



WISP

Western Interconnection Synchrophasor Program

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NASPI Work Group Meeting

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NASPI *North American
SynchroPhasor Initiative*

Acknowledgement and Disclaimer

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Western Electricity Coordinating Council

Assuring reliability in the Western Interconnection

Key Activities

- WECC's "Western Interconnection Synchrophasor Program" is installing more than 300 phasor measurement units (PMUs) and 60 phasor data concentrators (PDCs) across the Western Interconnection.

Aims and Strategies

- Provide grid operators and reliability coordinators with more frequent and time-synchronized system information.
- Better system visibility will help system operators avoid large-scale regional outages, better utilize existing system capacity, and enable greater utilization of intermittent renewable generation resources.

Results and Benefits

- 19 organizations are participating in the project, providing 100% coverage for the Western Interconnection.
- Real-time information and automated controls being deployed will enable grid operators to allow an additional 100 MW of operational capacity on the California-Oregon Intertie (COI). Similar system benefits are possible in other parts of the system.

Transmission System Modernization



Phasor Measurement Unit

Facts & Figures

Total Project Budget:

\$107,780,000

Federal Share:

\$53,890,000

Project Area:

Western Interconnection,
1.8 million square miles

Project Team:

19 utility organizations

Program Participants

- WECC – Program Awardee
 - **Program Director:**
 - Linda Perez — lperez@wecc.biz
 - **Program Manager:**
 - Vickie VanZandt — vrvanzandt@gmail.com
 - **Technical Delivery Manager:**
 - Eric Whitley — ericwhitley@wecc.biz
 - **Technical Architect:**
 - Dan Brancaccio — dbrancaccio@wecc.biz
 - **Program Controller:**
 - Jeanne Bullion — jbullion@wecc.biz

WECC Synchrophasor Infrastructure

Phasor Measurement Units (PMUs) and
Phasor Data Concentrators (PDCs)
in the Western Interconnection



● PMU locations

◆ PDC locations

Program Participants (cont.)

Cost Share Participants	Total PMUs	WISP PMUs	PDCs
Bonneville Power Administration	114	(114)	4
California ISO / CEC	0		2
Idaho Power Corporation	17	(4)	1
NV Energy	17	(11)	5
Pacific Gas & Electric (sub-recipient)	120	(120)	26
PacifiCorp	7	(5)	2
Salt River Project	42	(18)	2
Southern California Edison	74	(8)	Gateways
WECC			6
TOTAL	391	(280)	48

Program Participants (cont.)

10 Additional Participants in WISP	PMUs	PDCs
Alberta Electric System Operator	4	1
Arizona Public Service	7	1
British Columbia Hydro	11	2
Los Angeles Dept. of Water & Power	15	1
Northwestern Energy	2	1
Public Service of New Mexico	4	1
San Diego Gas and Electric	41	1
Tri-State G&T	1	1
Tucson Electric	2	1
Western Area Power Administration	6	1
TOTAL	93	11

