Duke Energy Carolinas
Smart Grid Investment Grant Update

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ARRA disclaimer

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Project participants

- Duke Energy Carolinas
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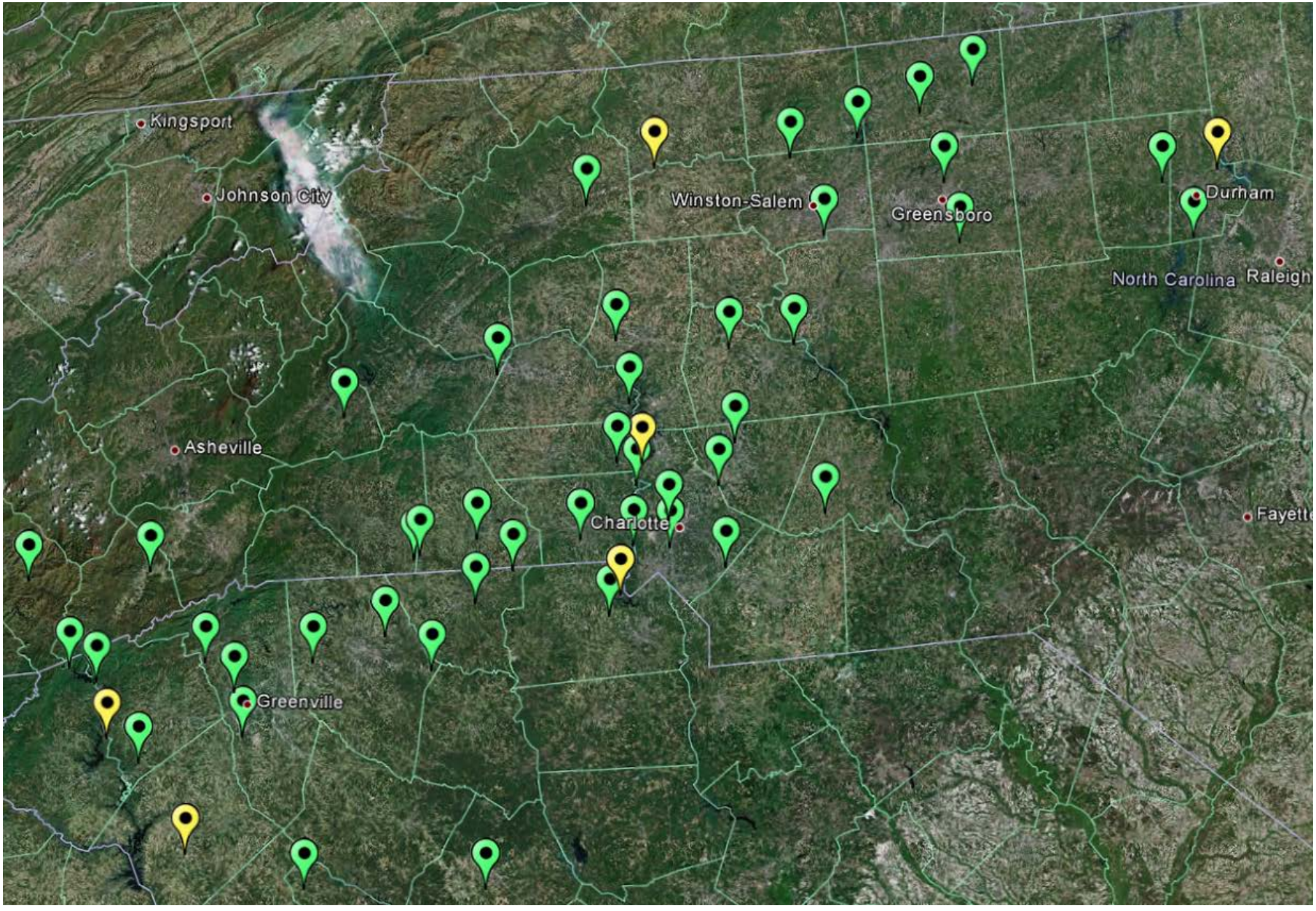
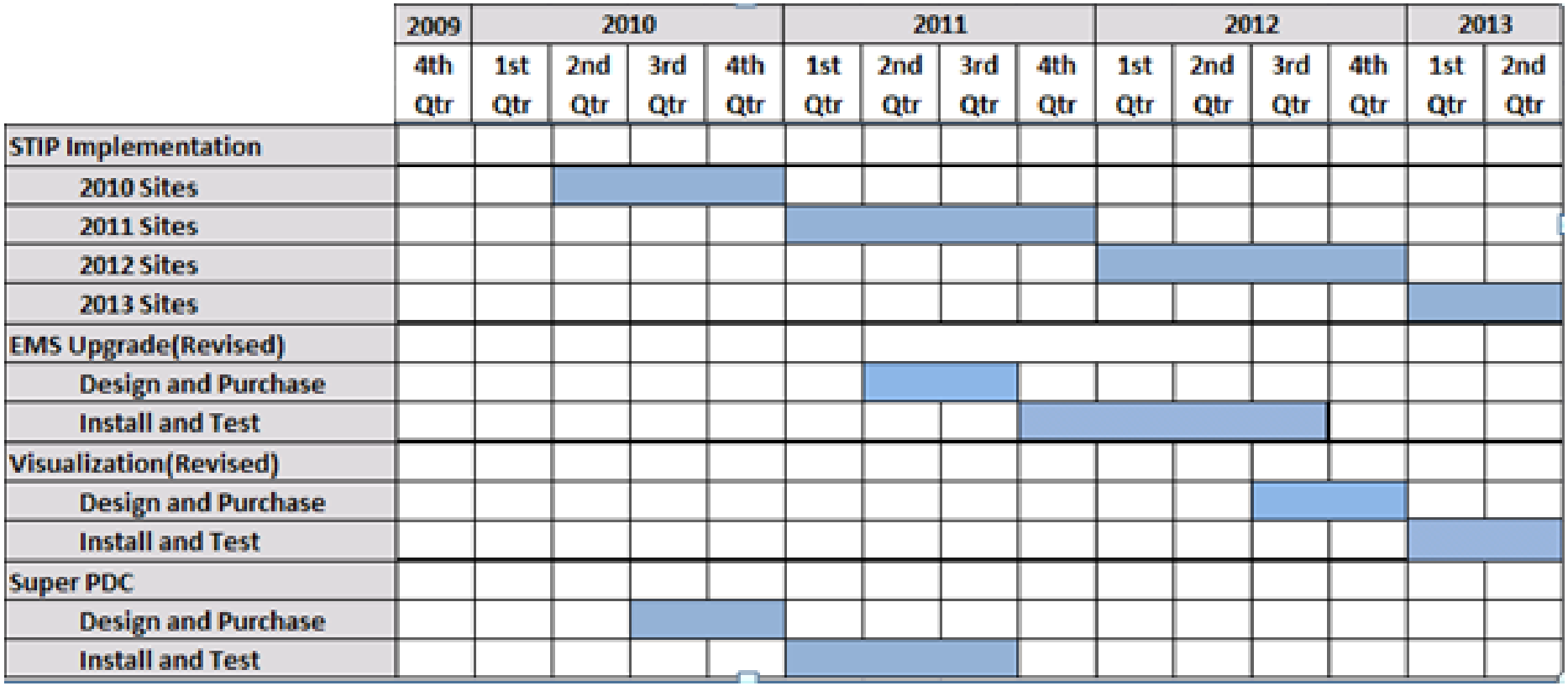
  - Tamara Harrison, Tamara.Harrison@duke-energy.com, 704-384-7723
  - 104 PMUs and 2 PDC systems to be installed
- Vendors: Alstom Grid, SEL, Cisco, OSIsoft, EPG

