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INDUSTRY SEMINAR 2012

EMEA

The Power of Data

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PI as a real-time Infrastructure covering the entire T&D spectrum: from grid operations support to asset management

Presented by **Ann Moore and Martin Levionnois - OSIsoft**

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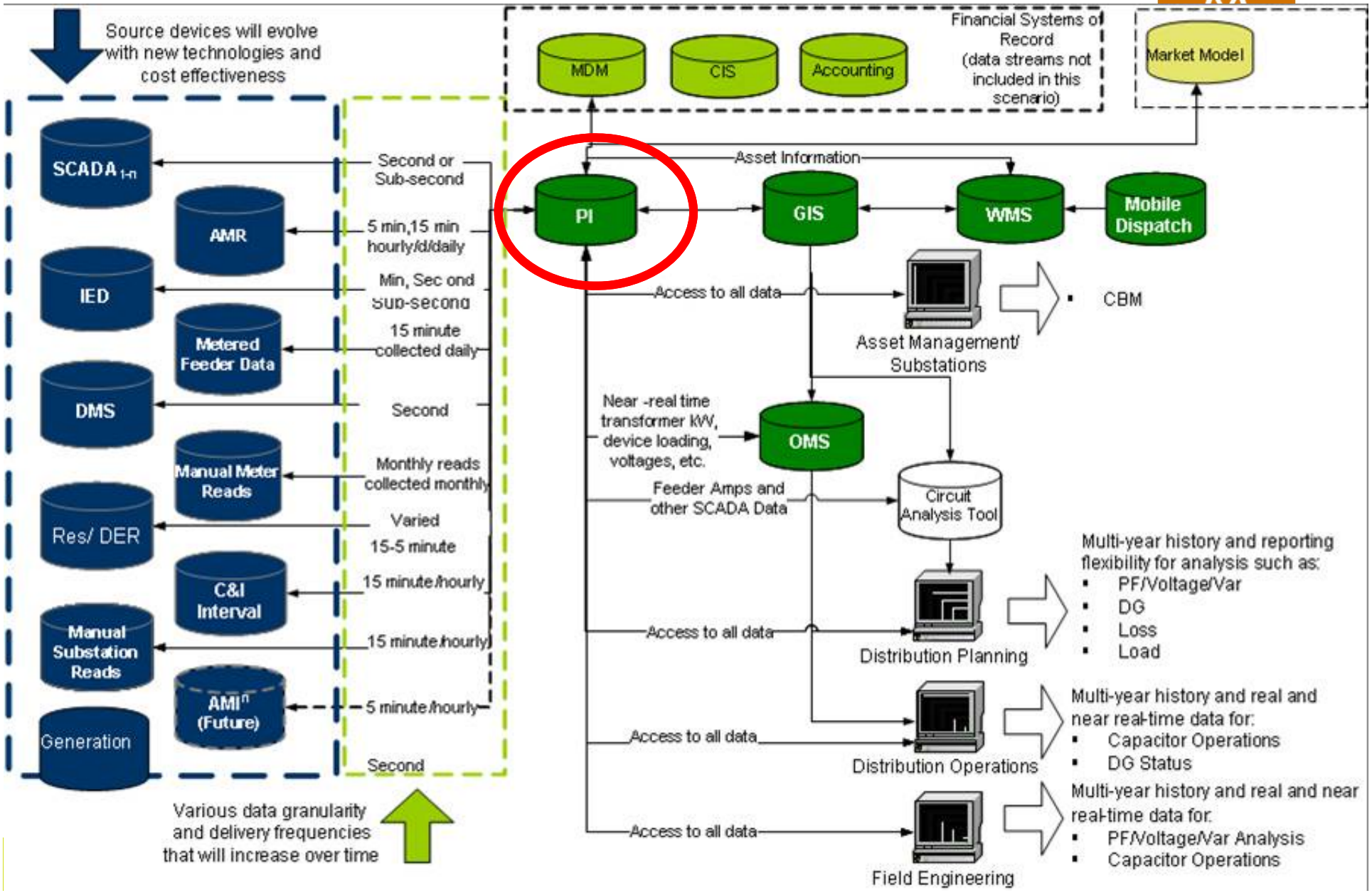
PI as the Enterprise Data Infrastructure



PI T&D Utility Trends

- EMS/DMS/SCADA Data for T&D Operations and Reliability
- Synchrophasor and WAMS-Wide Area Measurement System
- Power Quality/Transient/Disturbance
- Substation Automation
- Asset Management and Condition Based Maintenance
- Distribution Automation
- AMI/AMR Metering
- Smart City, Smart Grid and Microgrids

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1. PI for Grid Operations

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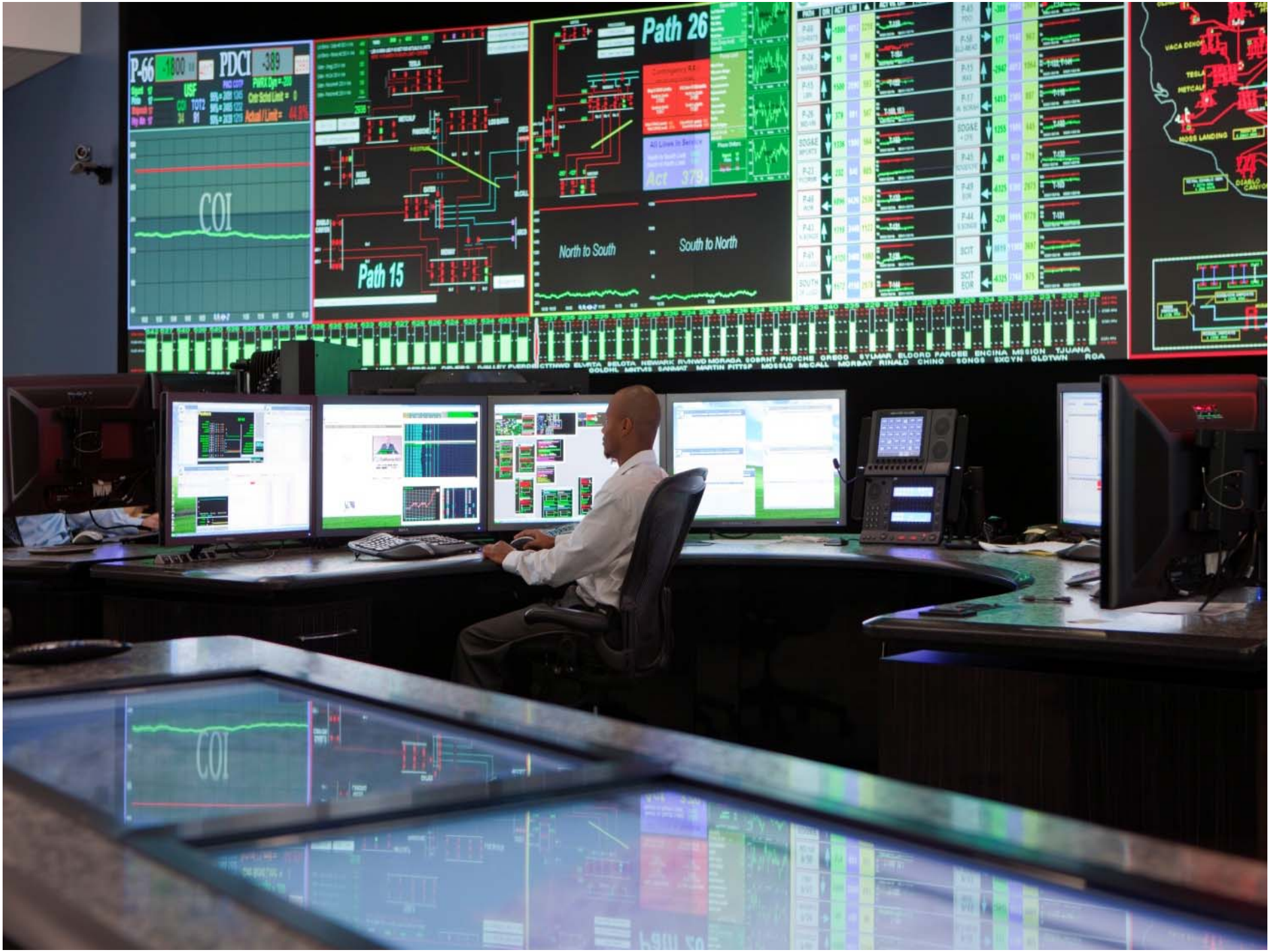
CAISO-Where we are now…


P-66
PDCI
COI
Path 15
Path 26
North to South
South to North
COI

Solutions helped if you think this way

- EMS provides reality and a way to operate reality
- The market is the forecast of the reality to come
- We need to provide operators visualization to tie the past, current, and the future
- Operators' confidence is increased as you provide the visualizations and accuracy of the forecast

PI is the continuum for operators to see and analyze the past, operate the current, and proactively make decisions to prevent a negative future

Courtesy: Hani Alarian, Director, Power Systems Technology Operations
Dr. Khaled Abdul-Rahman, Director, Power Systems Technology Development

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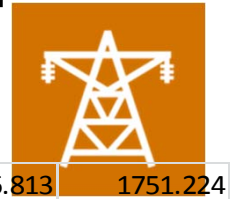
Example in Numbers only 6 hours of 24
Can you find the mistake?



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4:45	1782.593	1783.582	1740.005	1713.625	1763.2	1776.202	1772.523	1762.432	1765.907
5:00	1804.619	1804.311	1753.202	1722.105	1782.787	1798.3	1796.214	1783.199	1785.155
5:15	1851.697	1851.983	1775.265	1738.878	1833.121	1848.069	1846.02	1832.959	1832.181
5:30	1891.173	1889.403	1791.779	1749.428	1874.77	1890.169	1887.194	1871.383	1867.261
5:45	1918.68	1914.849	1803.538	1749.229	1901.105	1913.318	1905.974	1891.461	1883.946
6:00	1927.751	1928.128	1797.334	1736.343	1917.293	1927.759	1919.787	1900.453	1889.87
6:15	2001.637	2003.804	1827.463	1753.16	1994.741	2006.415	1996.289	1975.221	1958.406
6:30	2054.95	2058.036	1848.321	1764.349	2050.196	2060.041	2051.025	2028.24	2008.001
6:45	2112.258	2103.88	1872.549	1778.843	2095.131	2102.328	2094.292	2072.529	2050.109
7:00	2160.629	2137.386	1888.932	1790.602	2135.888	2143.732	2138.594	2116.436	2091.379
7:15	2232.516	2211.839	1943.359	1834.518	2220.943	2225.654	2219.614	2192.266	2166.789
7:30	2267.812	2254.537	1978.218	1865.147	2270.142	2268.746	2261.528	2233.358	2211.937
7:45	2294.774	2288.251	2006.233	1889.359	2308.142	2303.487	2294.172	2266.28	2249.907
8:00	2325.94	2322.89	2040.28	1920.23	2345.282	2336.993	2324.838	2299.474	2286.259
8:15	2370.621	2371.534	2099.076	1970.189	2400.857	2389.888	2377.086	2352.518	2342.512
8:30	2398.012	2401.169	2140.396	2007.306	2437.142	2420.344	2408.794	2385.162	2377.984
8:45	2427.269	2429.596	217.261	2038.443	2468.24	2449.527	2436.273	2415.056	2409.495
9:00	2452.356	2457.249	2208.352	2074.063	2499.239	2478.301	2465.481	2444.879	2441.46
9:15	2490.627	2502.216	2255.25	2117.835	2544.785	2520.463	2509.126	2488.076	2487.573
9:30	2521.597	2540.463	2288.521	2151.365	2584.2	2557.204	2550.518	2526.244	2525.164
9:45	2551.844	2575.42	2321.138	2182.995	2621.057	2593.661	2588.434	2561.901	2560.209
10:00	2588.298	2611.475	2350.499	2213.857	2655.357	2626.772	2622.822	2596.66	2594.748
10:15	2619.03	2650.911	2388.768	2256.956	2699.702	2668.777	2666.828	2638.944	2637.933
10:30	2645.652	2678.506	2411.097	2283.247	2724.45	2695.779	2698.503	2667.695	2667.878
10:45	2668.184	2703.642	2430.173	2307.043	2749.066	2720.254	2725.196	2691.454	2693.37
11:00	2682.564	2718.079	2442.608	2324.405	2763.242	2733.837	2741.958	2709.303	2710.661
11:15	2705.387	2736.648	2461.428	2349.543	2780.964	2750.594	2762.598	2728.487	2728.311
11:30	2715.591	2742.262	2472.007	2365.656	2788.949	2764.653	2778.697	2743.69	2742.778

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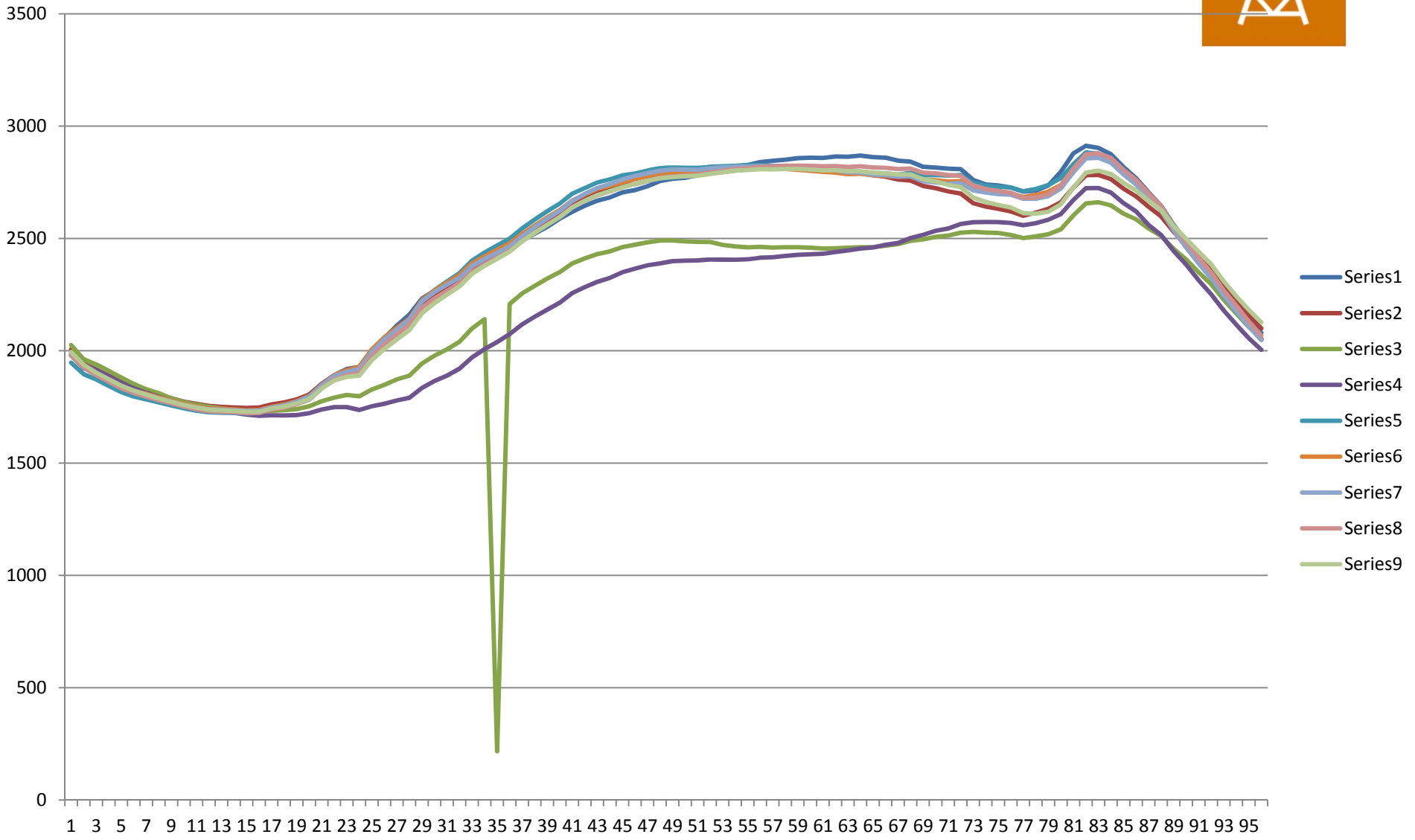
Same Example in visual
Can you find the mistake?



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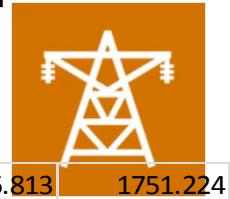

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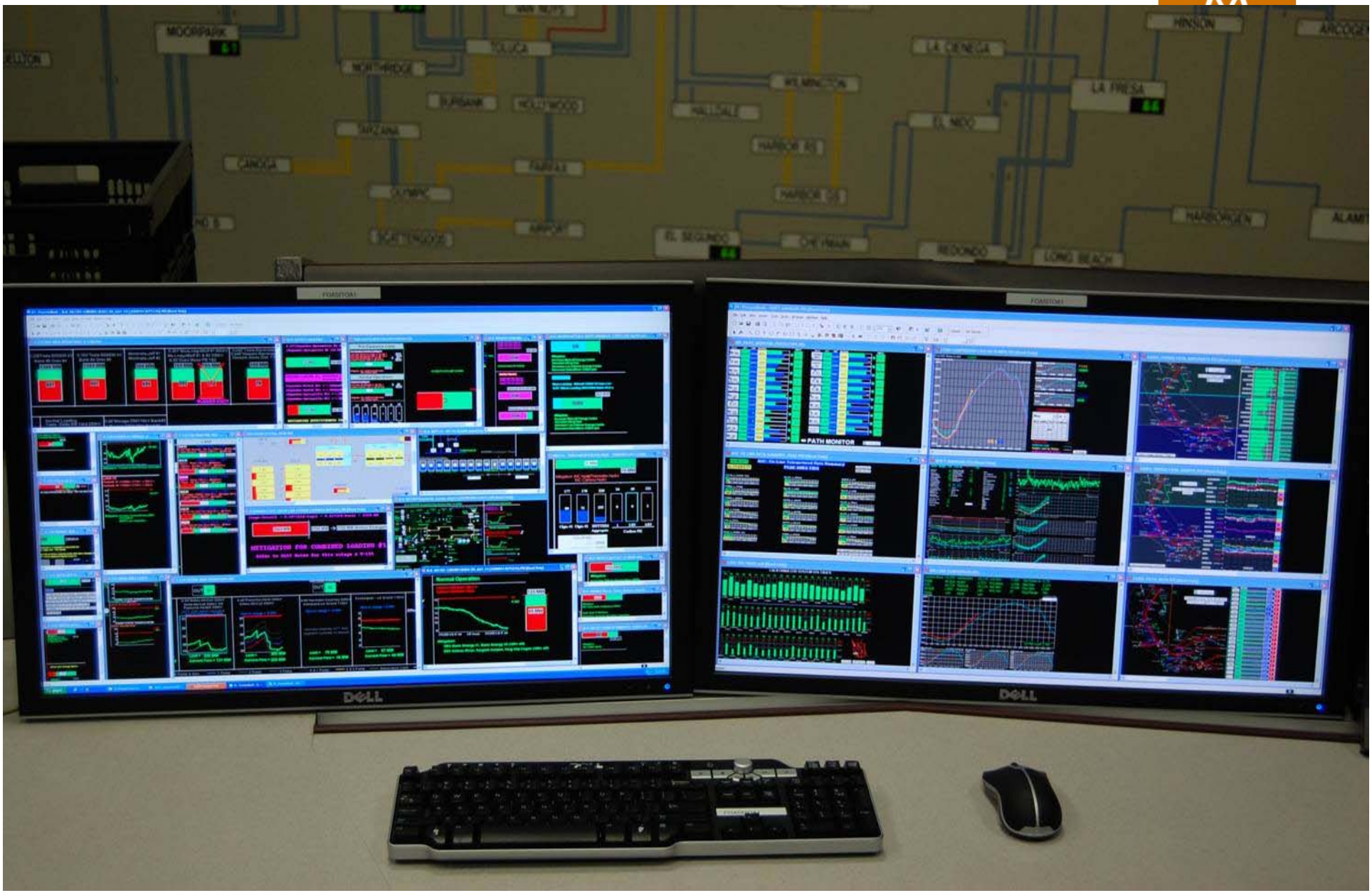
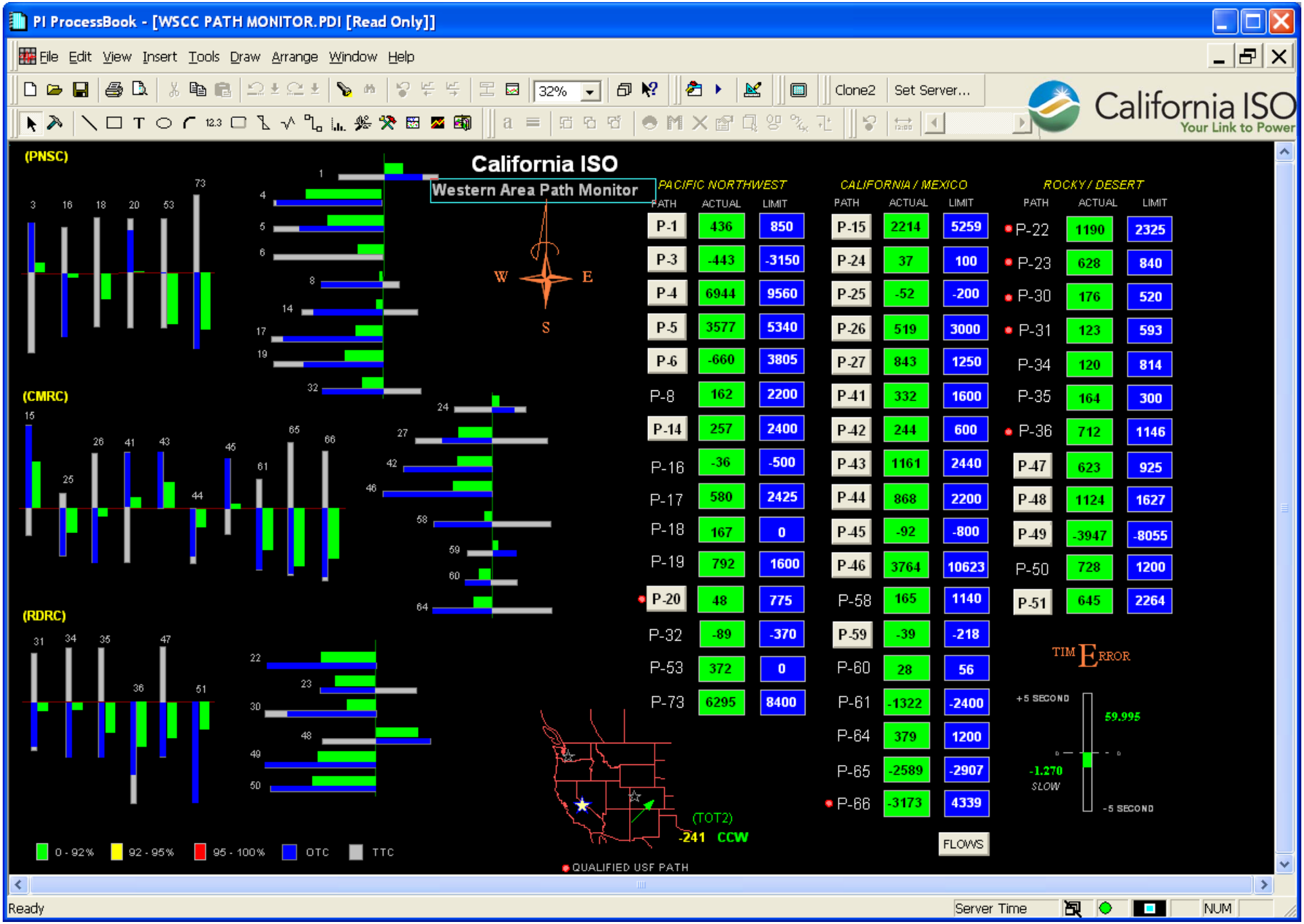
CAISO Typical Transmission Operator Views