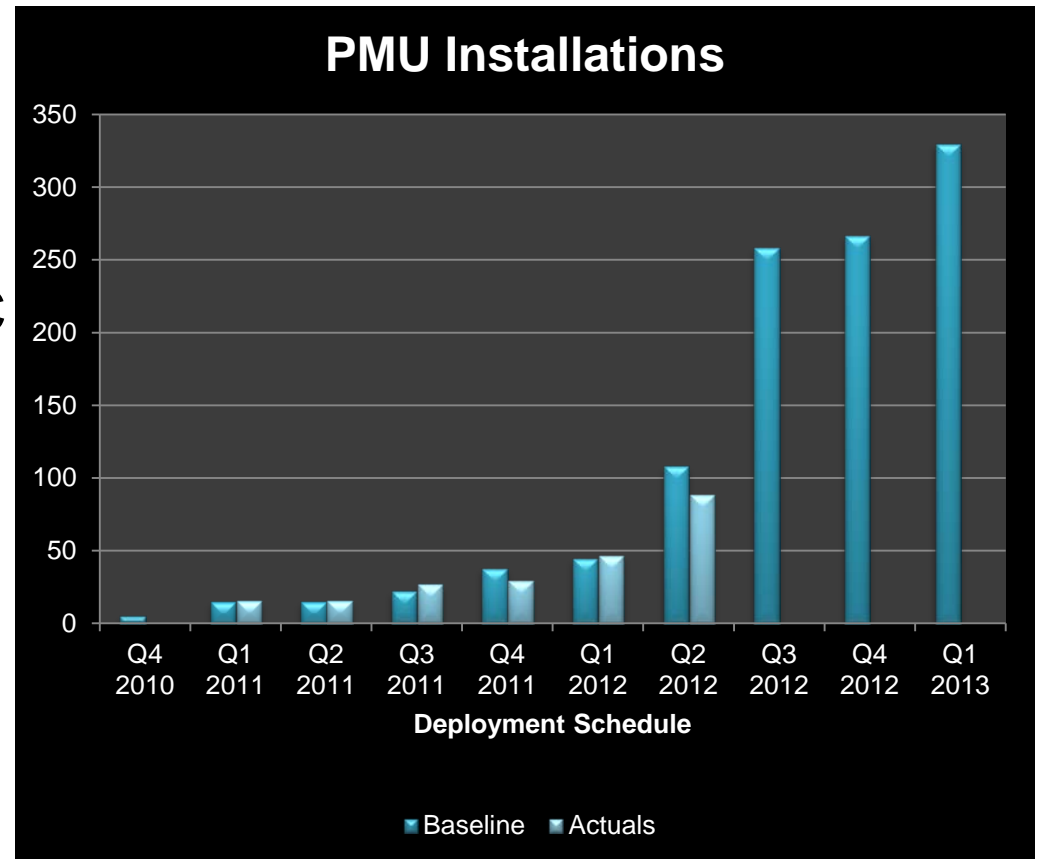
PMUs and PDCs

Total existing or planned PMUs	484
Total existing or planned PDCs:	59
PMUs currently deployed:	200
PMUs currently streaming data:	90

Class A data 50/50 mix sample rate 30Hz and 60Hz

PMUs

- Total WISP PMUs Now Installed: 89
- Total PMUs Currently Streaming Data to WECC RC: 88
- Total PMUs Currently Deployed: 200
- Availability statistics not yet tracked

