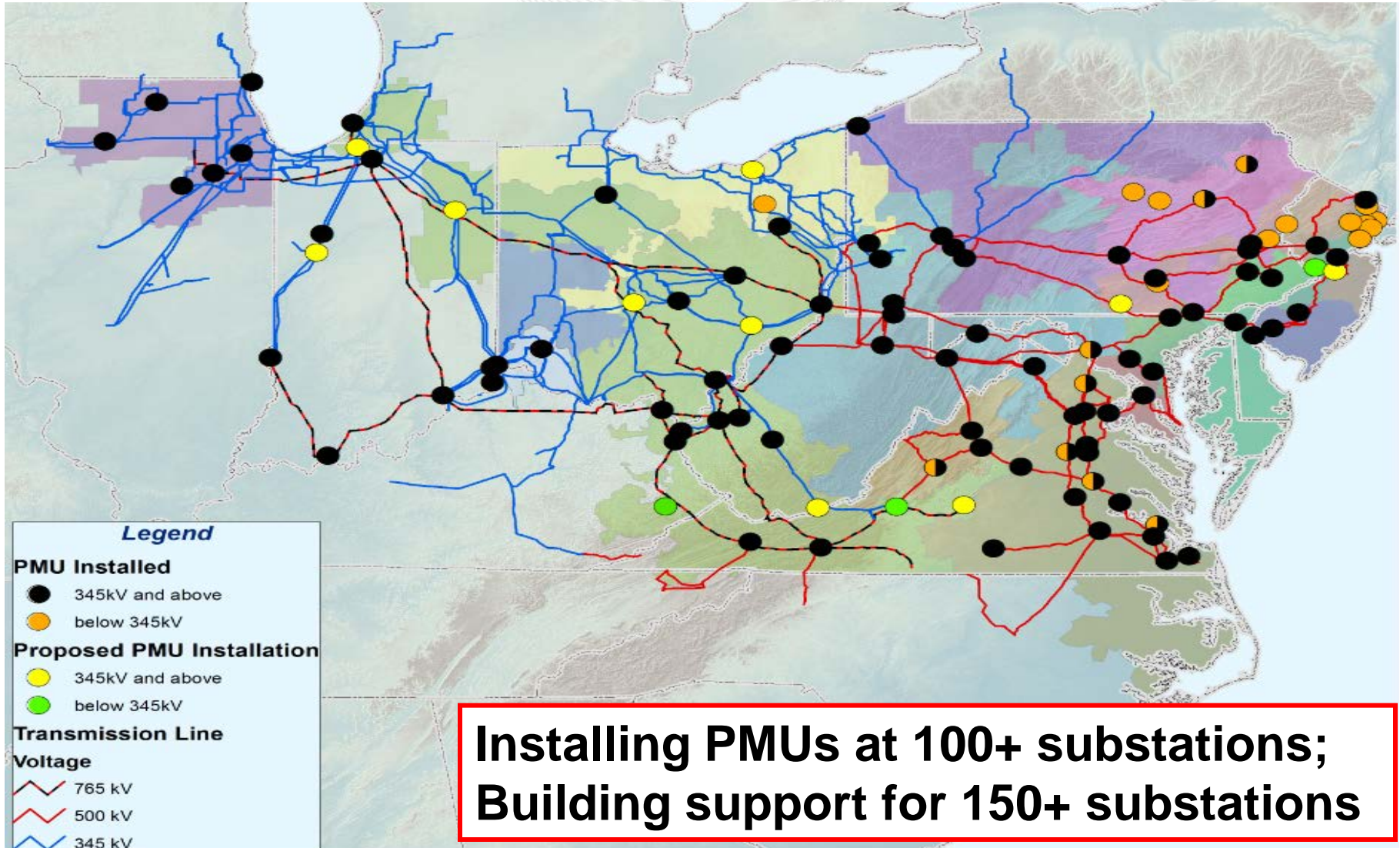


- **PJM Leads:**
 - Project Manager: Bill Walker (walkew@pjm.com)
 - SynchroPhasor Technical Lead: Mahendra Patel (patelm3@pjm.com)
 - Operations Management: Dave Souder (souder@pjm.com)
- **Vendor Partners:**
 - Electric Power Group (PDC and visualization software)
 - Quanta Technology (engineering/project management)
 - Virginia Tech University (PMU/PDC device testing)