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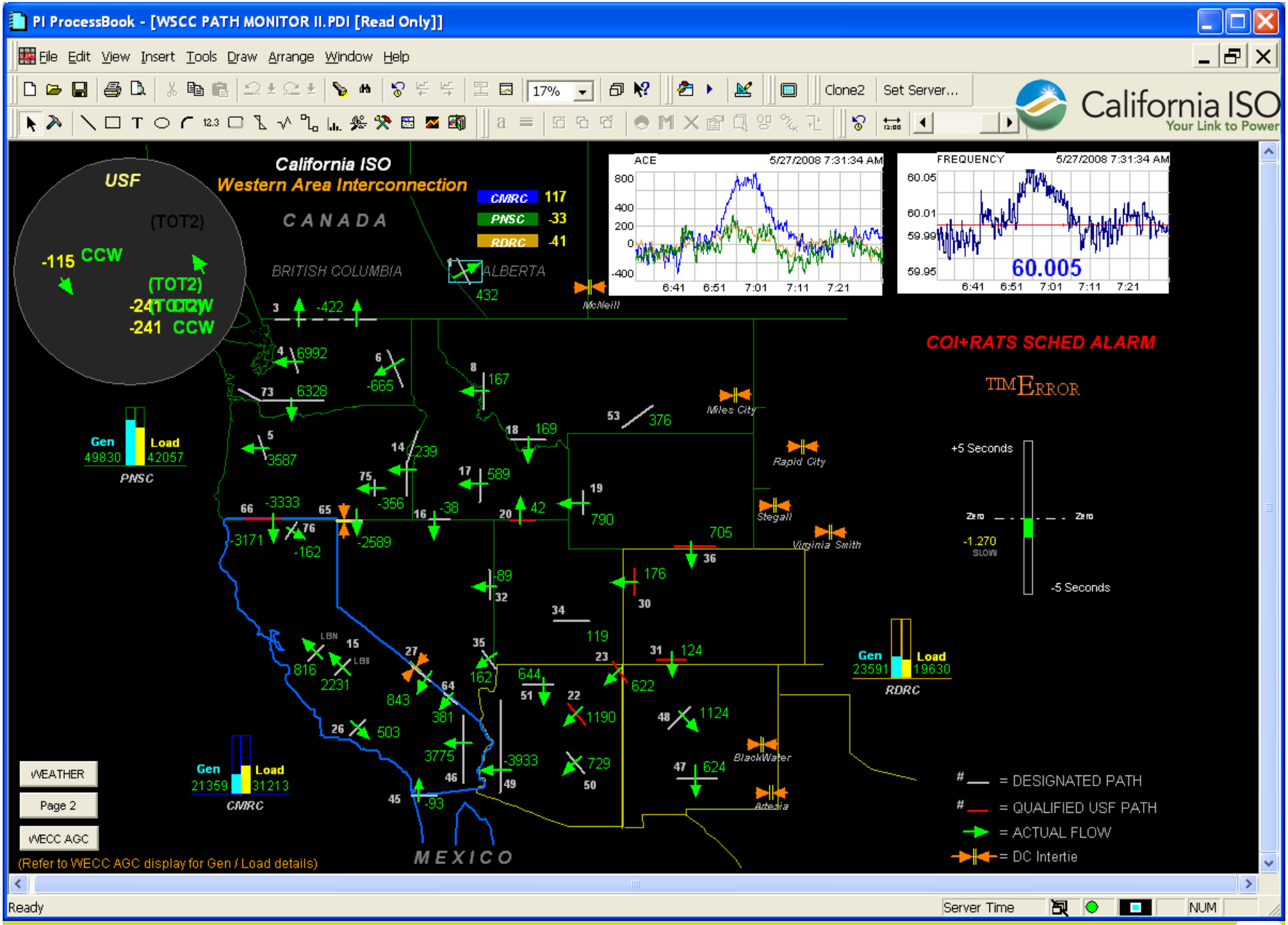

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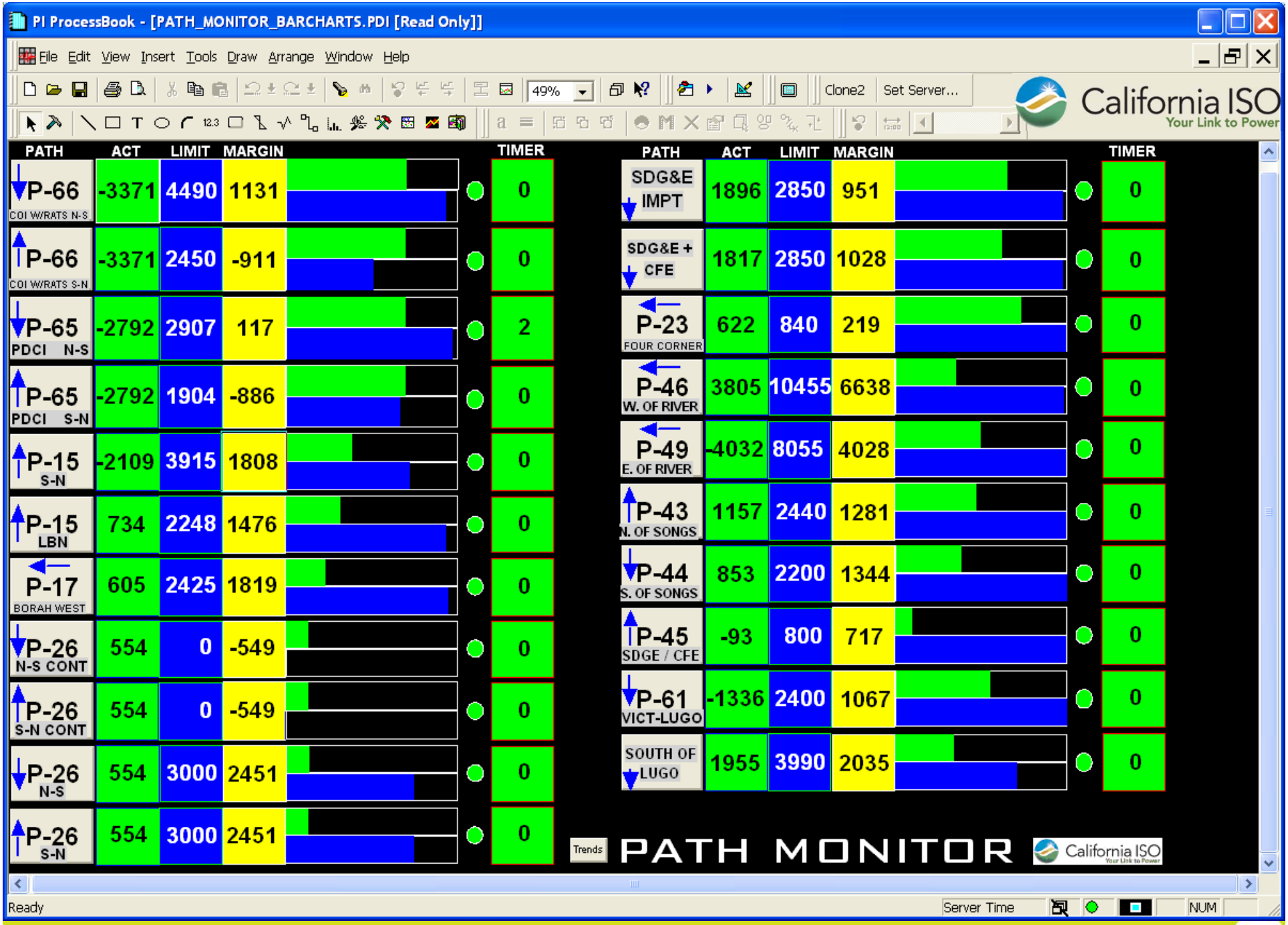

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PG&E (Pacific Gas & Electric) Grid Operations

- Clearance Tool
  - allows System Dispatchers to manage the impact of maintenance activity on the transmission grid
  - includes alarms to notify System Dispatchers of maintenance activity that requires action
- Operational Procedures
  - set screens verified by CAISO
  - make weather data available for use in PI ProcessBook (PB)
  - add data validity indicator to identify stale data
  - create a tool to synchronize PG&E (PB) screens with CAISO PB screens

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The situation:

- Transmission facilities change constantly
  - 40 to 60 maintenance operations per day
- Each chance removes grid resources and increases power flows in remaining resources
- Grid operators need:
  - A grid design that re-routes power
  - Assurance that re-routed power is safe and reliable

In other words, every day is a new grid

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Today – a spreadsheet

From

A Spreadsheet

Manually generated
30-60 times per day

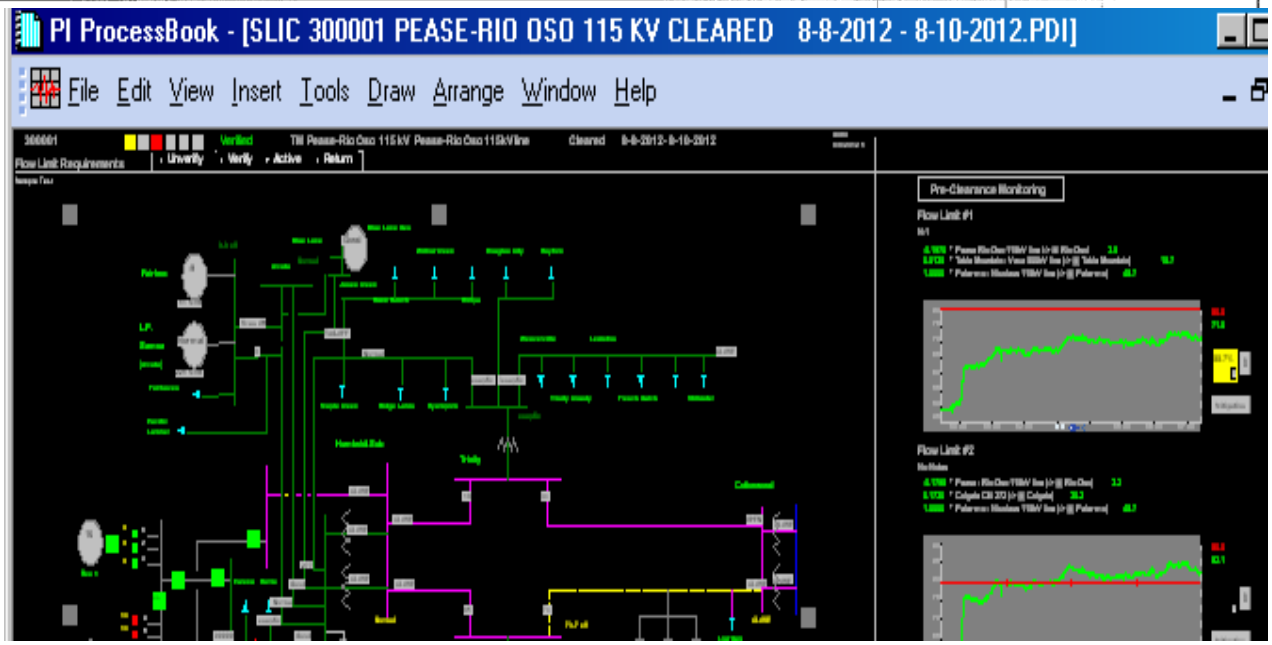
Moraga #1-230/115kV Bank (->)		77		
0.29*Moraga #3-230/115kV Bank (->)		64		Limit
	Total	141	MW	180
San Mateo #7-230/115kV Bank Cleared		**SLIC**	**188188**	**4/22-6/30**
Pre-Clearance Requirement - Flow Limit #1				
Ravenswood-San Mateo 115kV Line (-> @ Ravenswood)		44		
0.11 * San Mateo 230/115kV Bank #5		21		
0.11 * San Mateo 230/115kV Bank #7		0		Limit
	4 fps 1000 - 1900 Total	64	MW	115
	1900 - 1000 Total	64	MW	100
Real Time Requirements - Flow Limit #1				
Ravenswood-San Mateo 115kV Line (-> @ Ravenswood)		44		
0.11 * San Mateo 230/115kV Bank #5		21		
	4 fps 1000 - 1900 Total	64	MW	115
	1900 - 1000 Total	64	MW	100

To

A Graphic

Click and search data into PI AF
Automatically produce graphic

- one-lines
- flow trends
- alarms



Title, alarm, one-line and flow limit at a glance

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2. PI for WAMS

Wide Area Measurement System Synchrophasor Data

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PI for PMU Synchrophasor Data

- **Streaming Server:** Very Fast Sampling (up to 120 samples/sec) and Synchronized Sampling with PI Standard IEEE C37.118 Interface

- **Real-time Analytics:** Fast and Synchronized Real-Time Calculations (phase angle difference and FFT-Fast Fourier Transform, etc.)

- **Visualization/Alerts:** Enhance Operations and Early Warning to Prevent Grid Instability and Cascade Collapse