Project Map


Kingsport
Johnson City
Winston-Salem
Greensboro
Durham
North Carolina
Raleigh
Asheville
Charlotte
Greenville

Project Timeline



PMUs

- 1 transmission owner with total 104 PMUs
- Transmission elements monitored by PMUs
  - 13 elements @ 500kV
  - 91 elements @ 230kV
- 100% of regional load footprint monitored by PMUs
- 52 substations with PMUs
- PMU installation rate
  - Expect 101 installed by EOY 2012 (currently 87)
  - 104 installed by Q2 2013

PDCs and Communications

- PDCs
  - 2 RC/BA/TO control centers with PDC Systems
    - primary and contingency locations
  - 0 field PDCs
  - PDC availability rate 99.98%
- Communications system
  - Using IP over T1 lines, network predominantly Duke Energy owned with a few leased circuits
  - Plan to Install a Phasor Gateway Device
  - Communications system availability rate 99.75%/year

Communications and data

- Data flows and speeds
  - Phasor data 30x/second to PDCs
  - PDCs streaming UDP to centrally processed applications, using C37.118 adapter for PI
  - All data flowing up to the archive in real time and 7 day "buffer" on PDCs
- Data storage
    - Allocated 80 TB of SAN for phasor projects (40/site)
    - Plan for 3 years of data to be readily accessible, with event files archived
    - We currently have the data going to PI, which all our users can access easily
    - Total volume of data being generated by your phasor data system
      - 30x/second
      - 87 PMUs; A,B,C,+ phases monitored/PMU; ~20 data points measured per sample, plan to have ~8 data points calculated per sample (MW/MVAR)
      - Storing about 8GB/day (compressed), works out to 3.5 TB/year

Data quality and availability

- 100% of PMUs delivering good or better quality data to the PDC (not defined by RTDMS)
- 100% of PMUs delivering timely data
- 100% of good, timely data relative to total data flow possible
- Issues: Settings in the PDC, PMU clock settings
- Lessons Learned: Don’t try to do it all yourself, talk to your vendor and industry contacts

Phasor data-sharing

- Currently not sharing in industry because edge device not yet installed, plan to share in the future
- Sharing some data for research purposes
  - Universities and Data Analytics companies
  - Various project including baselining, fault location, stability analysis

Major operational applications using phasor data

- Wide-area situational awareness (Visualization)
  - RTDMS by EPG
  - Plan to deploy in control room
  - Operational May 2013
- Post-Event Analysis & Model “Validation”
  - PI Processbook
  - PGDA by EPG
  - Operational May 2013
- State estimation
  - Alstom EMS
  - Operational December 2012 (after upgrade to 2.6 Platform)

All applications are in development and are not currently used by our operators and operations support engineers. We plan to have them available by May 2013.

Challenges and lessons learned

- What have been your biggest technical challenges to date?
  - Complex network architecture
- What have been your biggest programmatic or execution challenges to date?
  - Coordination between field personnel and engineering groups
- Other lessons or insights about
  - PMU Performance – Data flags showing “valid” don’t always mean data is good quality
  - Communications system design and performance – High availability has been designed in-house because many vendors have not considered yet; UDP protocol worked best for us because of latency
  - Interoperability – sometimes challenging to integrate different vendors’ tools because of proprietary software
  - Physical or cyber-security – Need to be ready to accommodate ever-changing requirements
  - Data archiving – Found we oversized our SAN estimates when we started compressing some of the points (not all are compressed)
- Research needs – Analysis performed by back-hall operators transitioning to real-time applications that can be used by the control room operators to increase situational intelligence

Questions?