- 12 Transmission Owners installing measurement devices at 81 substations
 - TO's selected their own vendors
- Transmission Elements Monitored
 - 64 SS > 345kv
 - 17 SS < 345kv
- Approx. 20% of regional footprint monitored
- Installing PMU's, Relays, DFRs, DDRs

Participating Transmission Owners

Transmission Owner	# of Substations with PMU Installations	# of Central PDCs
Allegheny Power	8	1 (0)
American Electric Power	15 (22)	1
Baltimore Gas & Electric	2	2
Commonwealth Edison	4 (6)	1
Duquesne Light	2	2
FirstEnergy Services	6	2
PECO Energy	3	1
PEPCO Holdings Inc.	4	2
PPL Electric Utilities	12	2
Public Service Electric & Gas	11	2
Orange & Rockland Electric	1	1
VA Electric & Power (Dominion)	11 (21)	2
NEW Duke Ohio	3	1



**Installing PMUs at 100+ substations;
Building support for 150+ substations**

BIG PICTURE

NASPI *North American
SynchroPhasor Initiative*

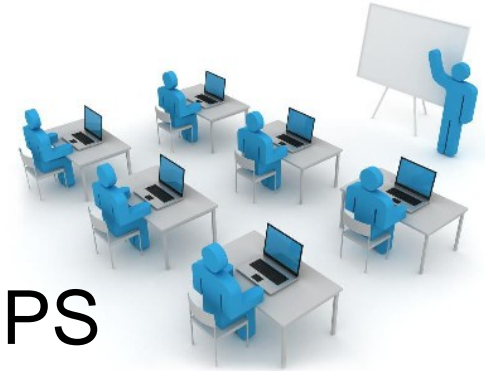
- Key Tasks:
 - Complete connections and configurations
 - Improve Data Quality and Availability
- Phasor Application Use:
 - Phase Angle display in Control Room
 - Feed Intelligent Event Processor (IEP)
- Measure of Success:
 - Data Validation and Event Analysis
 - Operations Integration
 - Data Exchange with neighboring RC's



- Database design
 - New ways to move and store large amounts of data
- Virginia Tech Testing
 - Provides insight into performance specs for multiple vendor product (PMU and PDC)

- TO Installation Schedule Changes
- Multiple vendors h/w and s/w in use
- Data Quality and Availability
- Coordination of all project stakeholders
 - TOs, Vendors, ISO/RTOs, DOE
- Ensuring the architecture is scalable
- Storage, Storage, Storage
- R&D approach vs. “touch it once” approach
- Data Exchange with other RTO/ISO’s

- Phased approach to Training
 - Trained on applications as introduced
- Information sessions delivered to OPS
 - High-level introduction to SynchroPhasors
- Remote view training to TO's
 - RTDMS functionality for remote access to views
 - Repeat/refresh needed
- Building new training modules



- Q4 2013 & Q1 2014
 - Connect remaining substation pmu's
 - Improve Data Quality and Availability
 - TO Operator Training/Release PJM-Wide views
 - Install additional data storage hardware
 - Data Exchange
 - Roadmap