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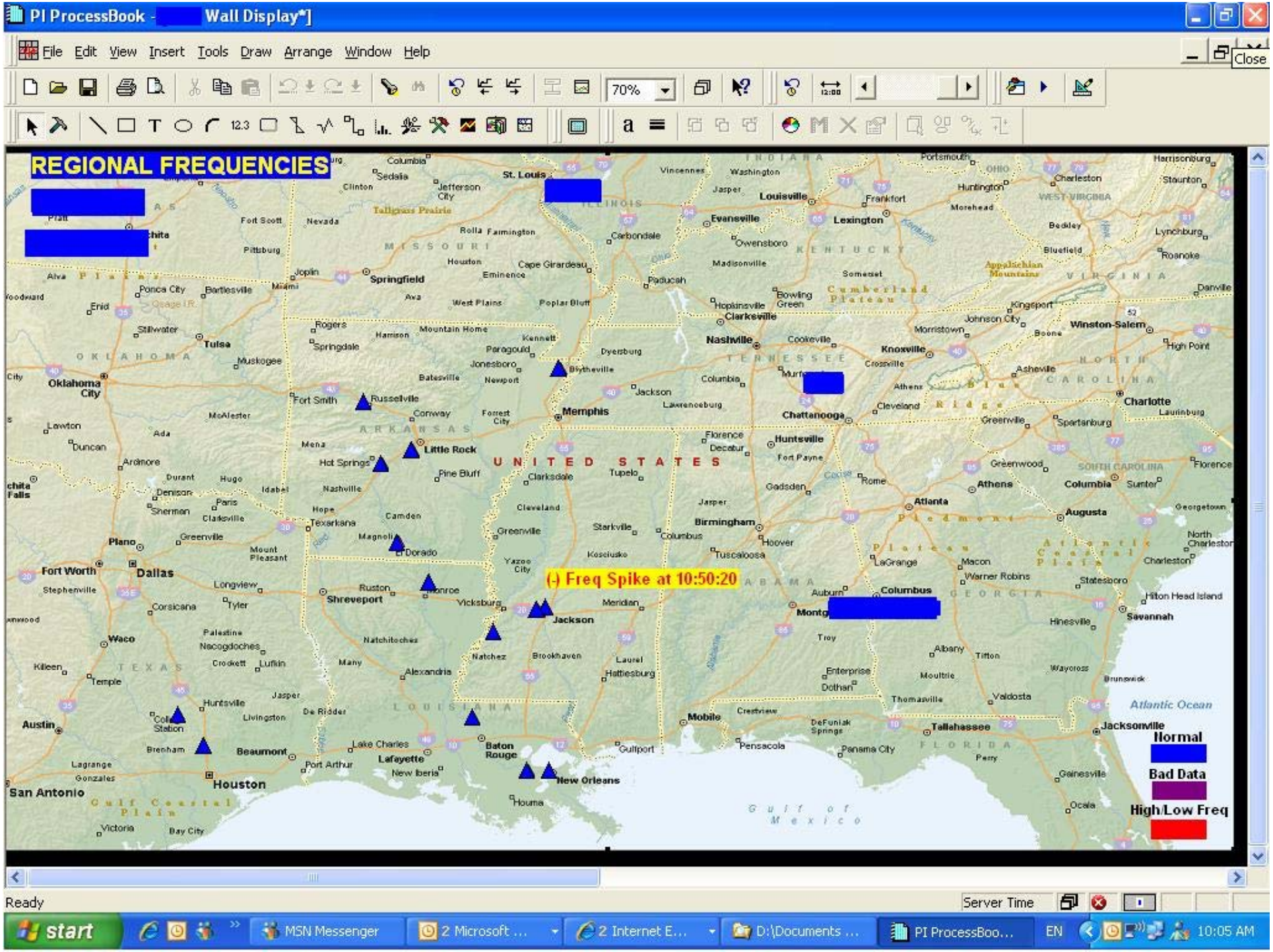
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[redacted]
(-) Freq Spike at 10:50:20
Normal
Bad Data
High/Low Freq
UNITED STATES
Gulf of Mexico
Atlantic Ocean
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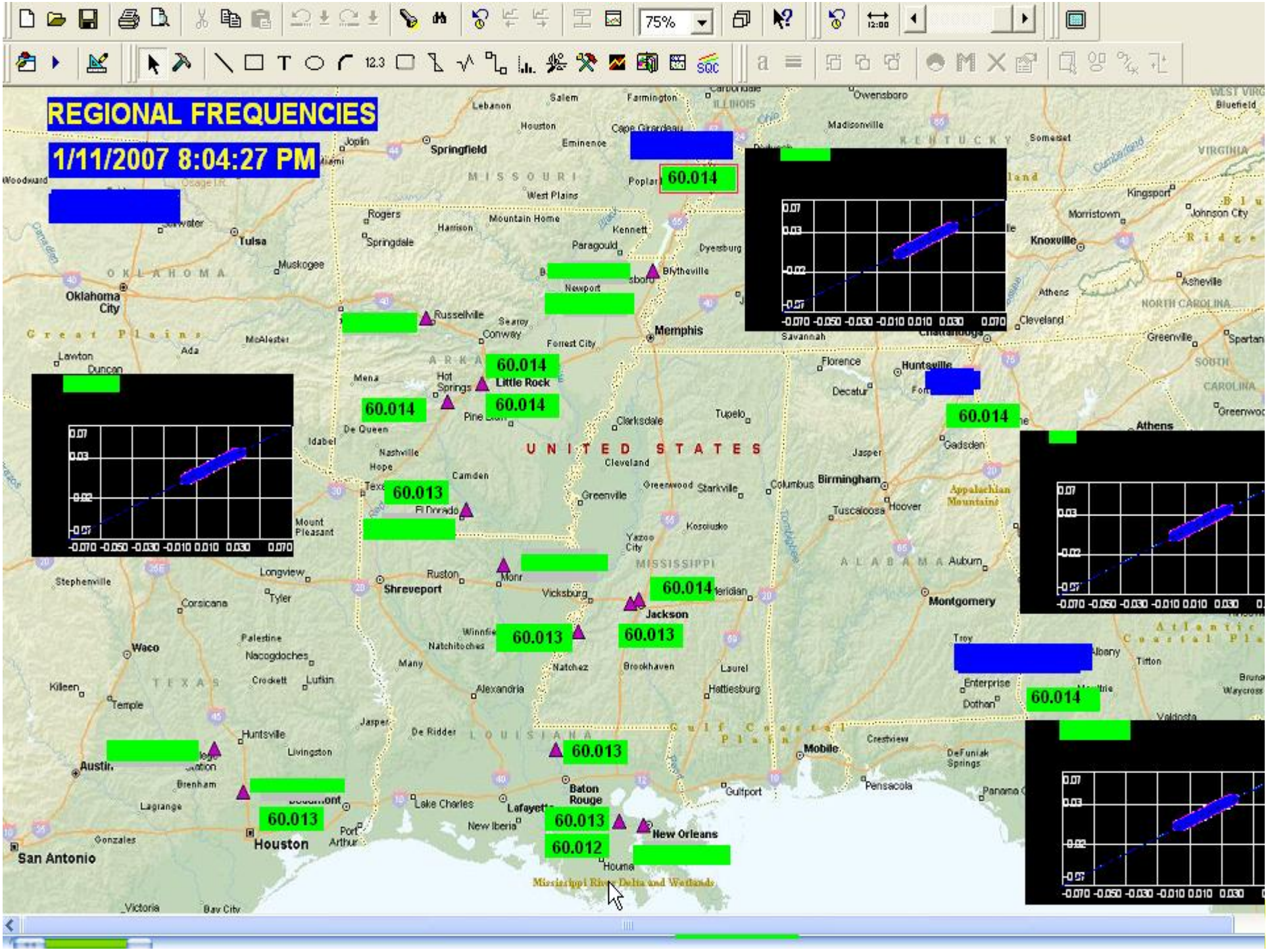
MSN Messenger
2 Microsoft ...
2 Internet E...
D:\Documents ...
PI ProcessBoo...
EN
10:05 AM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KENTUCKY
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Tulsa
Oklahoma City
Memphis
Little Rock
Shreveport
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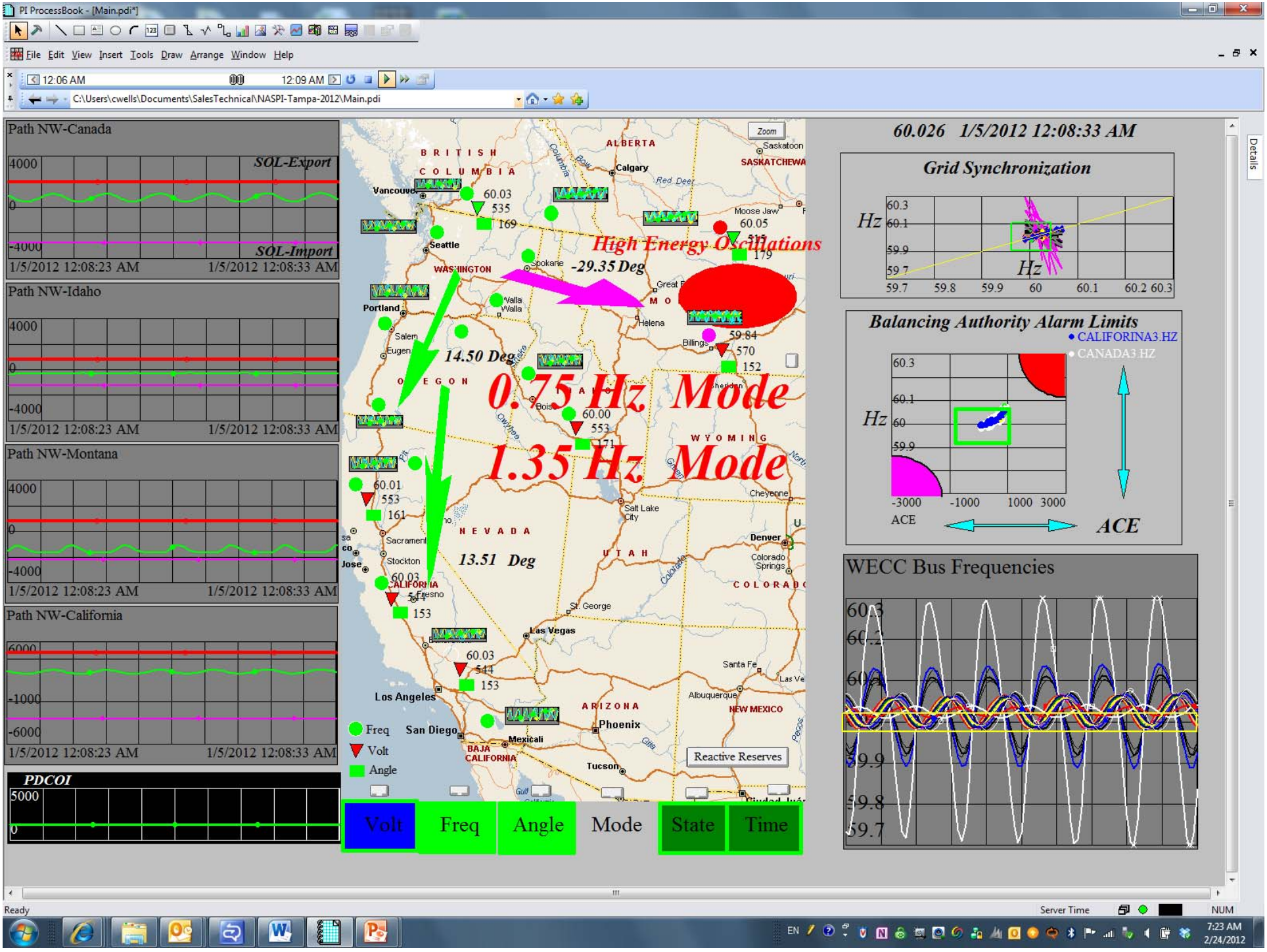
New Orleans
Houston
San Antonio
Austin
Birmingham
Montgomery
Mobile
Knoxville
Nashville
Atlanta
Mississippi River Delta and Wetlands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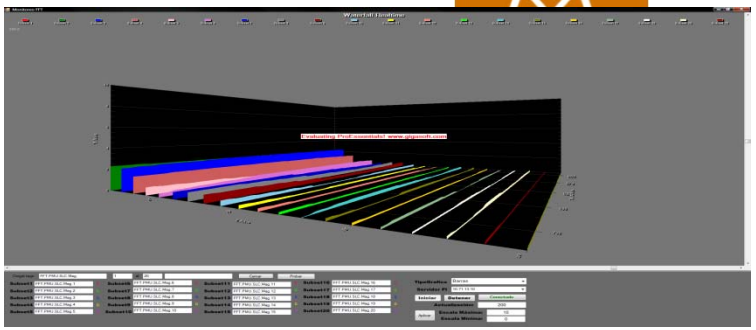
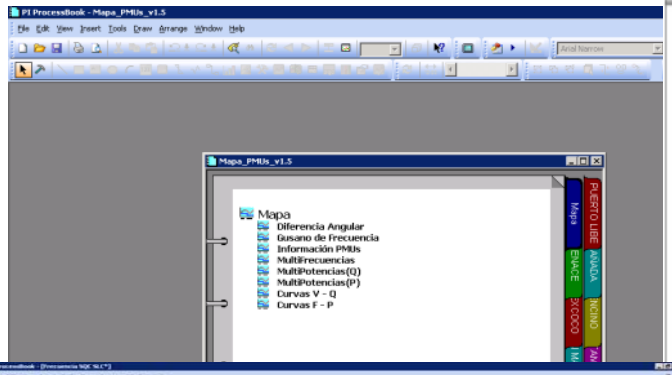
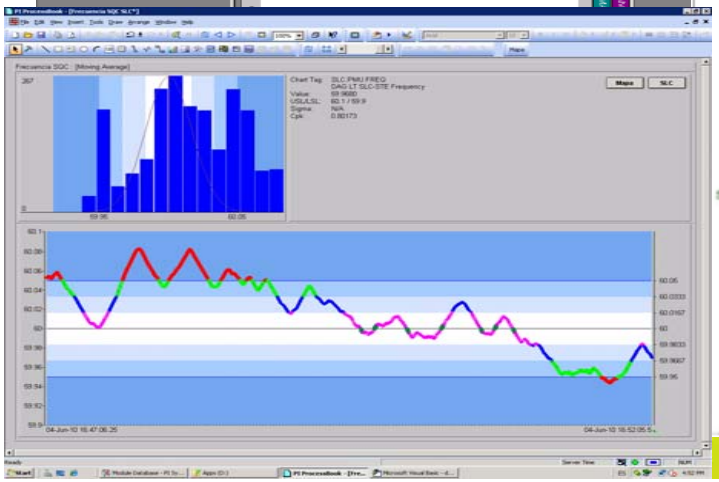
SOL-Export
SOL-Import
1/5/2012 12:08:23 AM
1/5/2012 12:08:33 AM
Path NW-Idaho
Path NW-Montana
Path NW-California
PDCOI
High Energy Oscillations
-29.35 Deg
14.50 Deg
0.75 Hz Mode
1.35 Hz Mode
13.51 Deg
Freq
Volt
Angle
Reactive Reserves
Volt
Freq
Angle
Mode
State
Time
60.026 1/5/2012 12:08:33 AM
Grid Synchronization
Balancing Authority Alarm Limits
CALIFORINA3.HZ
CANADA3.HZ
ACE
WECC Bus Frequencies
Ready
Server Time
NUM
7:23 AM
2/24/2012

Mexico Comision Federal de Electricidad (CFE)
Centro Nacional de Control de la Energía

MODICOSEN
(Dynamic Monitoring &
Control of the National Power System):







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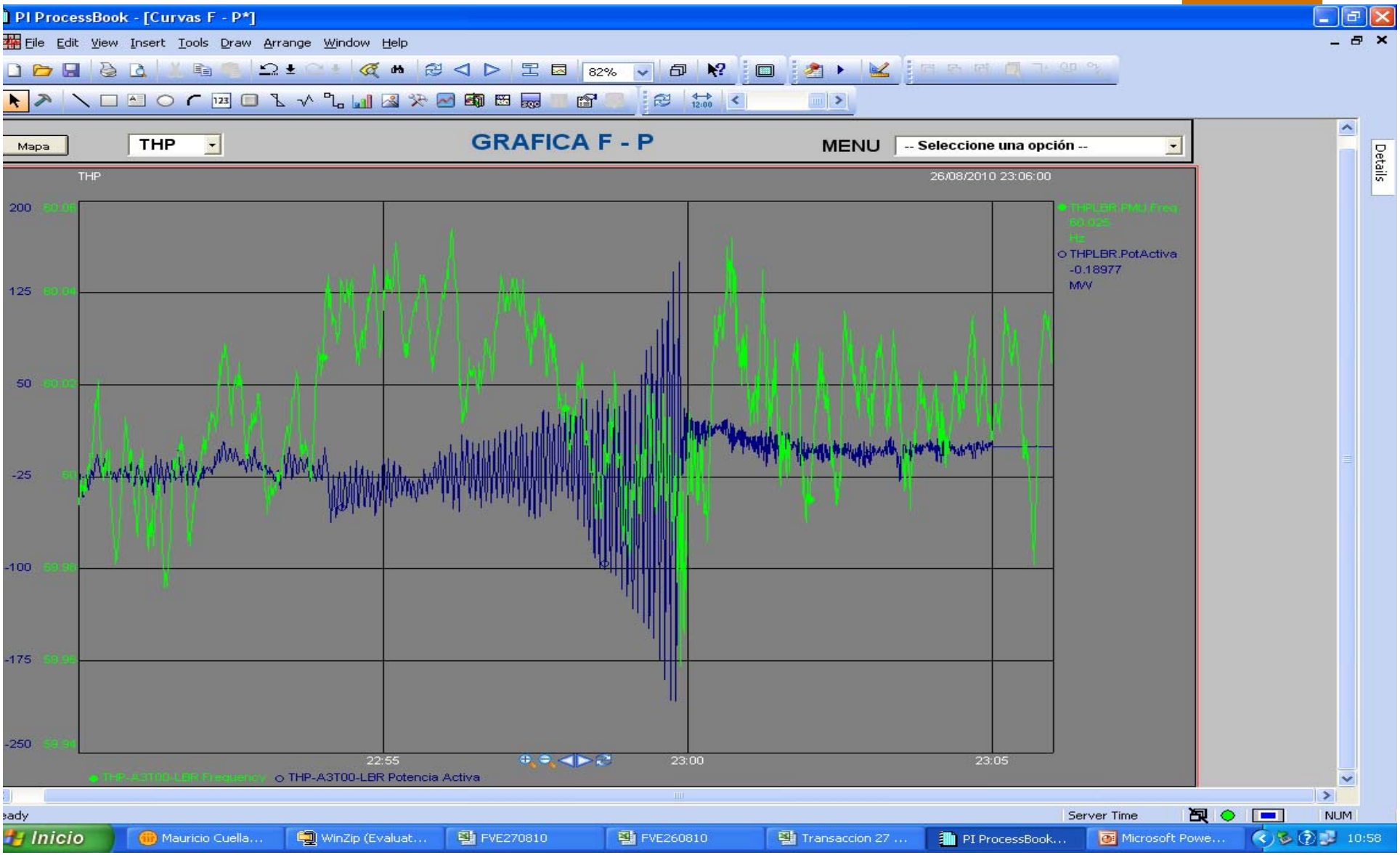
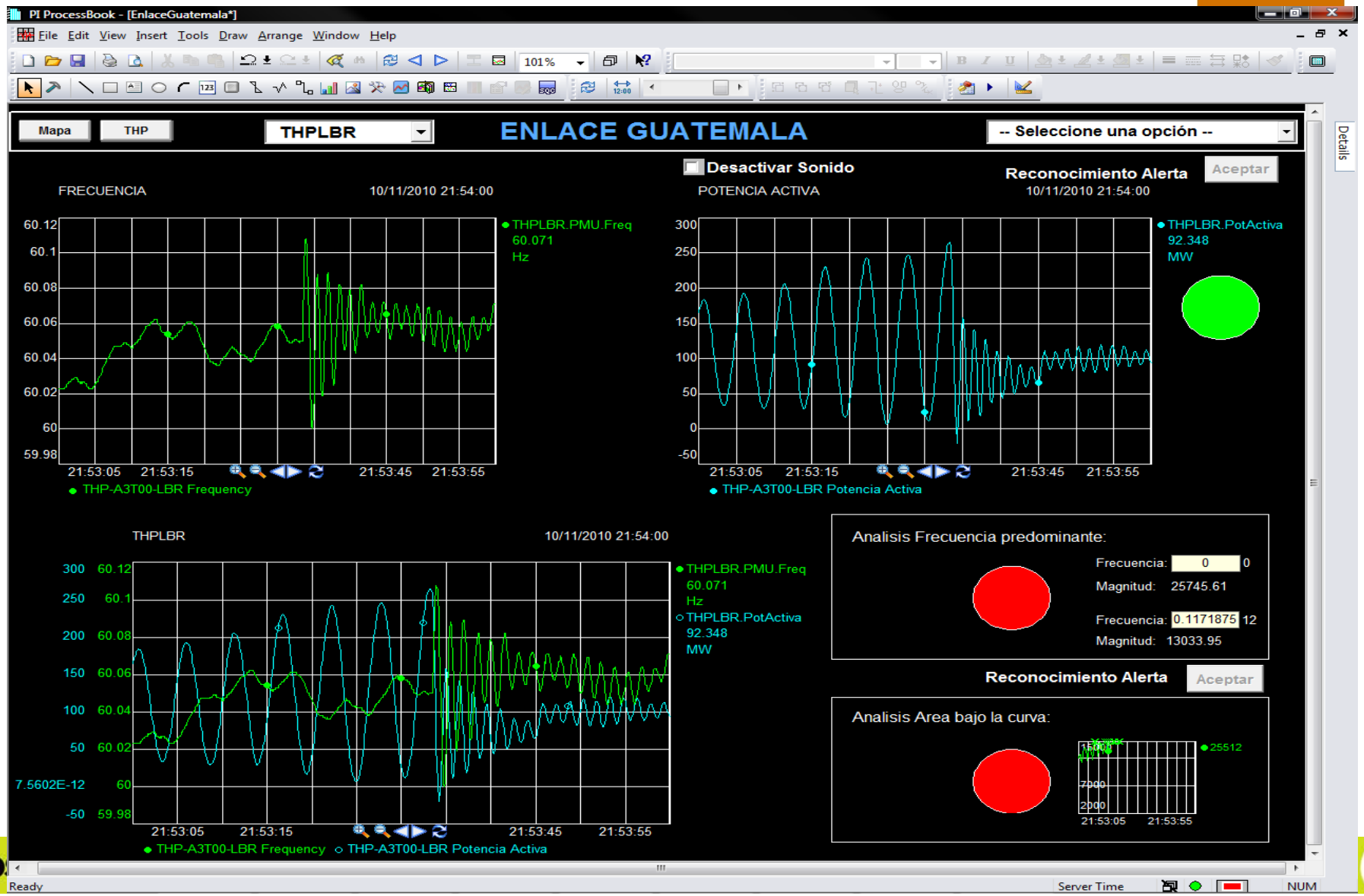
MODICOSEN Analytics

- Mexico – Guatemala Tie Line Event



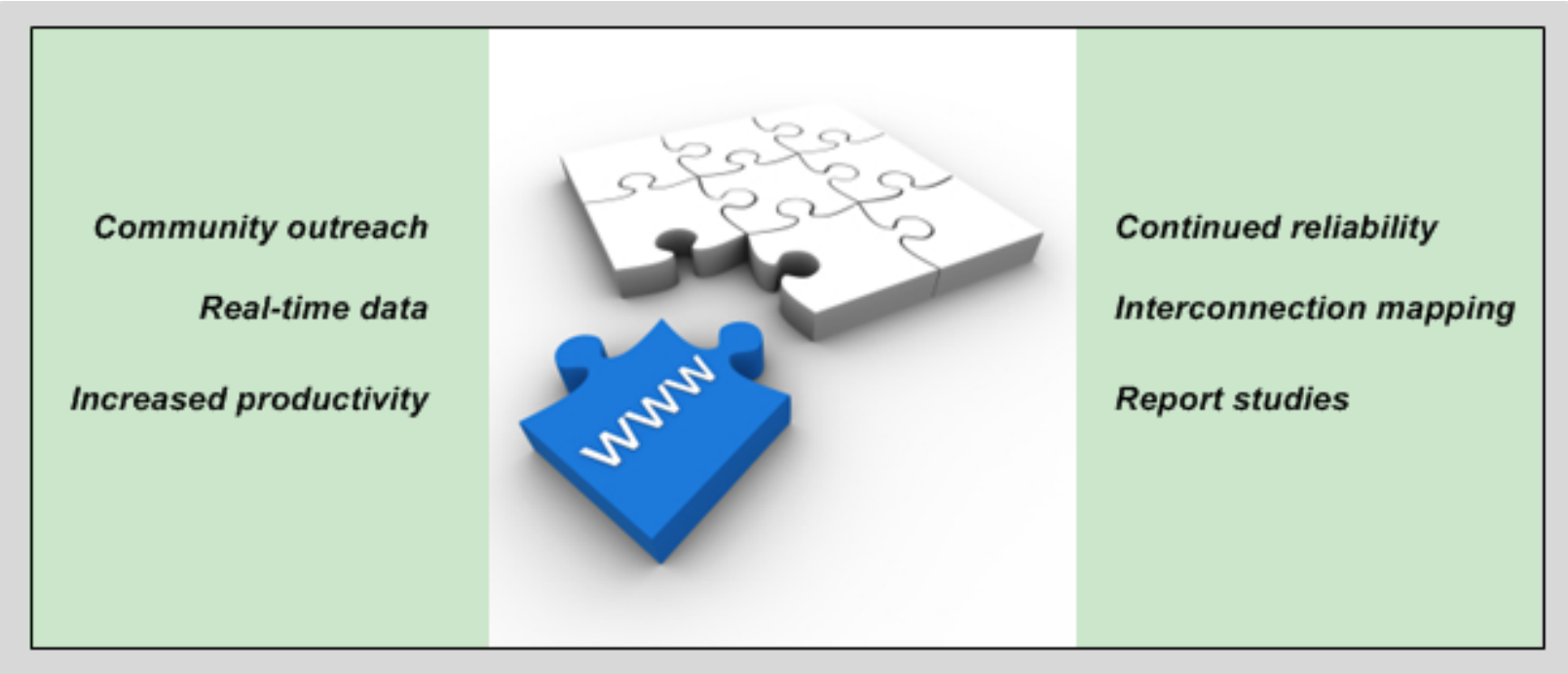
MODICOSEN Analytics

PI FFT Interface - Low Frequency Oscillations Detection and Alarming



WECC
Western Electricity Coordinating Council

Promoting Bulk Electric System Reliability



WECC Reliability Coordinator Website

Courtesy: Kirk Stewart – Manager Applications

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Wide-Area View (WAV)

- Content (note all driven from PI):
  - Path display (shows WECC paths loading)
  - Mode display (shows damping for WECC major modes of oscillations)
  - Voltage display (major voltages)
  - Frequency display (frequency within different BAs)
  - PMUs display (shows PMUs and their status)
  - Angle display (indicates angle differences among preselected voltages)

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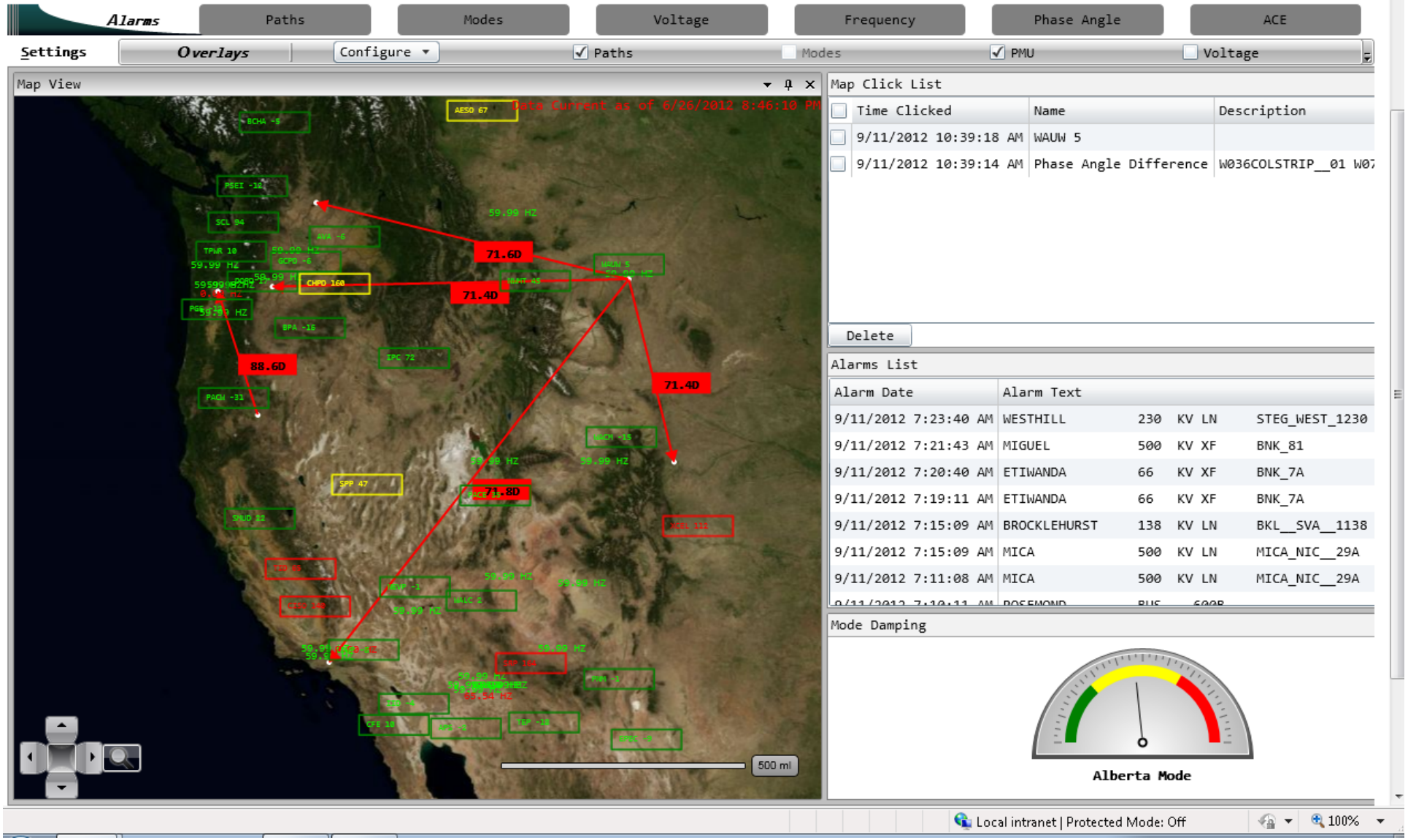