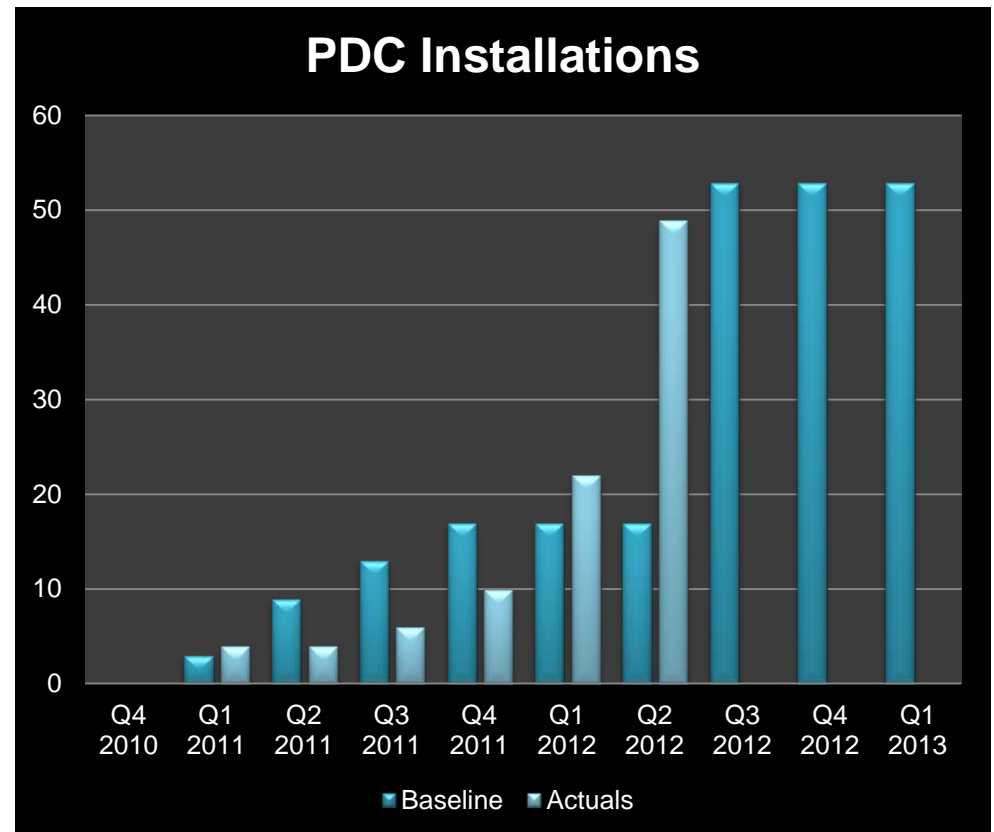


PMUs

- 18 Transmission Owners will deploy over 450 PMUs (some outside the WISP grant):
 - Each entity has selected its own vendor.
- Full coverage of Western Interconnection:
 - Number of PMUs and their location differ by application.
- Variety of Types:
 - Stand alone
 - DFR
 - Relay-based
- WECC RC will archive positive sequence only.

PDCs

- RC centers with PDCs: 2
- BA/TO control centers with PDCs: 21
- Field PDCs: 25
- Total Now Installed: 49
- Availability statistics not yet tracked



Archives

- Storage duration and capacity:
 - All Data On-Line – 15 months
 - Disturbances – 7 years
 - 100 TB

Communications

- Dedicated, private wide-area network (WAN);
- Provided by Harris Corporation:
 - All data on WAN is encrypted using GET-VPN WECC control keys;
 - WAN from RCs up to TOs/ISOs edge routers under contract to WECC;
 - Centralized management;
 - Core network deployment complete: Nov. 2011;
 - Final PDC to PDC communications testing: Nov. 2012; and
- Peer-to-peer communication is occurring; and
- Will facilitate NASPInet phasor gateway demonstration – March 2013.

Applications

- Data flows for applications
 - WECC RCs host a full suite of applications:
 - Modal Analysis
 - Voltage Stability
 - Angle Monitoring
 - Registry
 - Wide Area View
 - Historical Archives and Data Mining
 - Some Participants hosting their own applications.

Applications

- Data flows for applications
 - Some central applications are available to all TOs, TOPs, BAs, and RCs who have executed the WECC Universal Data Sharing Agreement through WECC's Reliability Portal WECCRC.org:
 - Secure Internet-Based Site; and
 - Access to Registry, Archives, Disturbance Reports, Wide Area View (WAV), Next-Day Studies, etc.