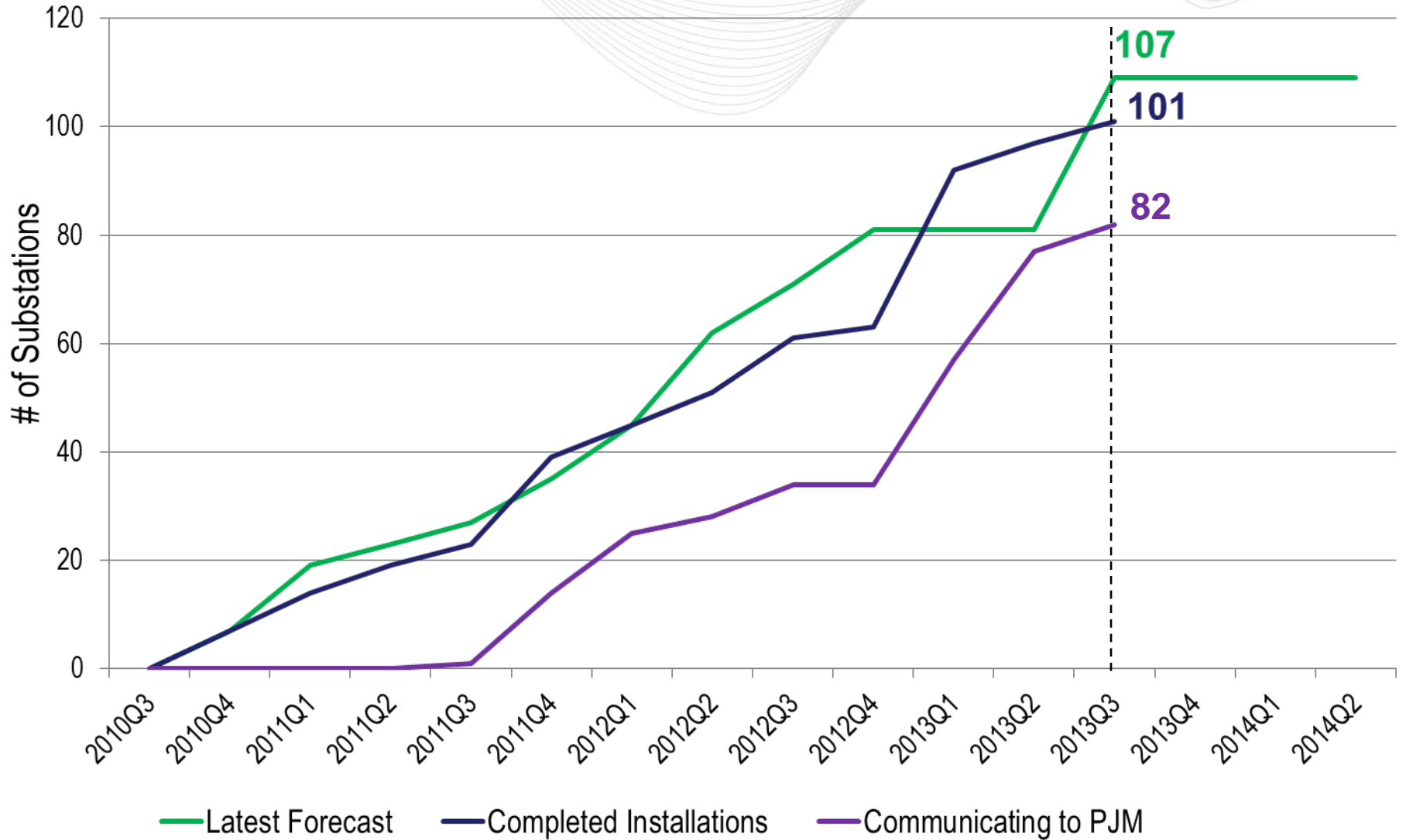


- Data Exchange with MISO
 - Receiving 250 pmu's
 - Sending 314 pmu's
- Data Exchange with NYISO
 - Establishing network connectivity
- Receiving data from 12 PJM TO's
 - 314 pmu's from 82 substations now live