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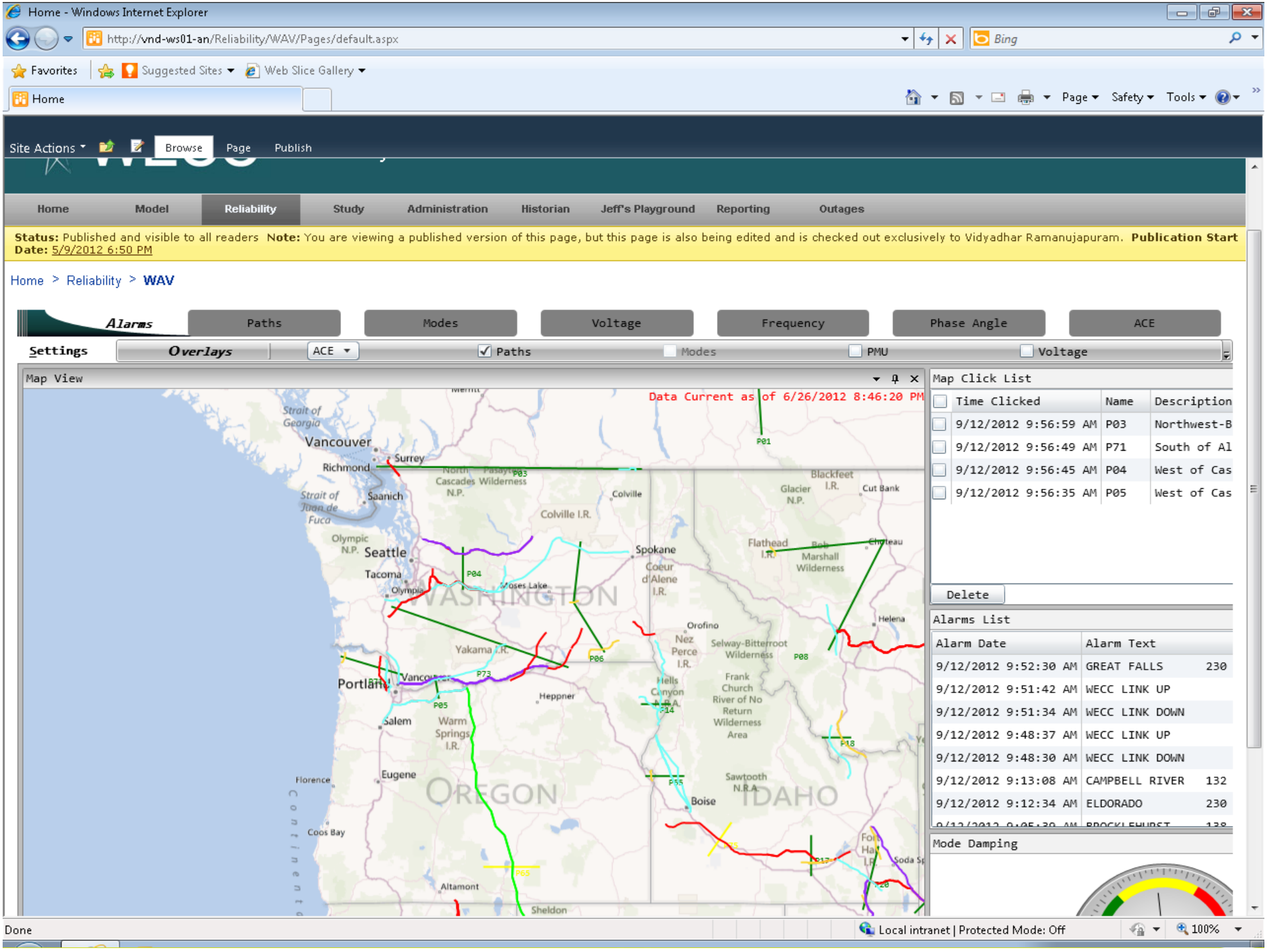
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http://vnd-ws01-an/Reliability/WAV/Pages/default.aspx
Bing
Favorites
Suggested Sites
Web Slice Gallery
Home
Page
Safety
Tools
Site Actions
Browse
Page
Publish
Home
Model
Reliability
Study
Administration
Historian
Jeff's Playground
Reporting
Outages
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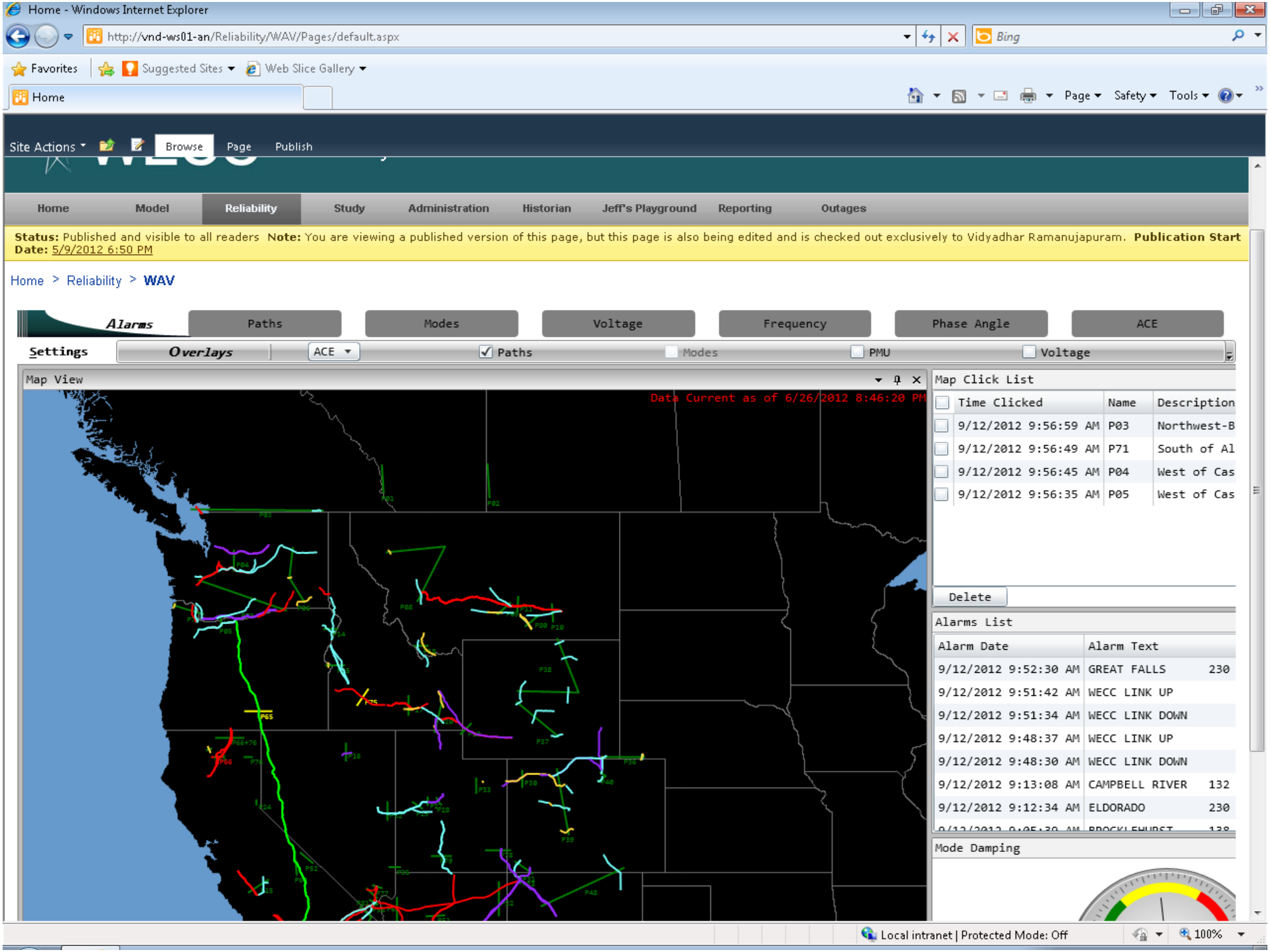
Home > Reliability > WAV
Alarms
Paths
Modes
Voltage
Frequency
Phase Angle
ACE
Settings
Overlays
ACE
Paths
Modes
PMU
Voltage
Map View
Data Current as of 6/26/2012 8:46:20 PM
Vancouver
Surrey
Richmond
Saanich
Seattle
Tacoma
Olympia
Spokane
Coeur d'Alene I.R.
Moses Lake
Yakama I.R.
Portland
Salem
Eugene
Heppner
Warm Springs I.R.
Colville
Colville I.R.
Blackfeet I.R.
Glacier N.P.
Cut Bank
Flathead I.R.
Marshall Wilderness
Helena
Orofino
Nez Perce I.R.
Selway-Bitterroot Wilderness
Frank Church River of No Return Wilderness Area
Hells Canyon N.A.
Sawtooth N.R.A.
Boise
Florence
Coos Bay
Altamont
Sheldon
WASHINGTON
OREGON
IDAHO
P01
P03
P04
P05
P06
P08
P14
P18
P55
P65
P73
Map Click List
Time Clicked
Name
Description
9/12/2012 9:56:59 AM P03 Northwest-B
9/12/2012 9:56:49 AM P71 South of Al
9/12/2012 9:56:45 AM P04 West of Cas
9/12/2012 9:56:35 AM P05 West of Cas
Delete
Alarms List
Alarm Date
Alarm Text
9/12/2012 9:52:30 AM GREAT FALLS 230
9/12/2012 9:51:42 AM WECC LINK UP
9/12/2012 9:51:34 AM WECC LINK DOWN
9/12/2012 9:48:37 AM WECC LINK UP
9/12/2012 9:48:30 AM WECC LINK DOWN
9/12/2012 9:13:08 AM CAMPBELL RIVER 132
9/12/2012 9:12:34 AM ELDORADO 230
Mode Damping
Done
Local intranet | Protected Mode: Off
100%


Home - Windows Internet Explorer
http://vnd-ws01-an/Reliability/WAV/Pages/default.aspx
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Suggested Sites
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Home
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9/12/2012 9:13:08 AM CAMPBELL RIVER 132
9/12/2012 9:12:34 AM ELDORADO 230
Mode Damping
Local intranet | Protected Mode: Off
100%

Real Time Displays - Windows Internet Explorer

http://vnd-ws01-an/Reliability/Pages/Real-Time-Displays.aspx

Favorites | Suggested Sites | Web Slice Gallery

Real Time Displays

Page | Safety | Tools

Site Actions | Browse | Page | Publish

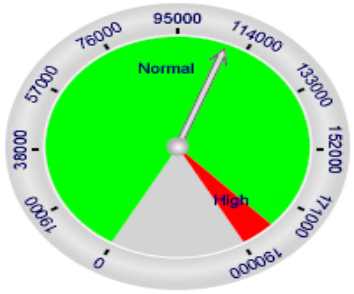
Home | Model | Reliability | Study | Administration | Historian | Jeff's Playground | Reporting | Outages

Status: Checked out and editable. **Publication Start Date:** Immediately

Home > Reliability > **Real Time Displays**

WECC TOTALS

WECC LOAD



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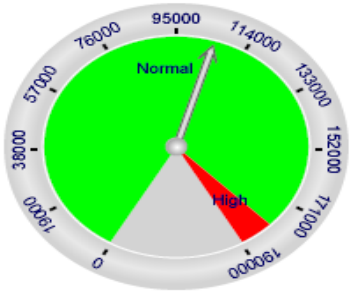
WECC GENERATION



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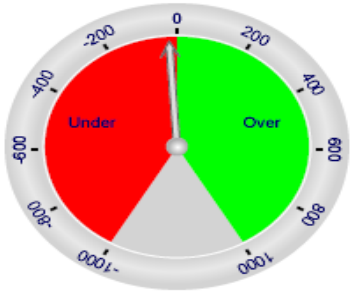
WECC ACE



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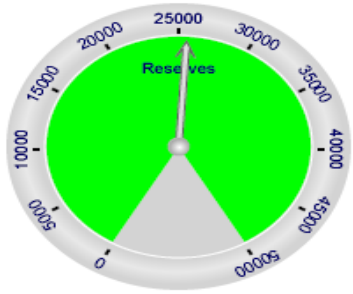
WECC ACT OPER RESERVE



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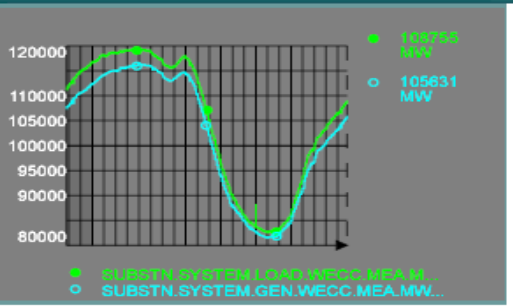
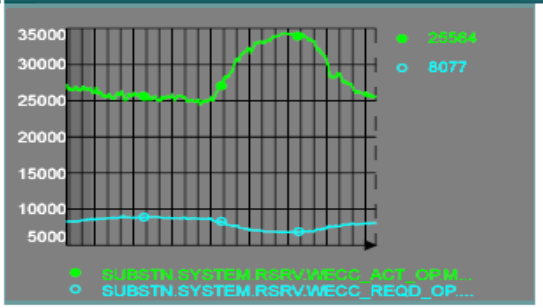
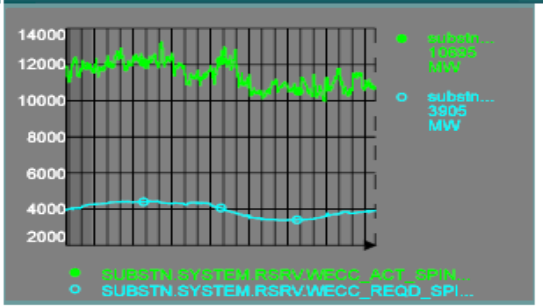
Load Verse Generation 24 Hours



Operating Reserves 24 Hours

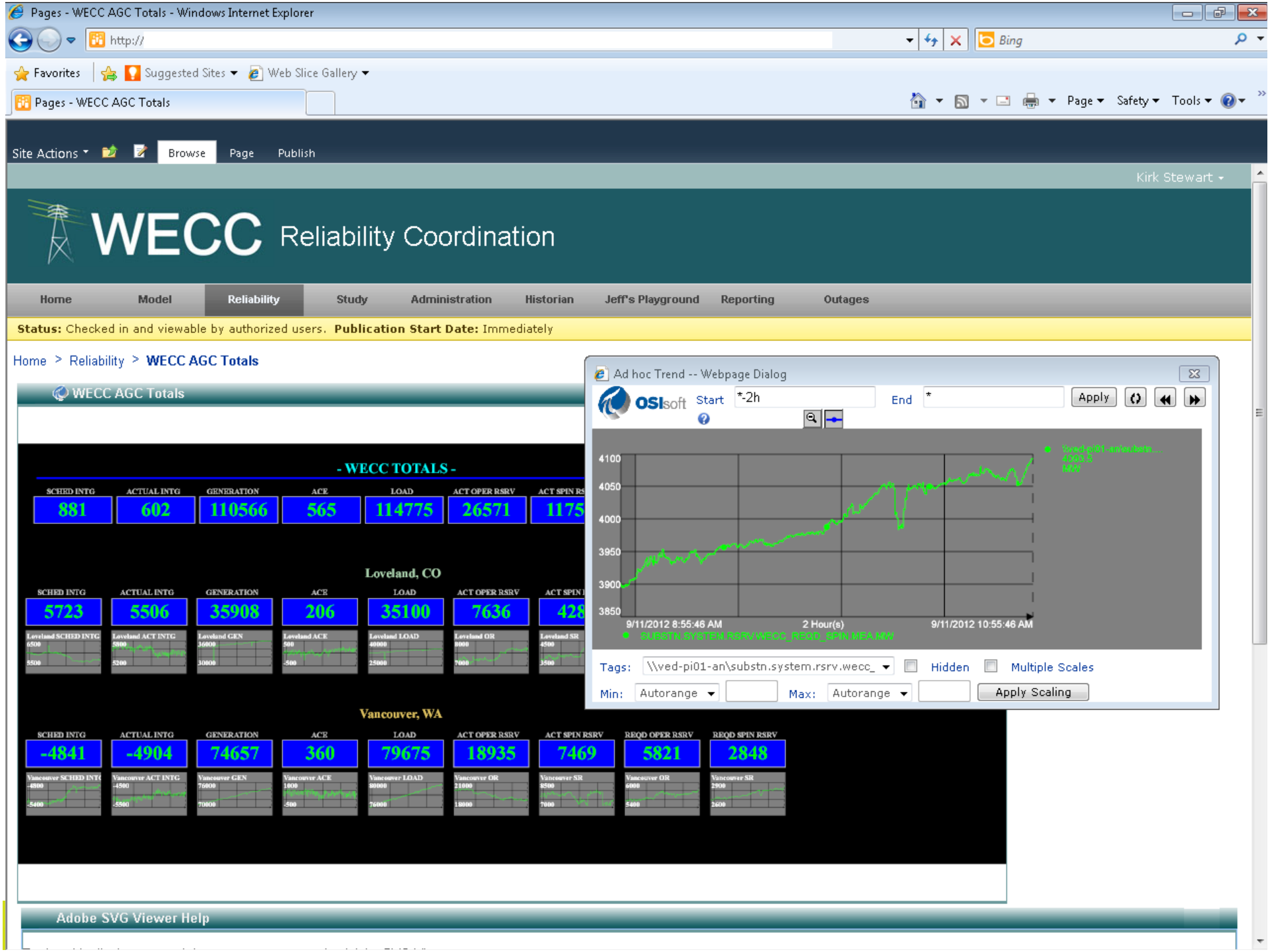


Spinning Reserves 24 Hours



The WECC RC maintains a vast array of applications to perform the Reliability Coordination function. This section of the site makes available many of the same displays the RC

Done | Local intranet | Protected Mode: Off | 100%


Pages - WECC AGC Totals - Windows Internet Explorer
http://
Bing
Favorites
Suggested Sites
Web Slice Gallery
Pages - WECC AGC Totals
Page
Safety
Tools
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Browse
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Kirk Stewart
WECC Reliability Coordination
Home
Model
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Jeff's Playground
Reporting
Outages
Status: Checked in and viewable by authorized users. Publication Start Date: Immediately
Home > Reliability > WECC AGC Totals
WECC AGC Totals
- WECC TOTALS -
SCHED INTG
ACTUAL INTG
GENERATION
ACE
LOAD
ACT OPER RSRV
881
602
110566
565
114775
26571
Loveland, CO
5723
5506
35908
206
35100
7636
Vancouver, WA
-4841
-4904
74657
360
79675
18935
7469
5821
2848
REQD OPER RSRV
REQD SPIN RSRV
Ad hoc Trend -- Webpage Dialog
OSIsoft
Start
*-2h
End
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Apply
4100
4050
4000
3950
3900
3850
9/11/2012 8:55:46 AM
2 Hour(s)
9/11/2012 10:55:46 AM
Tags:
\\ved-pi01-an\substn.system.rsrv.wecc_
Hidden
Multiple Scales
Min:
Autorange
Max:
Autorange
Apply Scaling
Adobe SVG Viewer Help

Pages - WECC Path Map - Windows Internet Explorer

http://

Bing

Favorites | Suggested Sites | Web Slice Gallery

Pages - WECC Path Map

Page | Safety | Tools

Site Actions | Browse | Page | Publish

Kirk Stewart

WECC Reliability Coordination

Home | Model | Reliability | Study | Administration | Historian | Jeff's Playground | Reporting | Outages

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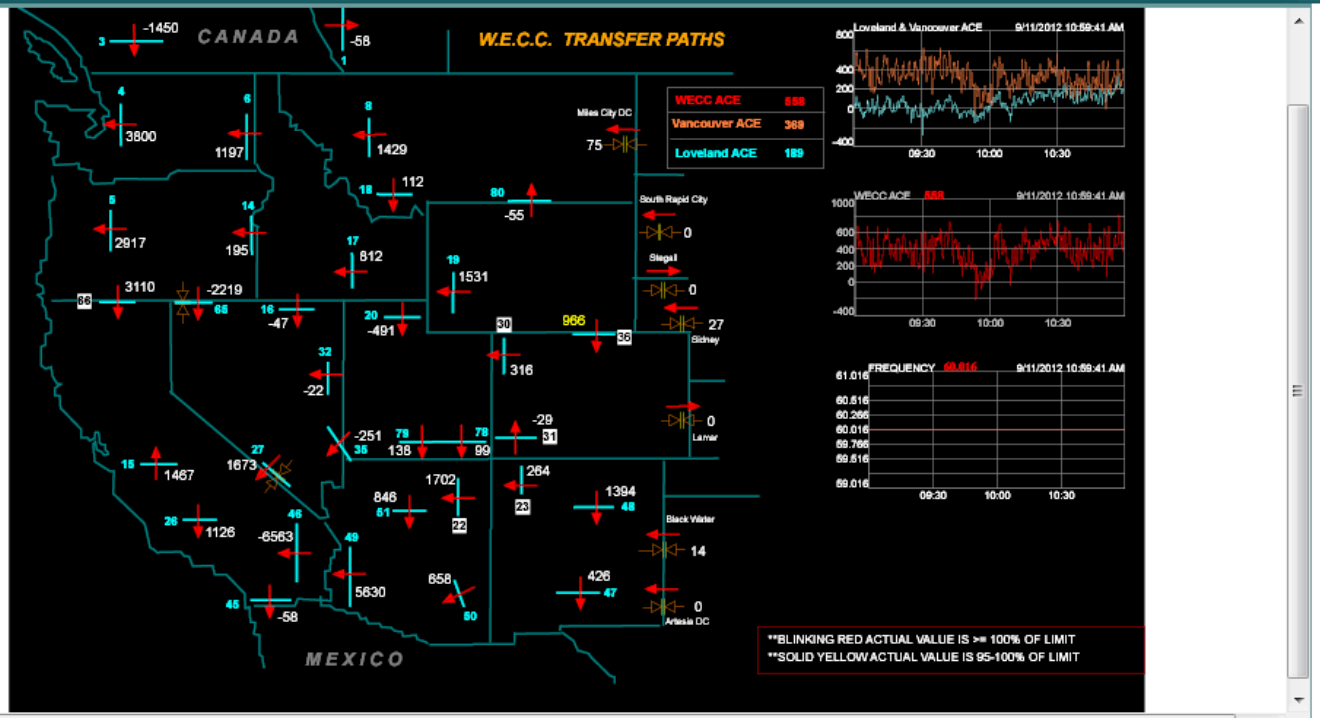
Home > Reliability > **WECC Path Map**