Phasor Data Sharing

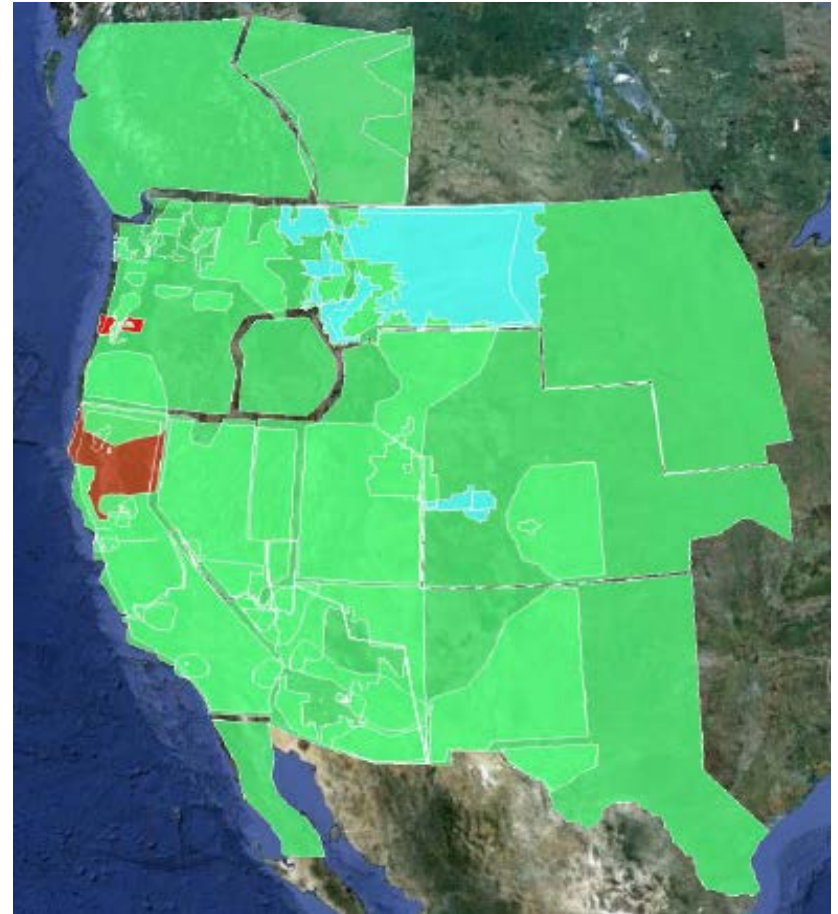
- 18 TOs will provide phasor data to the WECC RCs (everyone who has a PMU);
- Many of these will exchange data with each other over the WAN; and
- 97 Parties are eligible to receive phasor data through WECCRC.org, if they have executed the WECC Data Sharing Agreement (covering phasor and operating reliability data).

Data Sharing Agreement Coverage

Green = NDA Signatory

Blue = Waiver Signatory

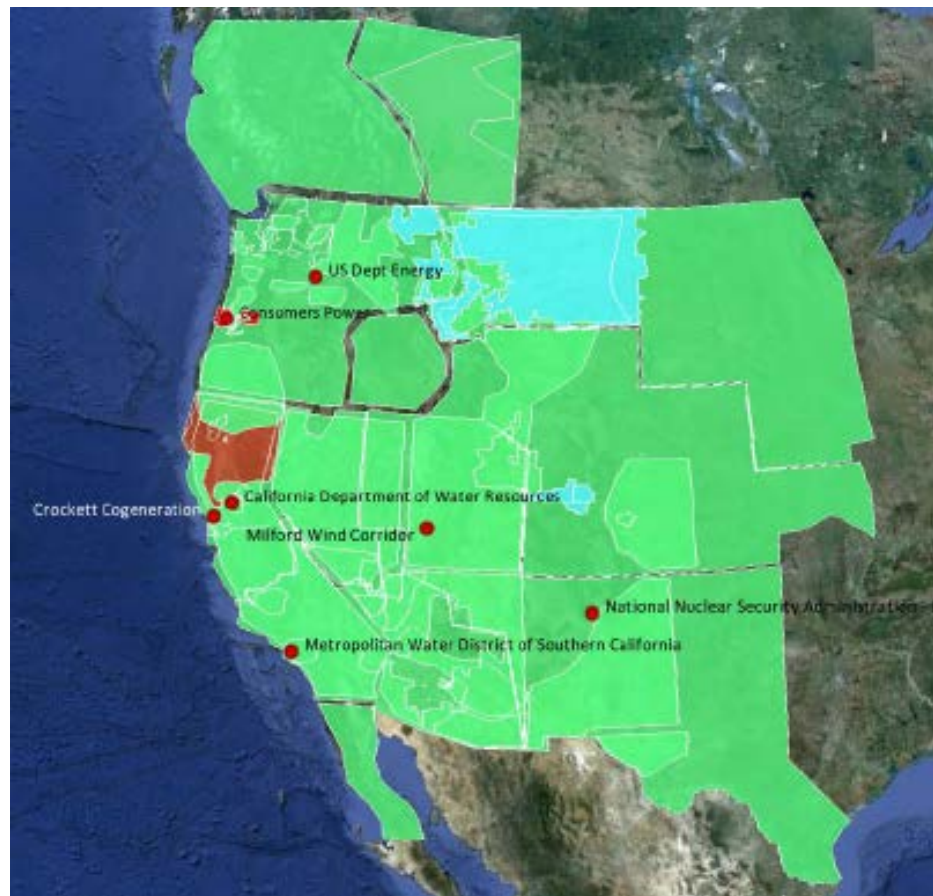
Red = Not Yet



Data Sharing Agreement Coverage

93% Complete

Seven Entities Remain



Phasor Data Sharing, continued

- 93 percent of eligible Parties have executed the Agreement or signed a Waiver allowing their data to be shared (seven Parties remain);
- Phasor Data is shared with four researchers:
 - Montana Tech
 - University of Wyoming
 - PNNL
 - Washington State University