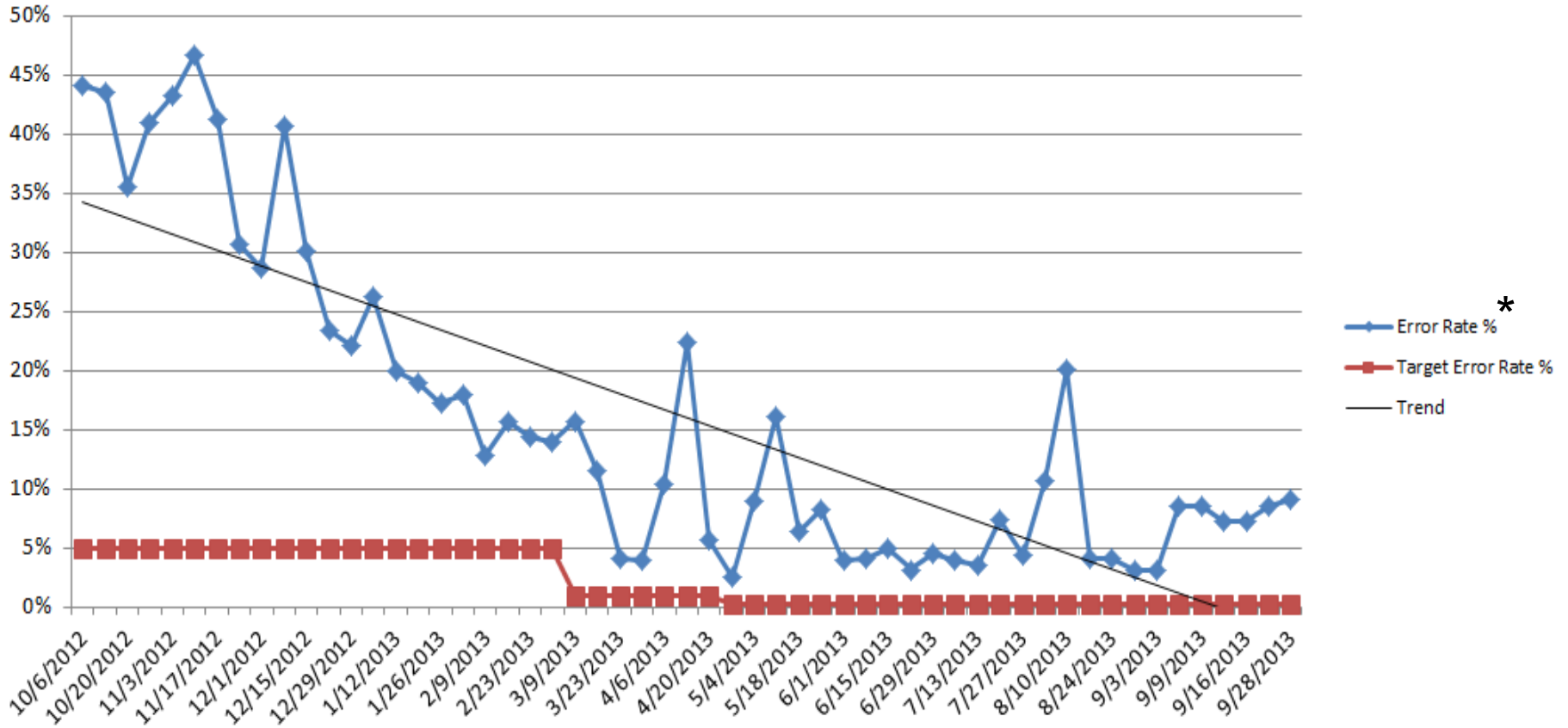
DETAILS

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- PDCs
 - 12 (+6) TO Control Centers with Central PDC
 - Archive Database Status
 - Storage Size – 220 TB (approx. 3 years retention)
 - Data archive considerations
 - 90 days real-time; 1 year near-real-time; 7 year archive
 - PJM PDC Availability: 99.86%
- Communication System
 - 12 (+6) dedicated/redundant links to TOs (T1 lines)
 - 2 dedicated MPLS Clouds; 1 Verizon and 1 AT&T
 - System Availability: 99.99%

PMU Error Rate Trend, All TOs



* Target of .2%.

- Overall 91% of data is received without errors
- 50% pmu's - "Good" [maintain < .2% avg. error]
- 58% pmu's - "Timely" [latency <500ms]
- Poor Quality – Root Causes
 - PMU Calibration
 - GPS Clock issues
 - Data Name limitations
 - Loose cables
 - Loss of telecom connection
 - Server overload
 - Aliasing at PDC
 - PDC configurations
- Lessons Learned
 - Establish test criteria to use at installation
 - Ensure data quality at TO PDC before sending data

- EPRI PPPD - Generator Model Validation
- Bigwood Systems - Network Model Validation
- Siemens State Estimator
 - Current and Voltage Phasor measurements
 - Testing impact of “bad” phasor data
- EPG RTDMS
 - Real-time phase angle displays, oscillation detection
- Intelligent Event Processor (IEP)
 - Alerts and Alarms through PI

Thank You