WECC Path Map



Adobe SVG Viewer Help

SVG Display Controls

Local intranet | Protected Mode: Off

100%

My Reporting

- Enables users to subscribe to events and be notified via e-mail when they have occurred
- Generates automatic reports from pre-defined events
- Provides download links to event-related data for post-mortem analysis using offline tools

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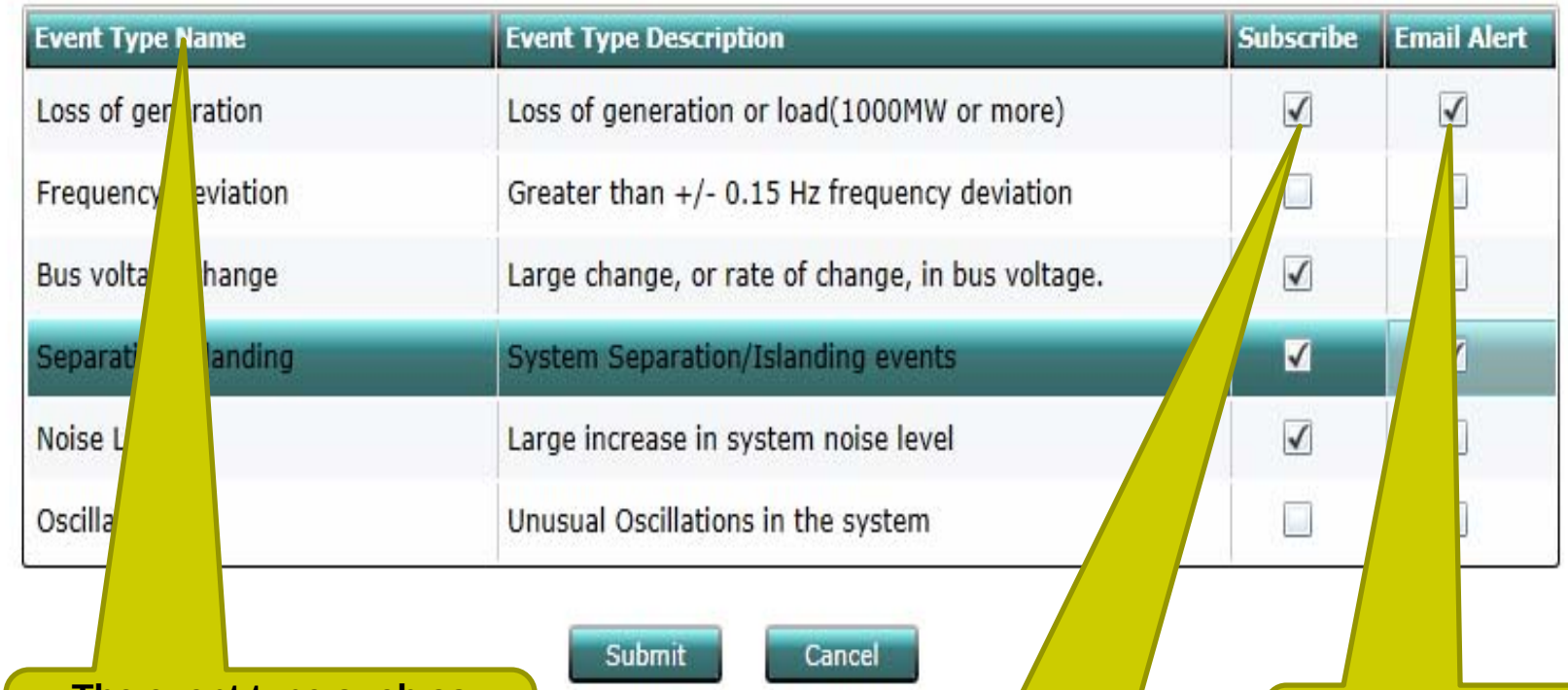
Subscribe Events Screen

This screen enables users to subscribe to pre-defined events and have email notifications delivered to their email address when the event occurs.



The event type such as Breaker Trip or Frequency Deviation

Check to subscribe. Event will show up using My Events Filter on View Events Screen.

Click the check box to have email notifications sent to your inbox.

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View Events Screen

Select a start and end date to restrict the event list to a specific time period.

By default, it displays only events that have occurred that you have subscribed to. Clicking and Selecting View will display all events.

Click to view data files.

Click to view reports.

WISPViewer

Start-Date/Time <M/d/yyyy> 15

End-Date/Time <M/d/yyyy> 15

Select Events View My Events

Submit

Event Type	Event Details	Date Time	Reports	DataFiles
Loss of generation	Loss of generation or load(1000MW or more)	9/27/2011 4:00:00		
Frequency Deviation	Greater than +/- 0.15 Hz frequency deviation	9/27/2011 4:00:00		
Bus voltage change	Large change, or rate of change, in bus voltage	10/3/2011 4:00:00		
Separation/Islanding	System Separation/Islanding events	10/3/2011 4:00:00		
Noise Level	Large increase in system noise level	10/3/2011 4:00:00		
Oscillations	Unusual Oscillations in the system	10/3/2011 4:00:00		

What is a Signal Registry at its Core?

- WECC's Registry Approach:
  1. A listing of Devices with an associated set of META data that defines each device.
  2. A listing of Measurements with an associated set of META data defining the measurement.
  3. A hierarchy that defines how the Devices and Measurements relate to each other.

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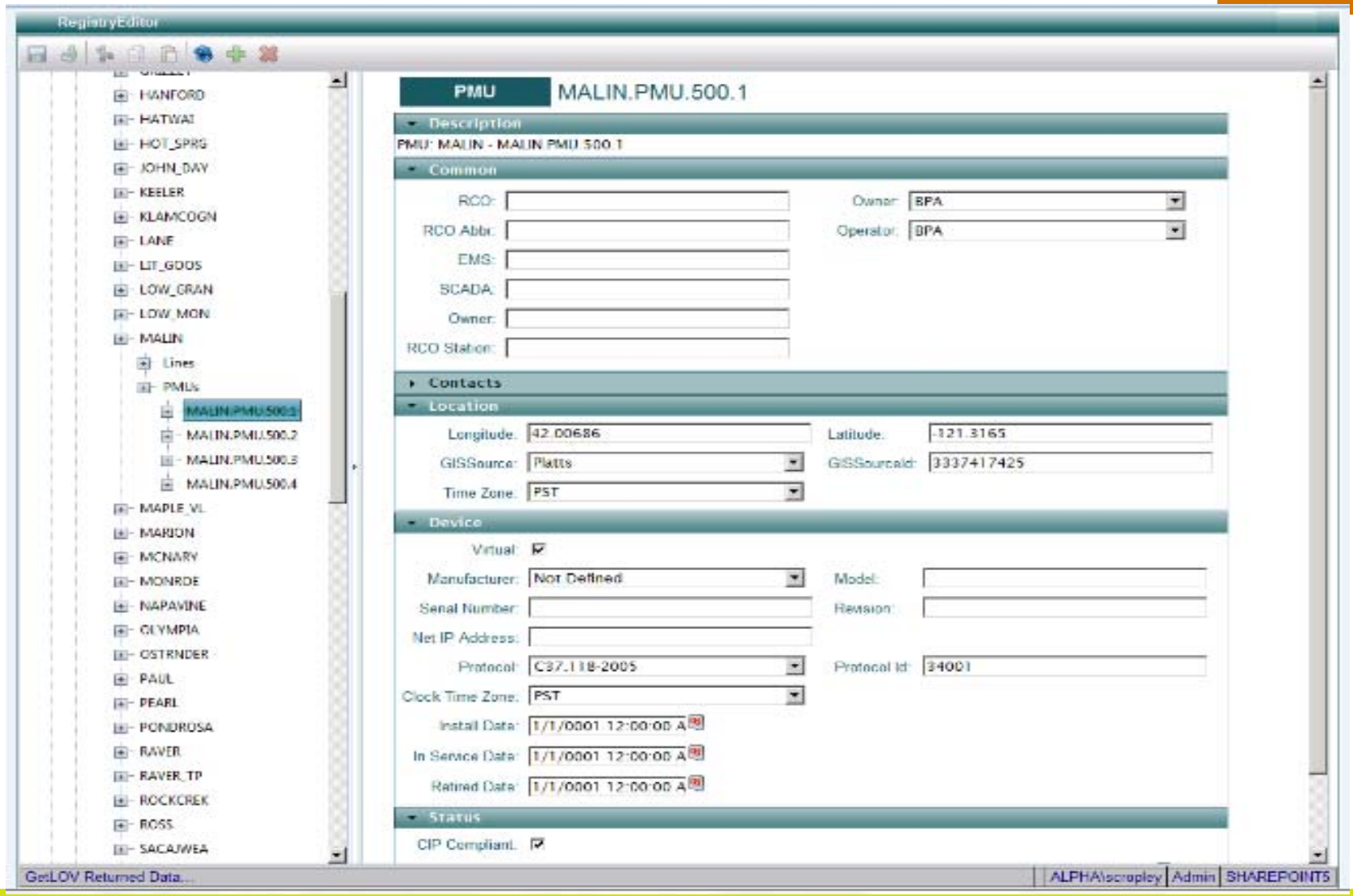
PMU META Data



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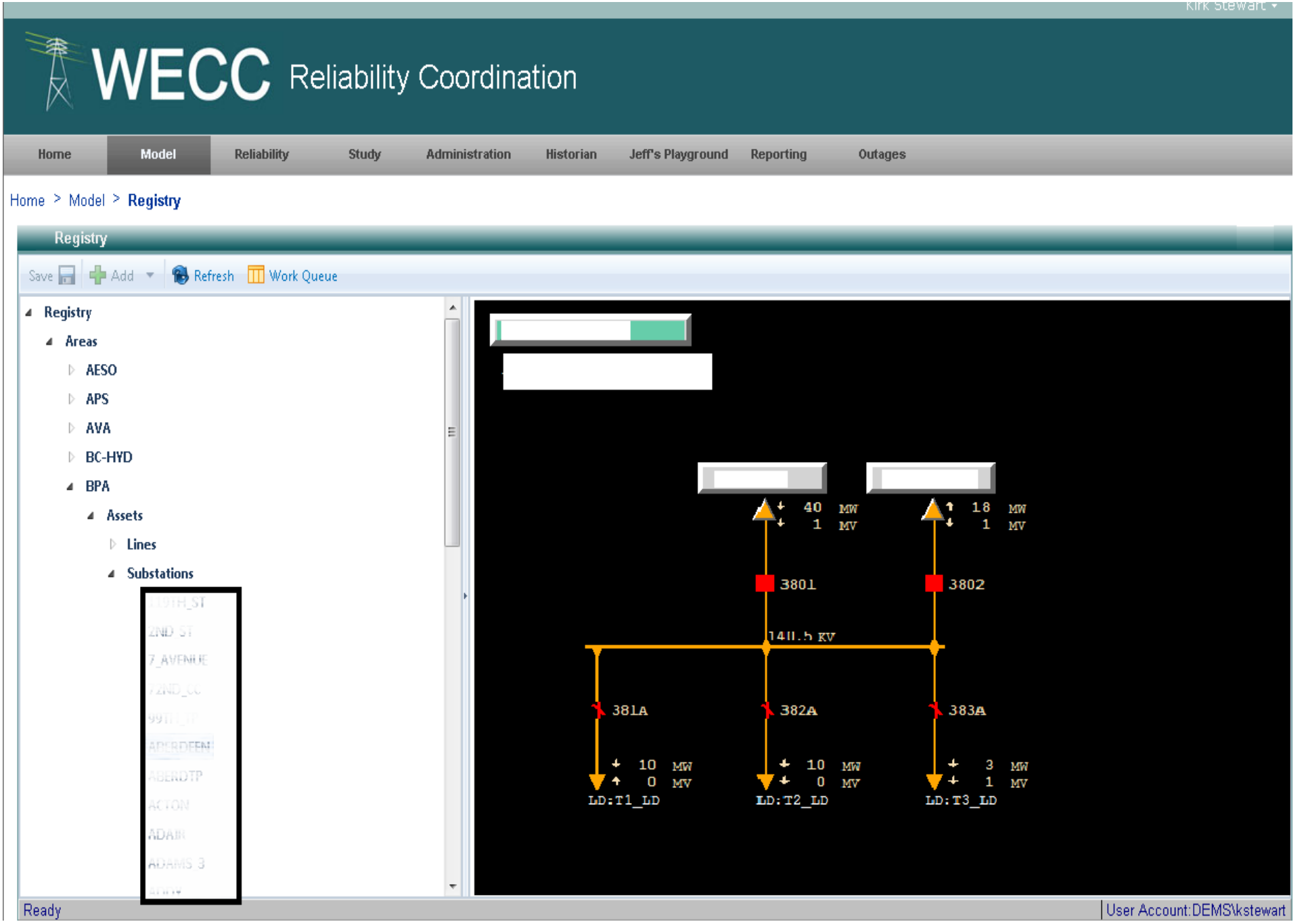

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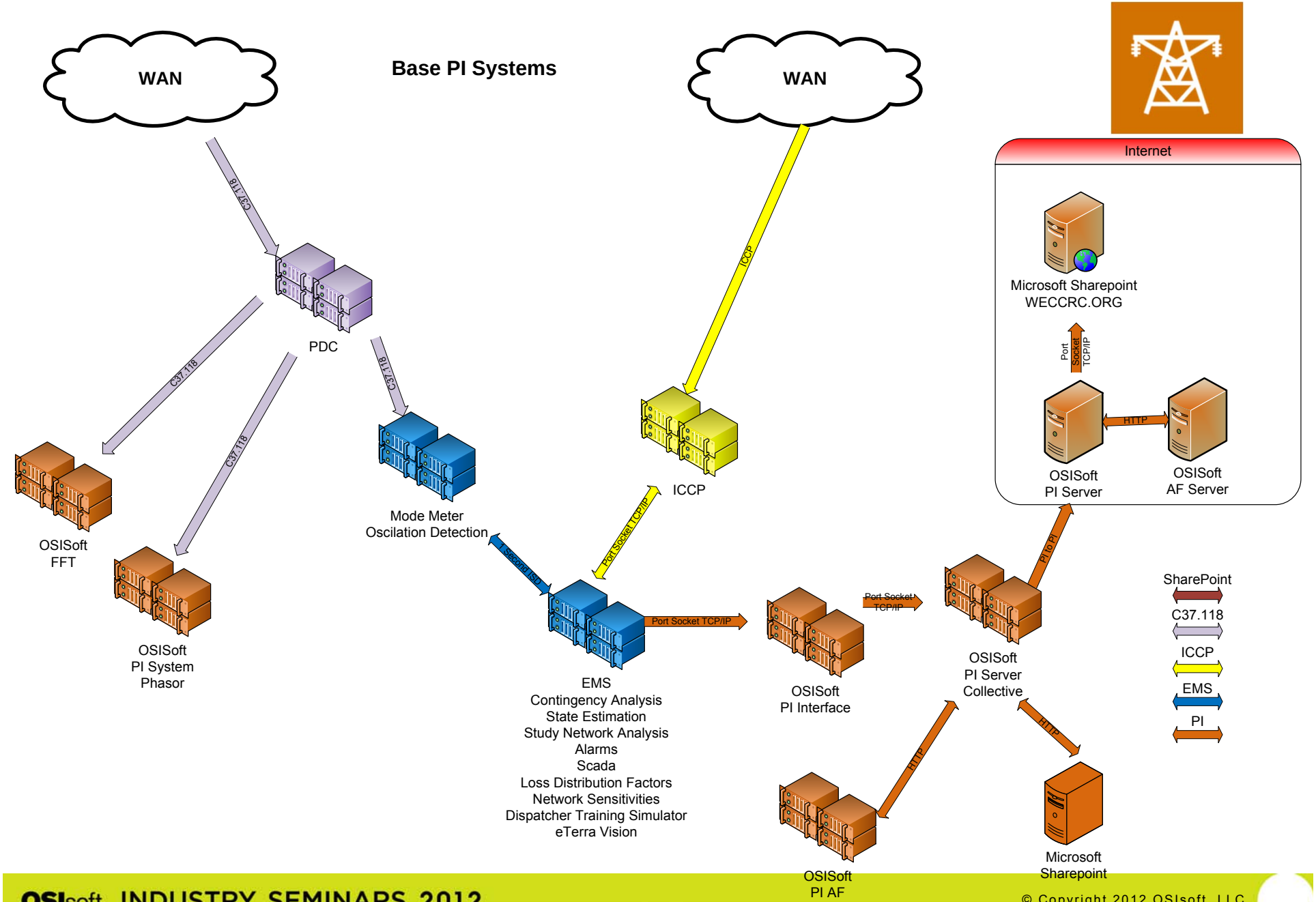

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3. PI for Asset Management and Proactive Maintenance

SDGE

A Sempra Energy utility®

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Sempra Energy Utilities OpEx 20/20

- In 2006, a team of employees developed a roadmap to prepare company for future success. The plan includes a renovation of the systems that support our operations. These initiative were named:

OpEx20|20
A Clear Vision for Continuing Operational Excellence

- The program's technology and process improvements will enable our utilities to *continue* to deliver our commitment of **Op**erational **Ex**cellence**.**
- **20/20** symbolizes a clear, sharp vision guiding our efforts.

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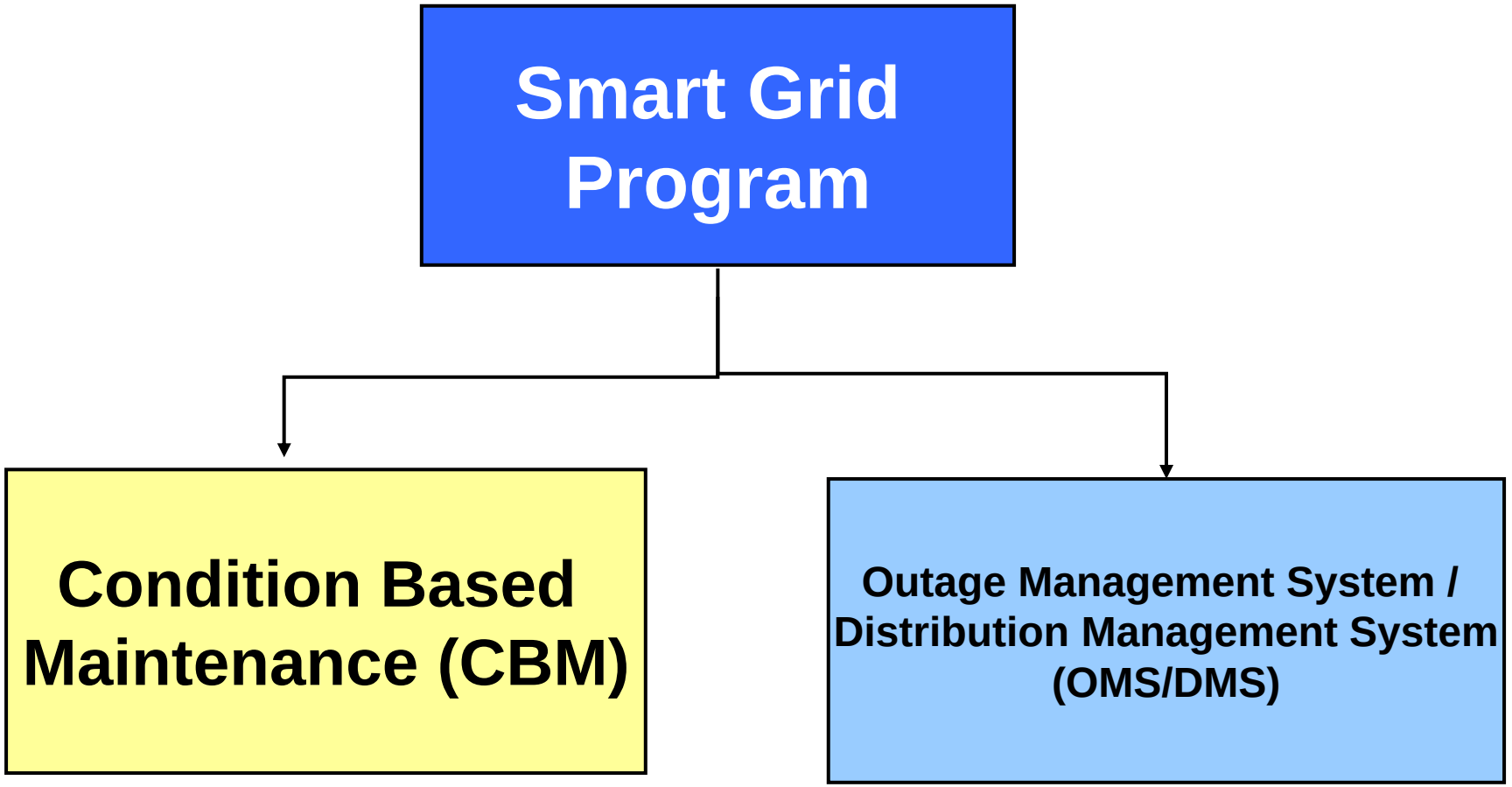
OpEx 20/20: Smart Grid Program



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CBM – Data Integration

- Weekly general inspections
  - ***LTC operations***
  - ***Alarms, temperature, visual***
- Monthly equipment inspections
  - ***Operation counters***
  - ***Temperature, Pressure***
  - ***Voltage***
  - ***Functional check***
- General asset
  - ***Rating***
  - ***Age, Type, Design***
  - ***Operating limits***
- Operational
  - ***Relays & Digital fault recorders***
  - ***PQ Monitors***
- Specific equipment
  - ***Operating conditions***
  - ***Stress factors***
  - ***Trouble history***
  - ***Maintenance data***
  - ***Oil test data***
  - ***Electrical test data***
  - ***Operating speed***
- Real-time
  - ***Voltage & Current***
  - ***Temperature***
  - ***Bushing On-line Power Factor***
  - ***Hydrogen in Oil***
- Simulated
- System & Engineering

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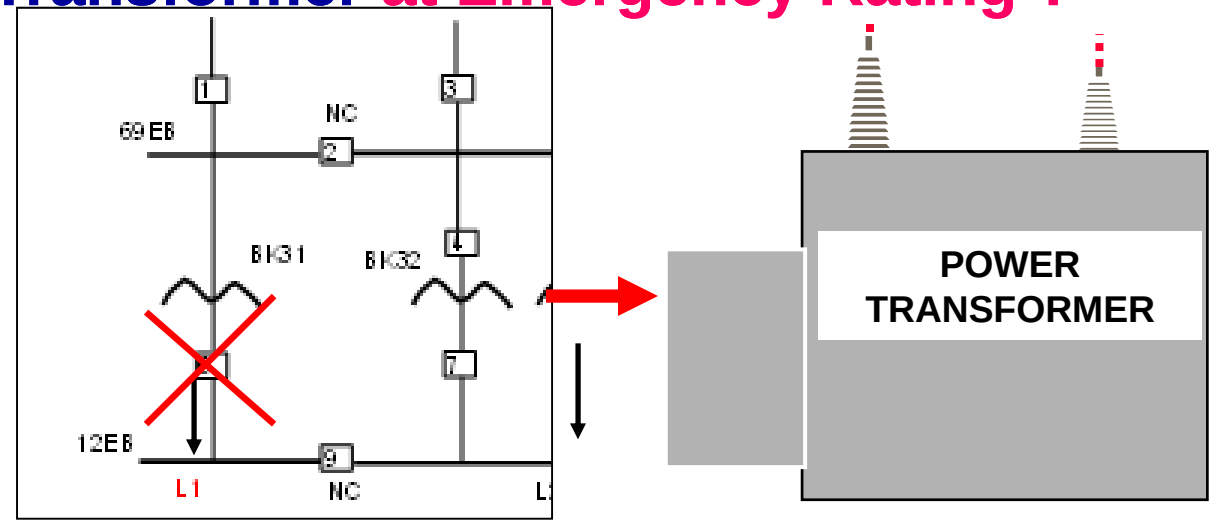
Operations Decision Support

Transformer at Emergency Rating ?