WISP Milestone Schedule

WECC Project Tasks	Start	Finish	2012				2013			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Production IT Infrastructure Deployment										
IT Production Environment Build (WA & CO)	Sep-11	Sep-12	[Progress bar from Sep-11 to Sep-12]							
Wide Area Network Deployment										
WAN Core Network Deployment	Jun-11	Nov-11	[Progress bar from Jun-11 to Nov-11]							
WAN Router Installation & Configuration	Nov-11	Nov-12	[Progress bar from Nov-11 to Nov-12]							
Application Delivery										
Final Acceptance of Modal Analysis Software (Montana Tech)	Aug-10	Oct-12	[Progress bar from Aug-10 to Oct-12]							
Site Acceptance Test (SAT) of WASA (Alstom Grid)	Nov-12	Nov-12	[Progress bar from Nov-12 to Nov-12]							
Site Acceptance Test (SAT) of Voltage Stability (V&R Energy)	Dec-12	Jan-13	[Progress bar from Dec-12 to Jan-13]							
NASPInet Phasor Gateway Demonstration	Apr-12	Mar-13	[Progress bar from Apr-12 to Mar-13]							
Application Development & Test										
Registry & Historical Data Archive (Internal Release)	Nov-11	Nov-12	[Progress bar from Nov-11 to Nov-12]							
Registry v1.0 (External Release)	Nov-12	Jan-13	[Progress bar from Nov-12 to Jan-13]							
Historical Data Archive Reports (External Release)	Nov-12	Feb-13	[Progress bar from Nov-12 to Feb-13]							
Wide Area View v1.0 (External Portal Release)	Nov-12	Mar-13	[Progress bar from Nov-12 to Mar-13]							
System Testing, Acceptance and Cutover										
System Testing	Jul-11	Mar-13	[Progress bar from Jul-11 to Mar-13]							
Final Acceptance and Transition to Production	Jan-13	Aug-13	[Progress bar from Jan-13 to Aug-13]							
User Training and Rollout	Feb-13	Sep-13	[Progress bar from Feb-13 to Sep-13]							
WECC RC Control Center Expansion										
RC Control Room Design and Procurement	Oct-12	Mar-13	[Progress bar from Oct-12 to Mar-13]							
RC Control Room Construction (Loveland, CO)	Jan-13	Jun-13	[Progress bar from Jan-13 to Jun-13]							
RC Control Room Construction (Vancouver, WA)	Dec-11	Mar-13	[Progress bar from Dec-11 to Mar-13]							
			[Yellow star icon in Q4 2013]							

PMUs

Receiving Streaming Data from 88 PMUs

Bonneville Power Administration	Idaho Power Company
NV Energy	PacifiCorp
Salt River Project	Alberta Electric System Operator
Los Angeles Dept. of Water & Power	Northwestern Energy
Public Service of New Mexico	San Diego Gas and Electric
Tri-State G&T	Public Service of New Mexico

PMUs (cont.)

- Data Quality:
 - 95 percent of PMUs delivering quality data some issues with older PMUs;
 - A small number of PMUs have timing issues (one is convinced it is 2034); and
 - In all cases so far, timeliness issues have been PMU related not communication system related, even when communications are over serial connections.

Communications

- Data flows and speeds:
 - PMU to PDC communication controlled by each Participant — latency varies among Participants.
 - PDCs to RCs for centrally processed applications:
 - Edge router to edge router latency requirement is 30 ms average over 10 min, experiencing 19 ms; and
 - Jitter requirement is 2 ms average over 10 min, experiencing 1.4 ms.
 - WAN availability 99.99 percent (measurement beginning May 2012).
 - Expecting 2100 phasor measurements initially — WAN capable of 10X this volume limited only by ‘last mile’ connection.