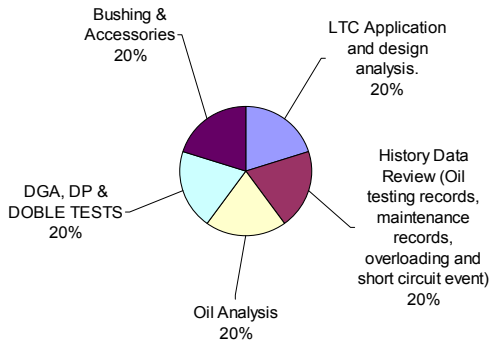
TRANSFORMER Health Indices

- Insulation Power Factor
- LTC Application & Design
- Oil Conditions
- Bushing & Accessories
- Operating History & Conditions

Paper Insulation Health

Location of Paper Sample	Degree of Polymerization (DP)
NLTC – Phase A	586
NLTC – Phase B	737
69kV Bushing C	688

New Insulation Paper: 1000 < DPv < 1300
Middle Aged Insulation Paper: DPv = 500
Old Age Insulation Paper: DPv < 251
Severely Degraded Insulation Paper: DPv < 151



Transformer Operating Limits

PTLOAD-Design - ...ion_ Assessment\eprisoft\El Cajon Bk33 64 mva.run

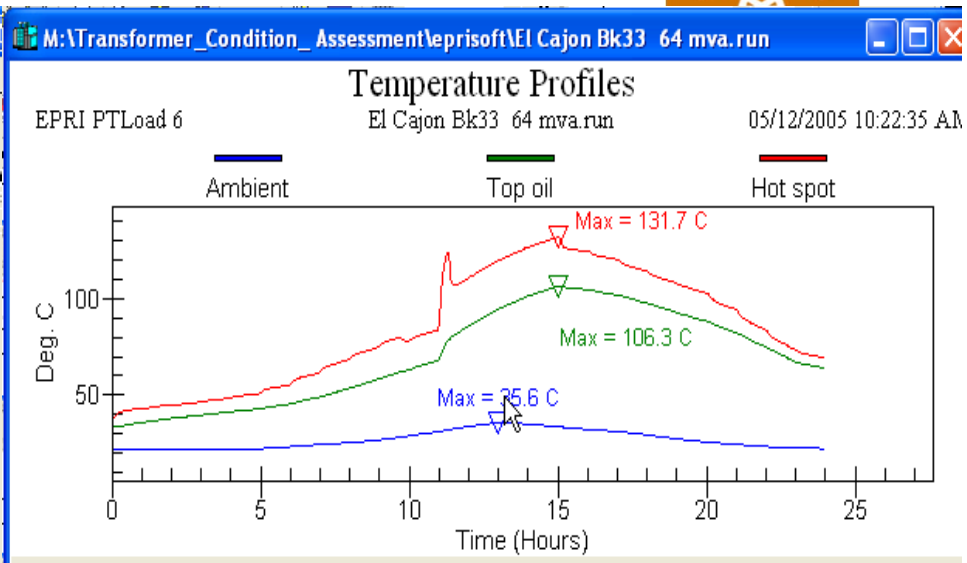
File Edit Tools Options Help

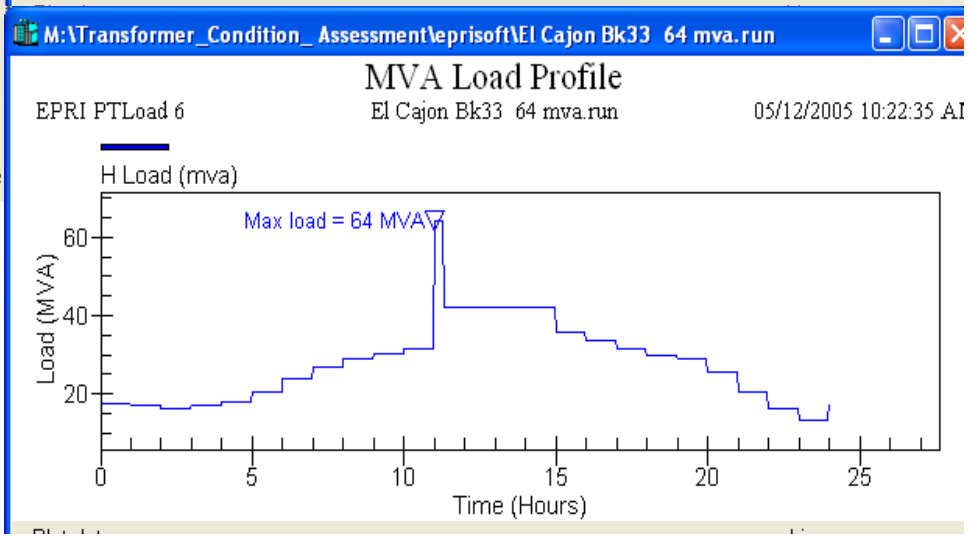
Transformer | Cooling | Ambient Cycle | Load Cycle | Bubbles | Calc Type | Results

A. OUTPUT SUMMARY

```
Date of Calculation        = 05/12/2005 10:22:35 AM
Number Iterations          = 6
Limiting factor            = Fixed upper limit
Contingency Load (Amps)    = 2963.145
Peak Load (MVA)            = 64
Peak Load (Amps)           = 2963.145
Peak Load (PU)             = 2.285714
** Warning: ratings in excess of 2.0 P.U. are not supported
by IEEE guidelines and the results may be unreliable.
Max Hot Spot (Deg C)       = 131.64
Max Top Oil (Deg C)        = 106.19
Peak Age Accel Factor      = 8.1068
Cumulative % Loss of Life  = 0.01401
Max Bubble Risk (mmHg)     = -799.5175

Bubbles are not likely to form given the temperature and load profile
```





Comparison of hot spot rise over top oil simulated versus actual

	Top Oil	Hot Spot	LOL
IEEE	105	176	.149
Ptload	105	145	.039
Actual HS rise	106	131	.014

Decision: Based on Transformer Unit Health and Real Time Conditions

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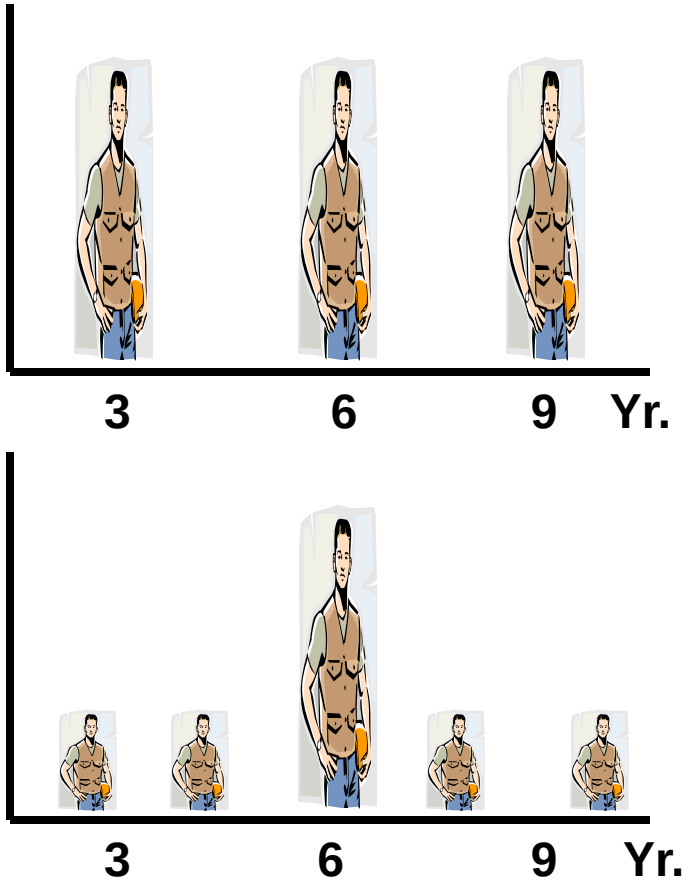
Time-based to CBM – Circuit Breakers

Data Available

- **Weekly safety inspections**
- **Monthly equipment insp.**
- **Asset Data**
- **Historical Data**
  - Operating conditions
  - Stress factors
  - Trouble
  - Maintenance data
  - Test data (insul & elec)
- **Operational data**
  - Relays & Digital fault recorders
  - PQ Monitors
- **Real-time data**
  - Voltage & Current
  - I^2T and Contact Wear
  - Operations Counter

Maintenance Intervals



Planned Approach

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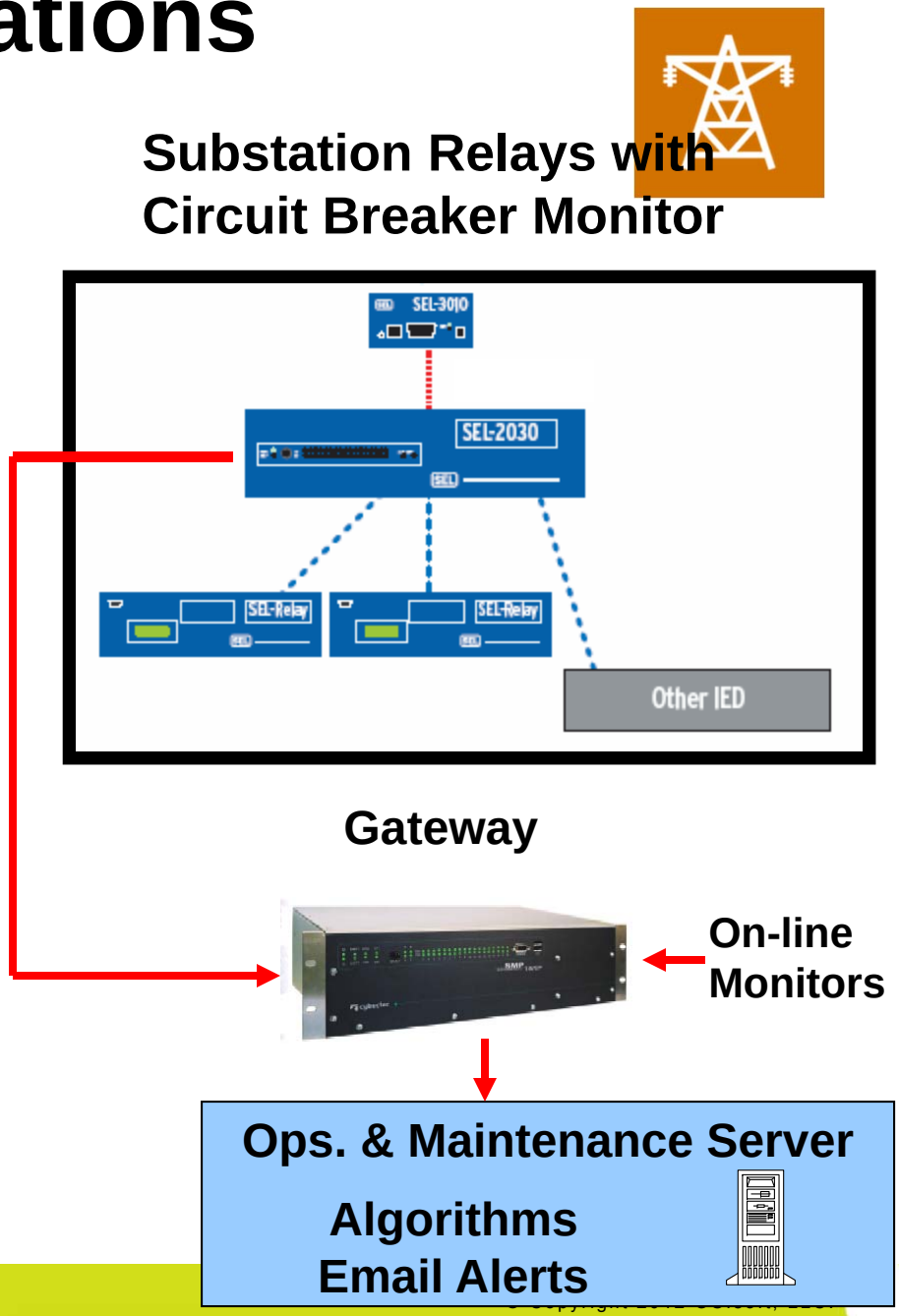
Circuit Breaker Operations

Concerns

- Proper fault clearing
- Fault testing with a circuit breaker

Solution

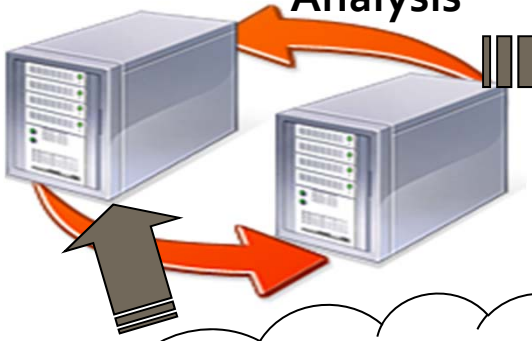
- Verify the health of CB
  - Contact wear
  - Insulation medium integrity
  - Bushings and accessories
  - Operating history
- Use historical and real-time contact wear data (I^2T) to make a decision



CBM Process Flow

Substation Monitoring

Data Analysis



Alerts

Email/Text Notifications

Technical Analysis

Condition-Based Maintenance Schedules

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PI as the CBM Server & Analytics

- Controls communication from Enterprise Gateway to PI
- Maps new data points automatically from Enterprise Gateway
- Collects and stores all time-series data
- Provides Analytics (PI ACE) and Visualizations (PI WebParts)
- Visualizes graphing, trending and analytics
- Integrates with other internal PI Systems
- Integrates with Legacy applications
- Sends PI Notifications and Acknowledgement
- Serves as a CBM Model server

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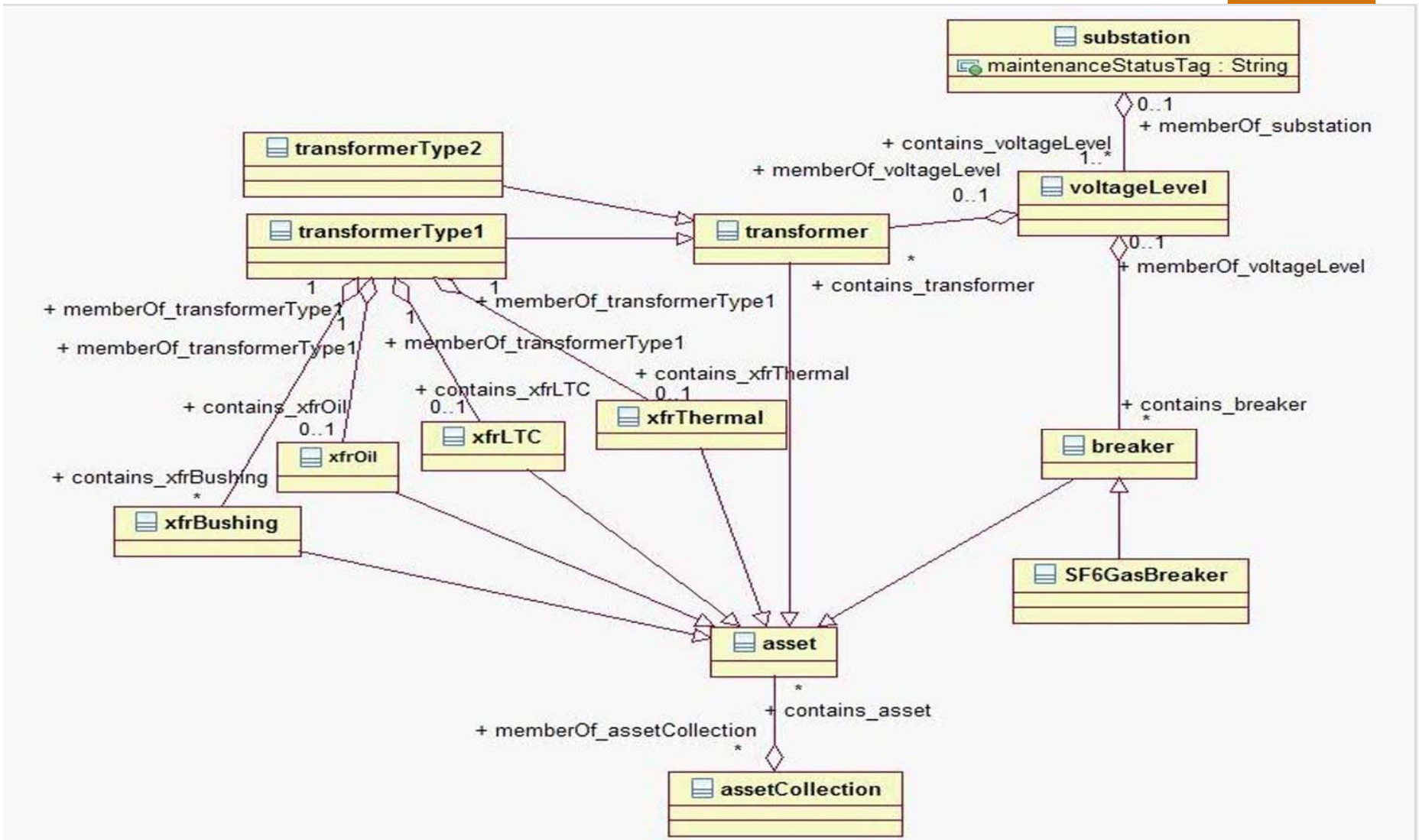
CBM CIM (Common Information Model) Asset Model



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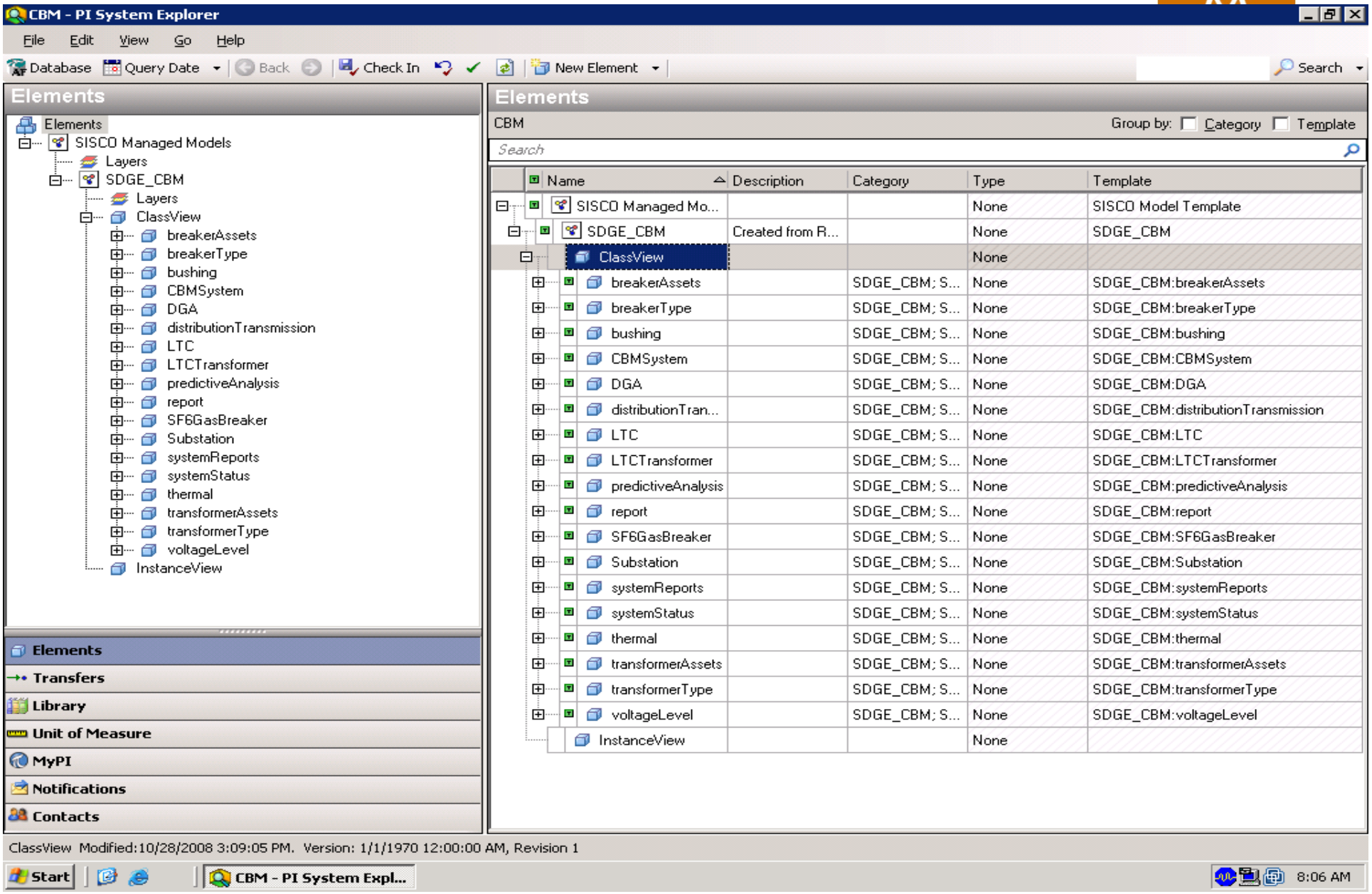
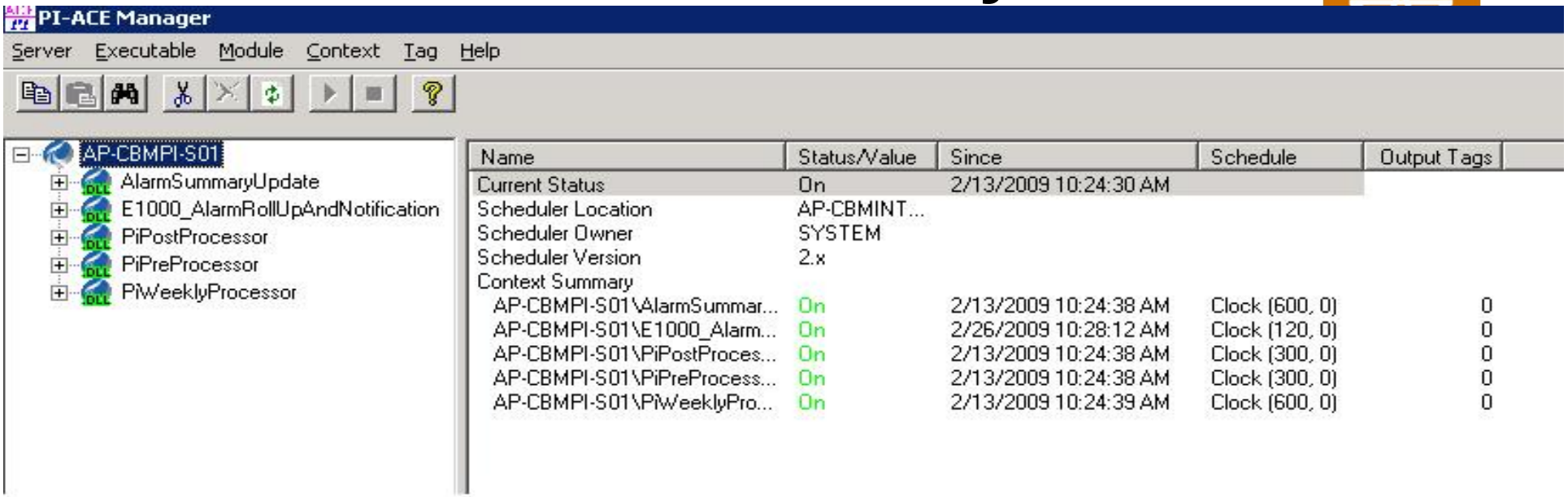
PI Asset Framework Modeling



PI ACE Calculation and Analytics



- Background Calculation Jobs
  - Alarm Tags Generation
  - Transformer Oil Analysis
  - Alarm Summary
  - Alarm Increase Reports
  - Alarm Decrease Reports

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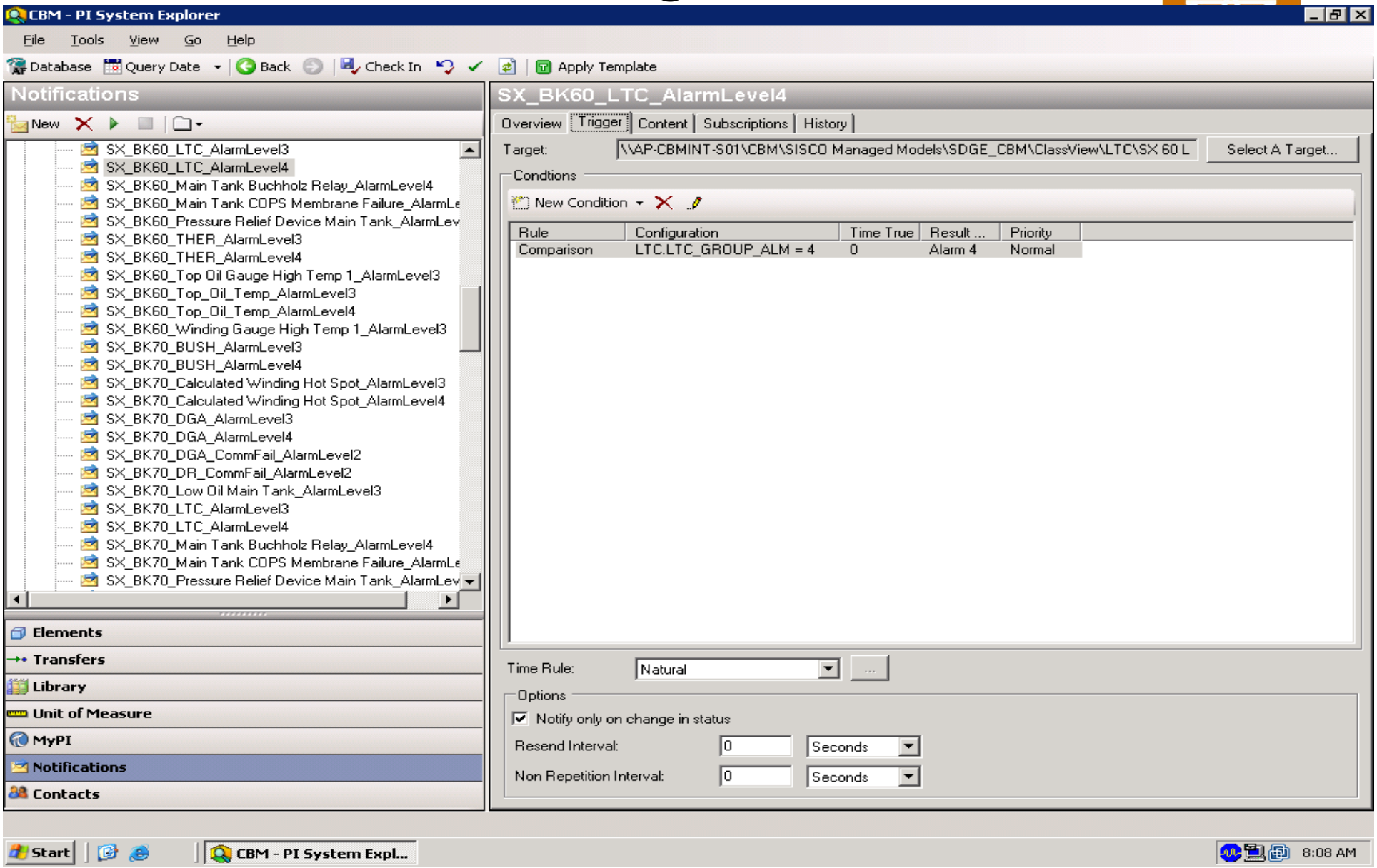
PI Notifications Management



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PI Notifications Email Alert

From: opex2020cbm@semprautilities.com
Sent: Wed 1/21/2009 11:57 AM
To: CBM-XfmrLv4 Ack
Cc:
Subject: SX_BK71_THER_AlarmLevel4

Name: SX_BK71_THER_AlarmLevel4
Description: [redacted] Bank 71 Thermal Alarm Level 4
Server: AP-CBMINT-P01
Database: CBM2
Start Time: 1/21/2009 11:56:24 AM Pacific Standard Time (GMT-08:00:00)
Trigger Time: 1/21/2009 11:56:24 AM Pacific Standard Time (GMT-08:00:00)
Target: AP-CBMINT-P01\CBM2\SISCO Managed Models\SDGE_CBM\ClassView\thermal\SX 71 Thermal
Value: Alarm 4
Priority: Normal

Link:
SX - BK71 - Thermal

Actions:
Acknowledge
Acknowledge with comment

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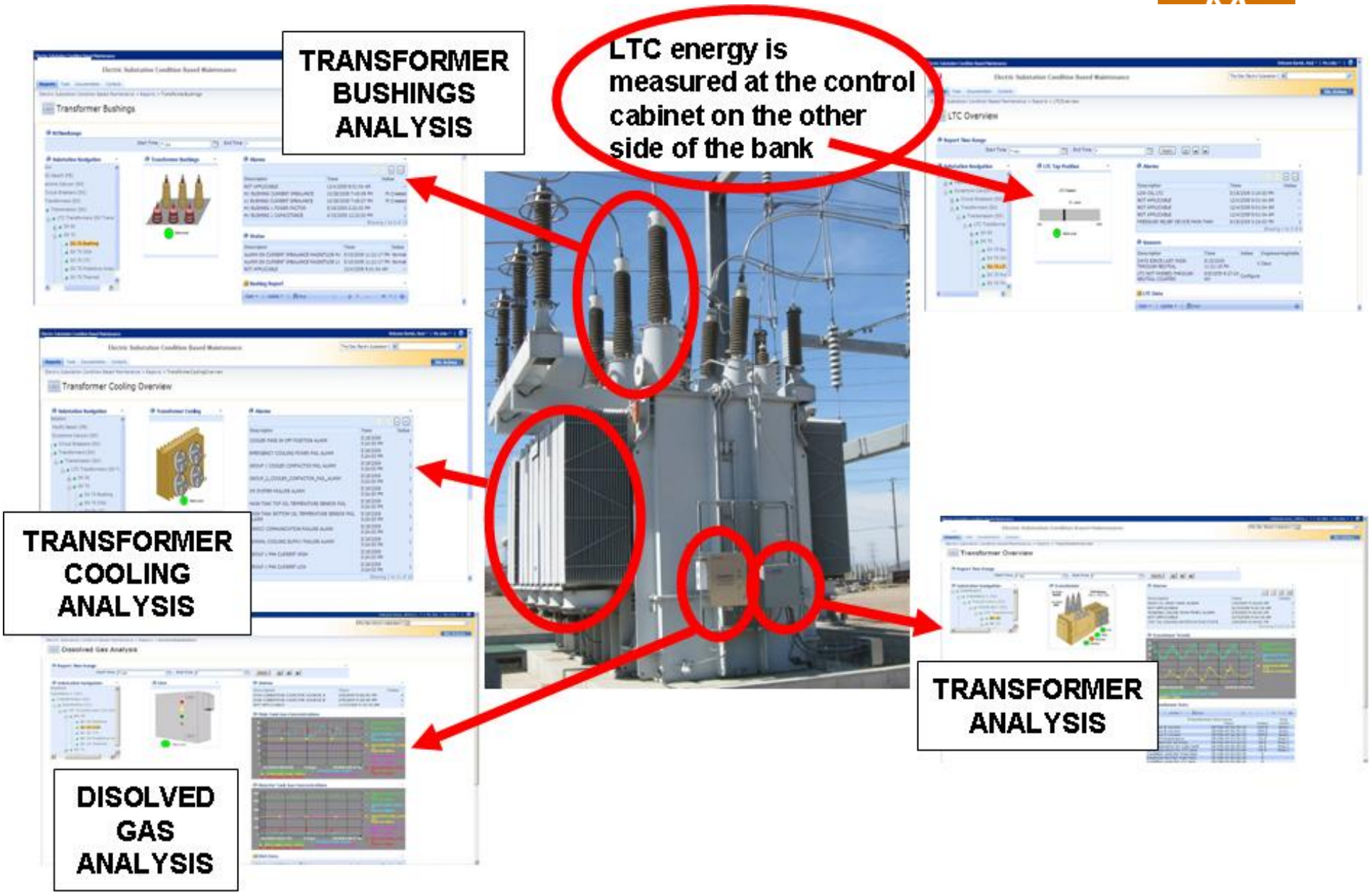
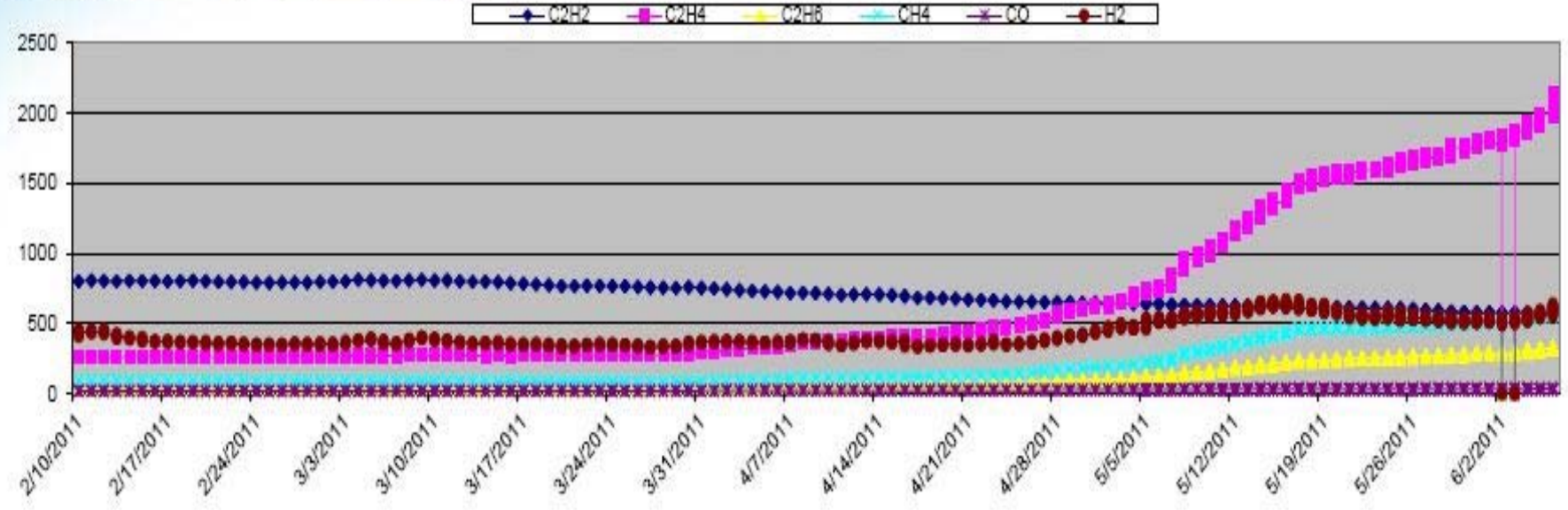
CBM Visualization and Reporting



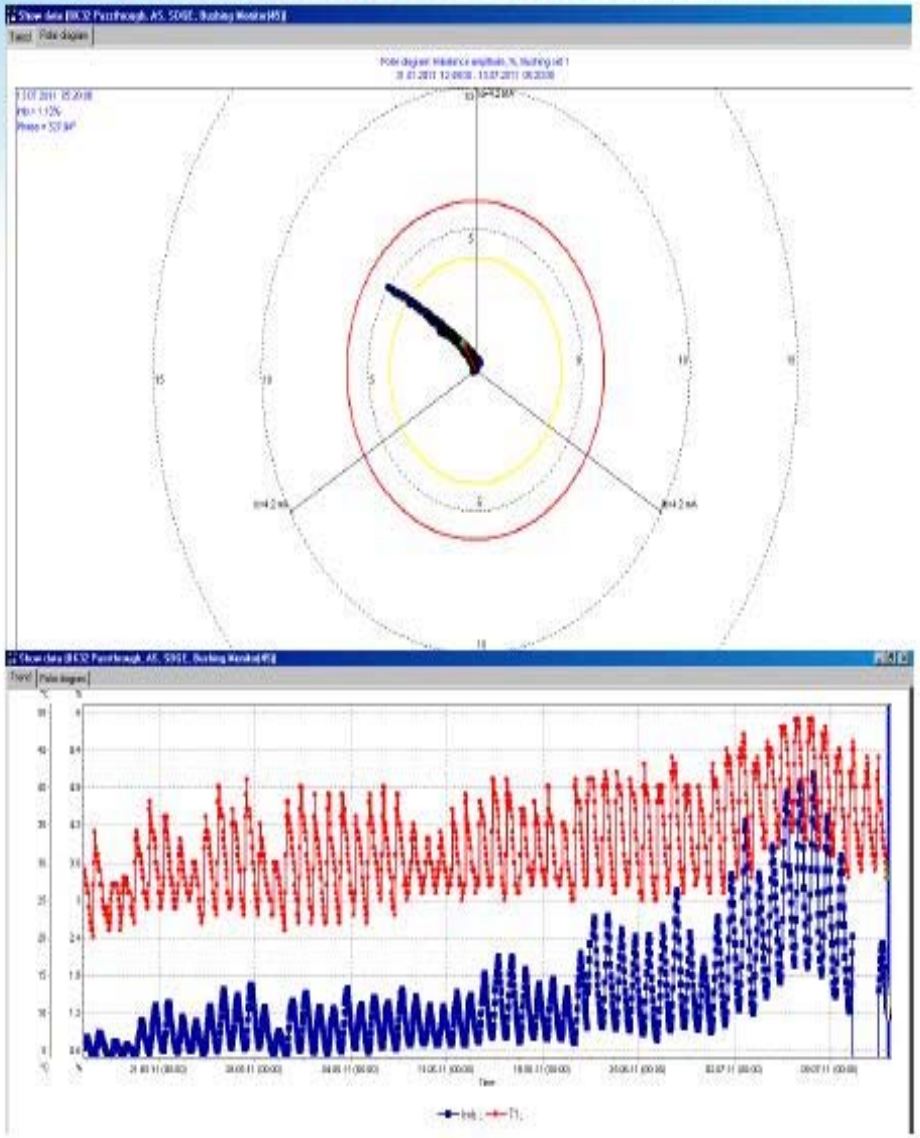
Condition-Based Maintenance

- June 2, 2011, DGA alert level 3 on LTC tank
- June 6, 2011, inspection resulted in replacement of LTC contacts from heating and coking

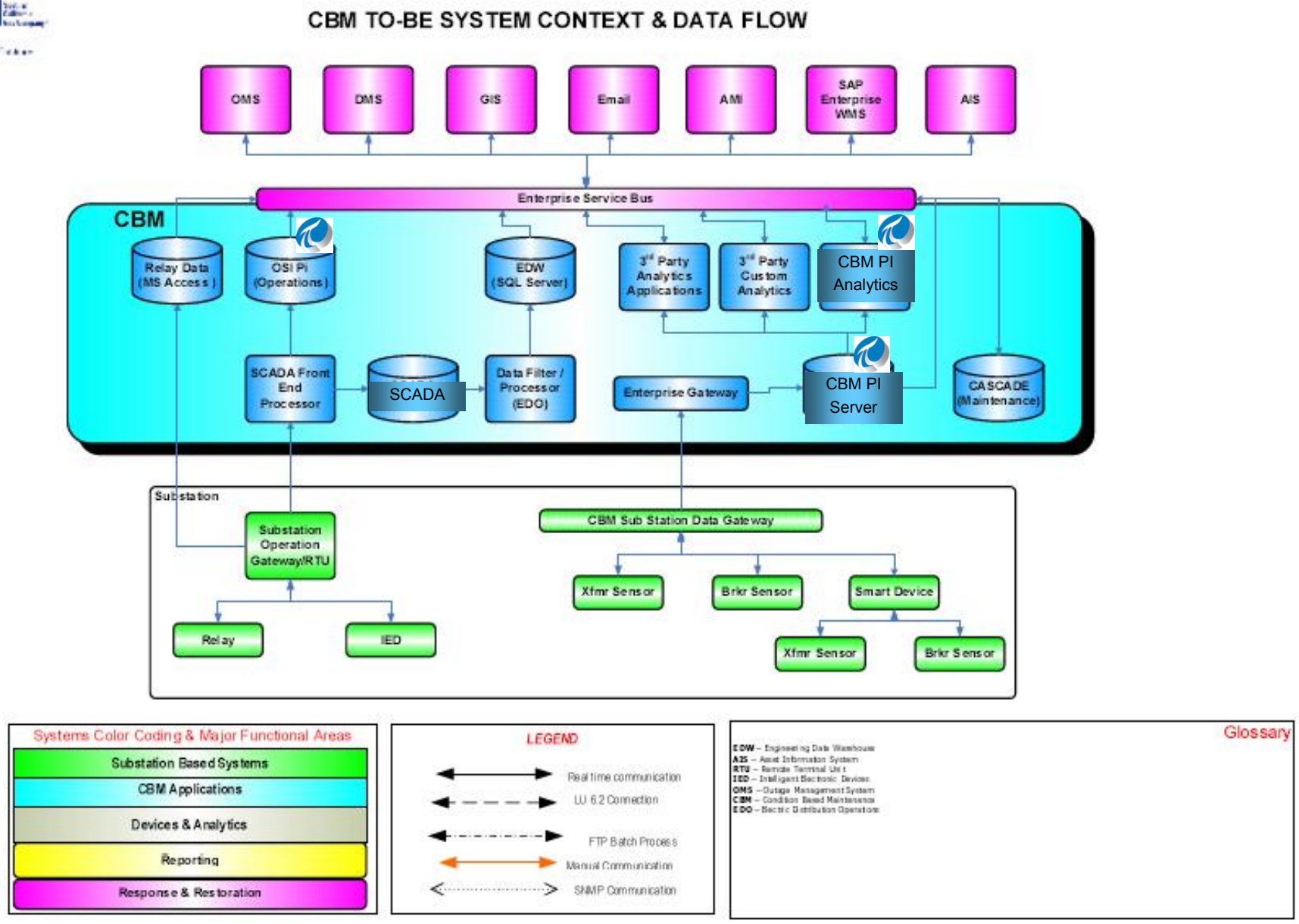


Condition-Based Maintenance

- July 19, 2011, Bushing Health Monitor alert on C-phase
- 2008 test = 0.3 power factor
- 2011 test = 2.25 power factor
- Transformer was removed from service and all three bushings were replaced