Communications

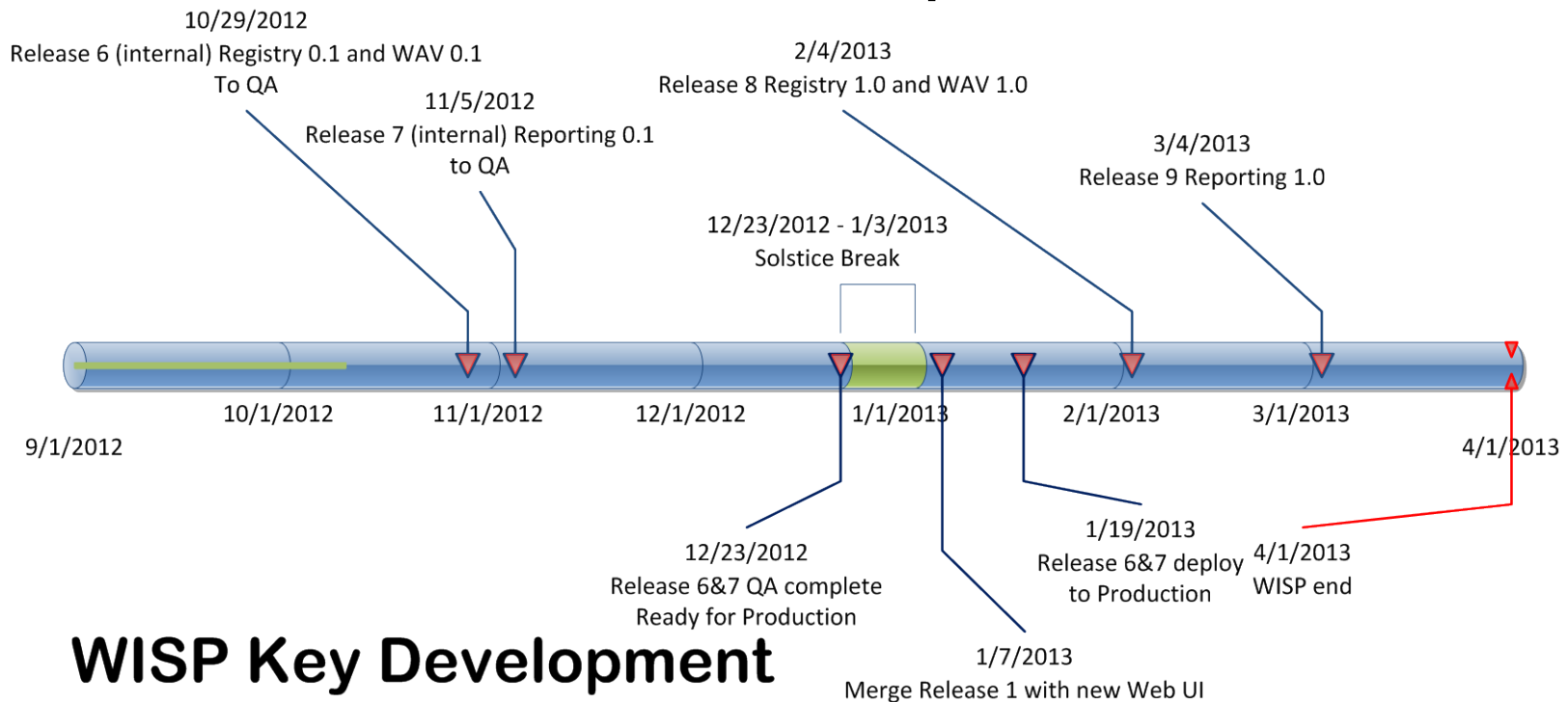
- Data flows for applications
 - Applications required to meet performance requirements with 4200 phasor measurement volume;
 - All data flows up to the RC archives in real time; and
 - Some Participants will archive their own data and that exchanged directly with peers.

Major Operational Applications

- Number of TOs/ISOs sharing phasor data: 18
- Wide-Area Situational Awareness:
 - Alstom/Psymetrix – General visualization, monitoring, alarming and archiving: Dec. 2012
 - OSISoft – Archiving: Feb. 2013
 - Montana Tech/University of Wyoming/PNNL, Psymetrix, Washington State University – Oscillation Monitoring: Oct. 2012
 - V & R Energy – Voltage Stability: Jan. 2013

Registry, Reports from Archives & Wide Area View (WAV)

- WECC In-house development:



WISP Key Development Milestones

Major Operational Applications

- Wide Area View: Testing Complete Feb. 2013
- Automated Report Generation: Testing Complete Jan. 2013
 - System performance following events.
 - For baselining, model validation, trending.
- Renewable generation now covered by PMUs: 343 MW.
- Response-Based Controls: BPA – March 2015:
 - Fast reactive switching; and
 - Primary and total reactive requirements for wind power plants.

Challenges and lessons learned

- Biggest Technical Challenges:
 - Data mining tools for information retrieval;
 - Difficulty in deploying a common naming convention;
 - Upgrading first releases of vendor products to CIP standards;
 - Absence of long-term use of Applications (finding and working out the bugs);
 - Integrating old PMUs and PDCs; and
 - Applications not ready for data volume.

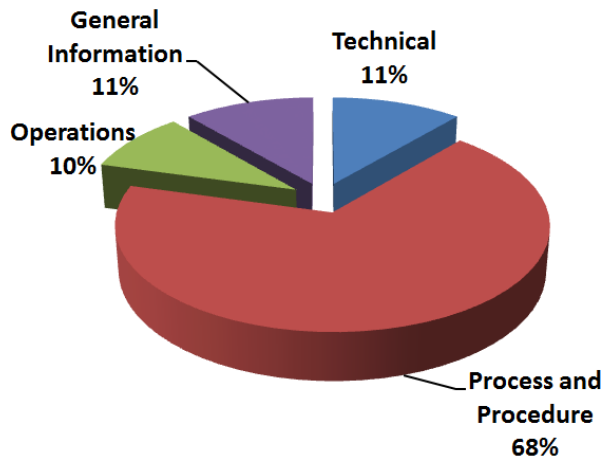
Challenges and lessons learned

- Risk: User Acceptance of New Technology
 - Dedicated training-and-outreach initiatives are in place to ensure active mitigation:
 - **Help Desk:** Trends are carefully monitored each week;
 - **Training:** Professional suite of interactive training webinars, combined with companion quick-reference materials, are provided with each deployment of program features; and
 - **Communications:** End-user communications (specific program updates, electronic newsletters, and briefs) are regularly published.

Challenges and lessons learned

Community Outreach Ensures Active Mitigation

Help Desk Trends Monitored



Current Help Desk trend categories.

Curriculum Developed

WECC
Western Interconnection Synchrophasor Program
WECC RC Training Center, Vancouver, Wash.

WECC Reliability Coordination Website

Community outreach
Real-time data
Increased productivity

Continued reliability
Intercornection mapping
Report studies

Promoting Bulk Electric System Reliability

“WECCRC.org Operating Procedures Feature”

September 11 – 12, 2012

Classification: Public

Interactive, custom-designed webinars recap applicable goals and objectives for each newly deployed feature.

Challenges and lessons learned

- Biggest programmatic/execution challenges
 - Took much longer than originally expected:
 - WAN deployment delayed by individual contract negotiations;
 - Infrastructure construction constrained by significant generator outages;
 - Competition for construction resources; and
 - Synchronizing resource availability.
 - Additional data sharing agreement:
 - Difficult to garner full participation
 - Close, but a few more entities to go.

Research Needs, Next Steps

- Baselining
 - Phase angle differences:
 - What is normal between two locations.
 - Are there correlations between damping levels and phase angle differences – or between and among other system stress indicators? What are they?
 - What values warrant intervention (alarms or action indicators)?

Research Needs, Next Steps

- End-to-end data latencies
 - Latencies not created by communications.
- Shared wide area view
 - New features.

Questions/Comments