CBM Enterprise Integration



SDG&E-San Diego Gas & Electric
Distribution Control Center

SDG&E Distribution Plans

- Interfacing weather data into CBM (Condition Based Maintenance) PI to make better operational decisions
- Installing dynamic line rating sensors to calculate conductor tension, sag, and real-time conductor
- Modifying existing distribution transformers, to allow for control of both customer load and distributed generation
- Maximizing transformer capacity by monitoring the current consumption, and scheduling electric vehicle charging and smart appliances during low loading periods
- Helping demand response and energy efficiency programs for customer and residential programs

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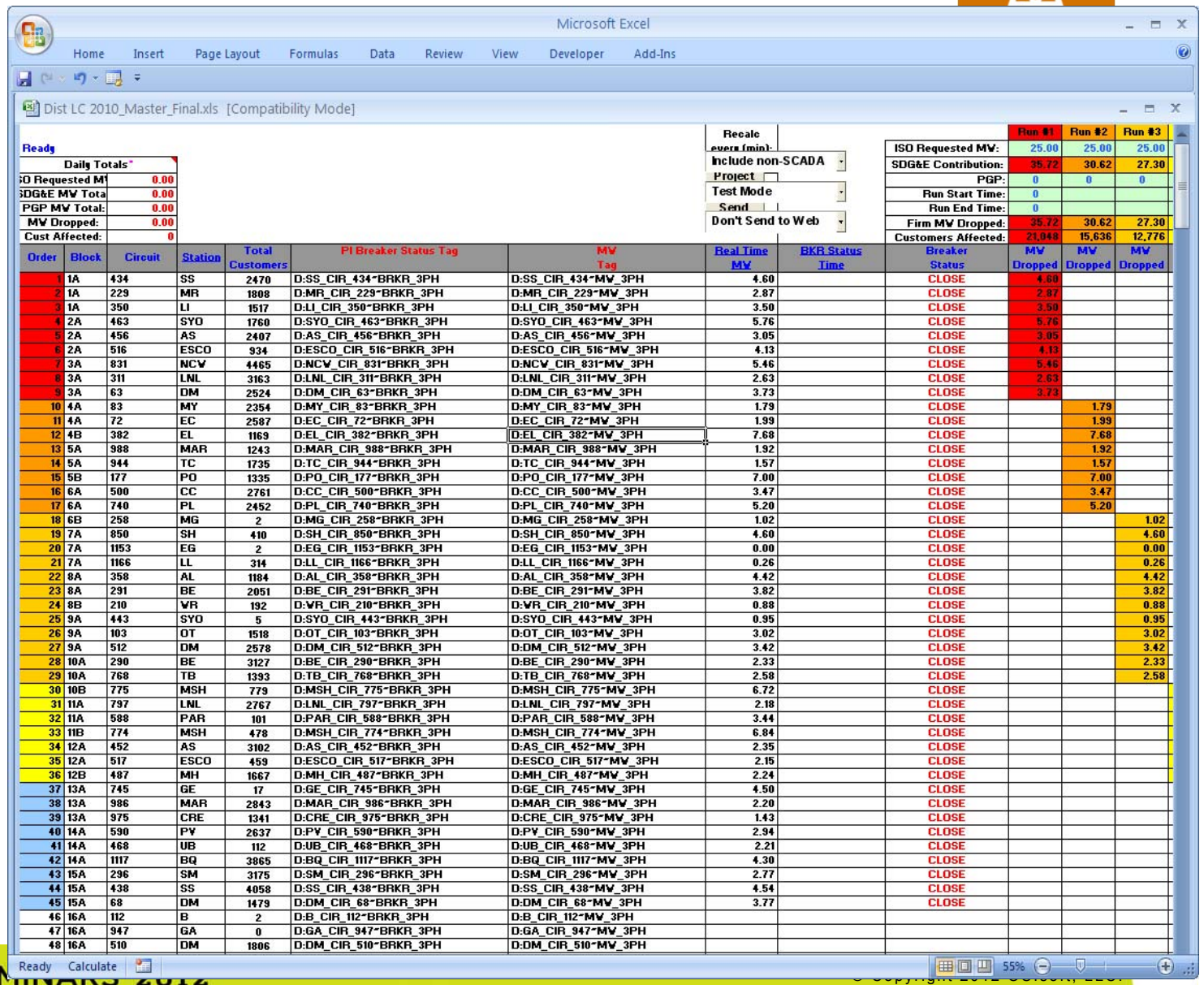
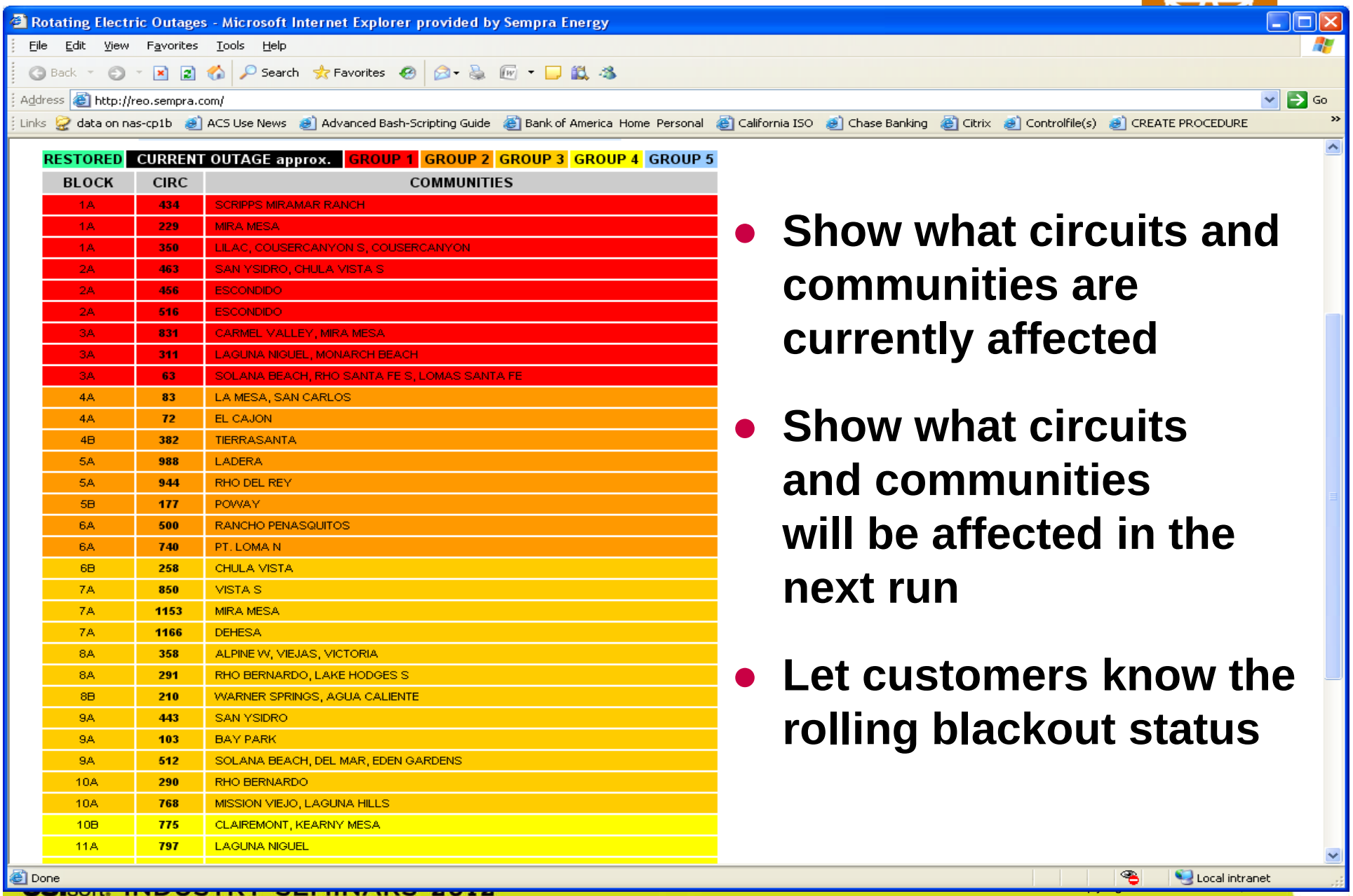
SDG&E Load Curtailment Screen

- Enter total MW's required to be dropped
- Show circuit breakers status and MW load
- Automatically calculate how many breakers need to be opened and total customers are out
- Automatically publish to SDG&E public website and report to CPUC and Regulator



Load Curtailment for SDG&E Public Website



- **Show what circuits and communities are currently affected**
- **Show what circuits and communities will be affected in the next run**
- **Let customers know the rolling blackout status**

4. PI as the platform for reporting and BI across and beyond the Enterprise

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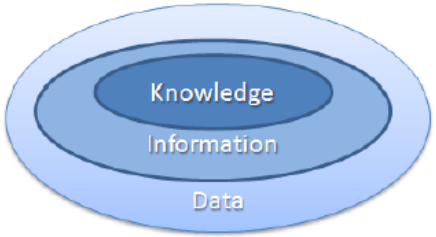
Business Intelligence by leveraging real-time data from OSIsoft PI

What is Business Intelligence?

Business Intelligence is the ability to transform data into information and information into knowledge, so as to optimize the process of making business decisions



CFE BI Project Vision

- CFE had no Business Intelligence (BI) applications in the information system infrastructure that is currently supported by OSIsoft Technology
- As BI applications are required to achieve rapid and sustained growth of CFE Energy Market
- Utilizing the real-time infrastructure provided by the OSIsoft PI System and Microsoft latest technology offerings

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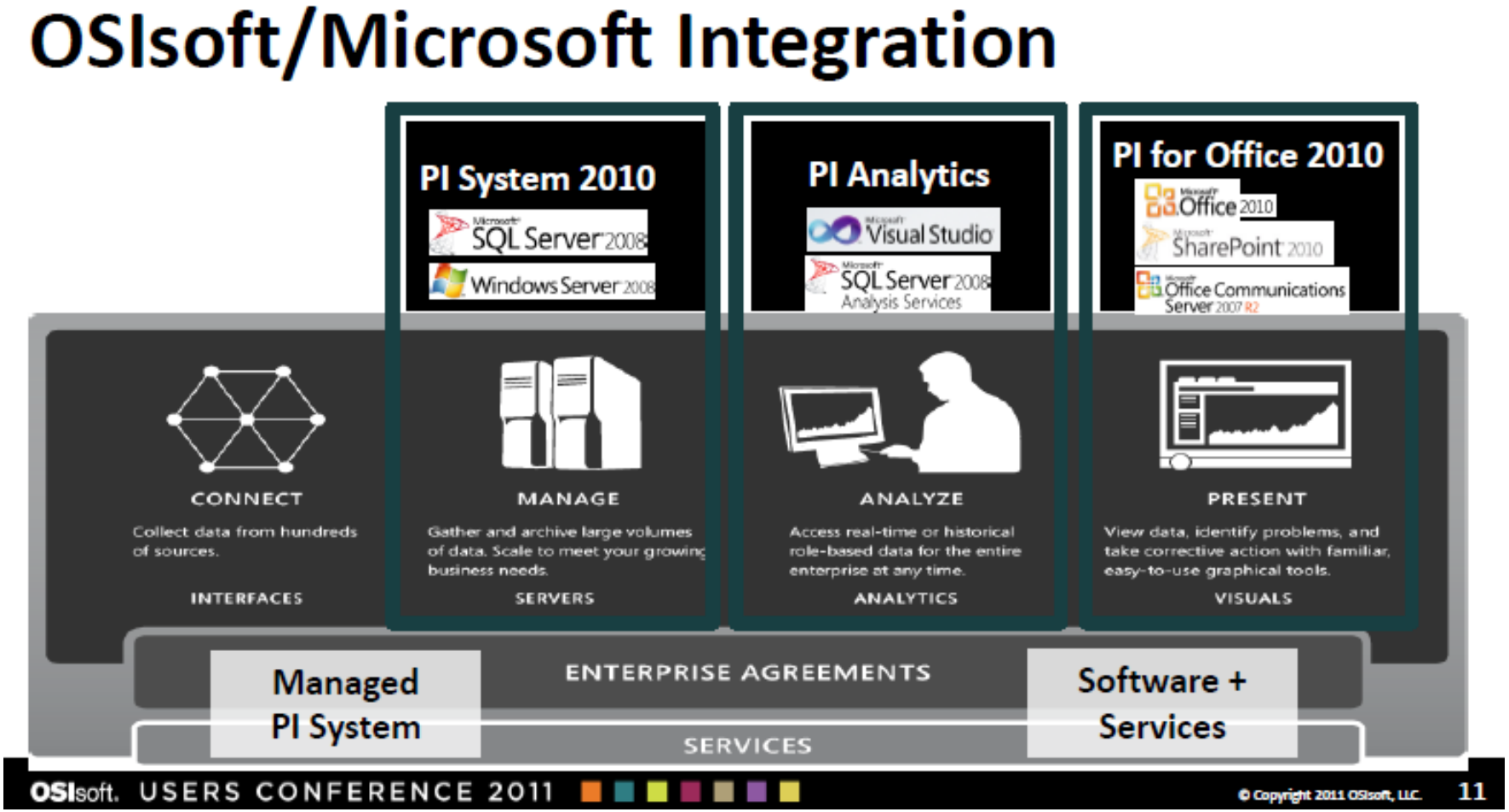
Leveraging OSIsoft & Microsoft alliance to deliver best-of-breed BI



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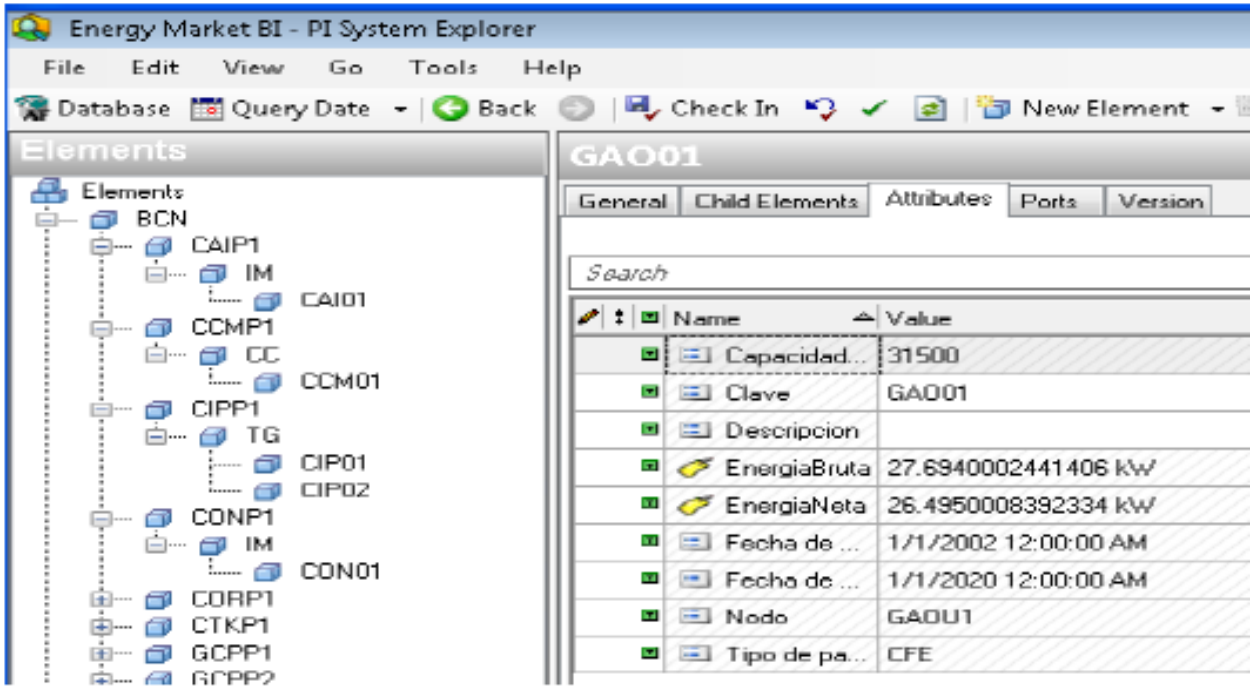
Using PI-AF to create an contextual model for an easier access to data

PI AF Hierarchy



Built Complete Hierarchy

For Area, Central, Type of Generation Unit

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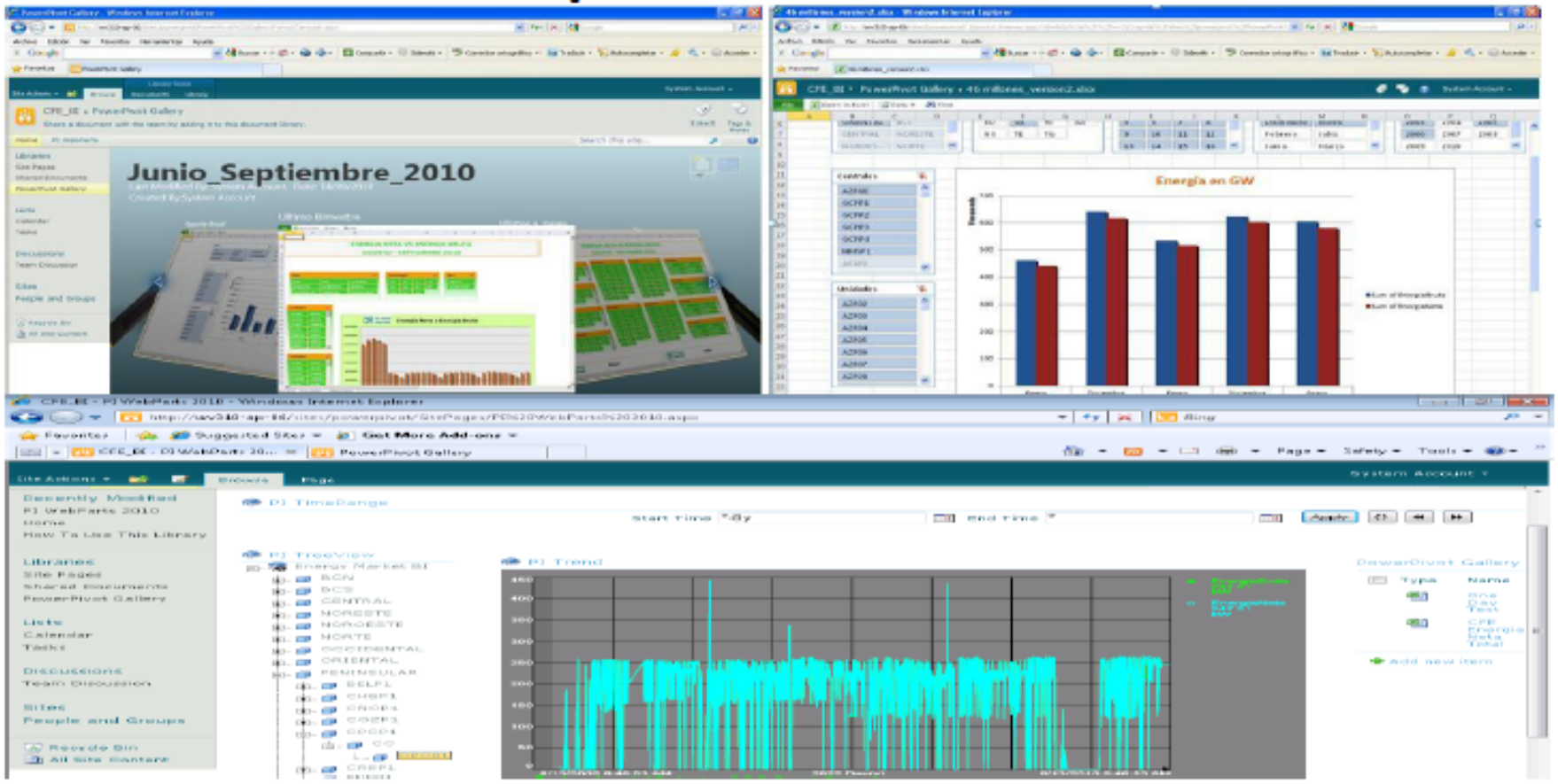
Web Portal strategy to make data readily available in a contextual manner

SharePoint Site Implementation



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Easy access to data for end users

End Users PowerPivot Reports

- Internet Explorer 8
- Silverlight
- Office 2010
- PowerPivot for Office 2010
- PI SQL Commander
- PI System Explorer 2010
- PI DataLink 2010

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Intangible benefits…

Intangible Benefits

- To provide the users with a single channel to operate comprehensive information brought from different data sources
- Users can generate their own reports and analyze data
- Users can publish their own reports
- Users can download reports to the local machines for their own further analysis
- Have a common repository for all reports
- Provide analysis in time
- Provide the mass data storage but with excellent response time (in seconds)

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5. PI as the backbone for SmartGrid

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SDG&E Enterprise Initiatives

Draft of recent activity for illustration purposes

SDG&E Borrego Springs Microgrid Project

Utilize advanced technologies to integrate and manage distributed resources within the Smart Grid

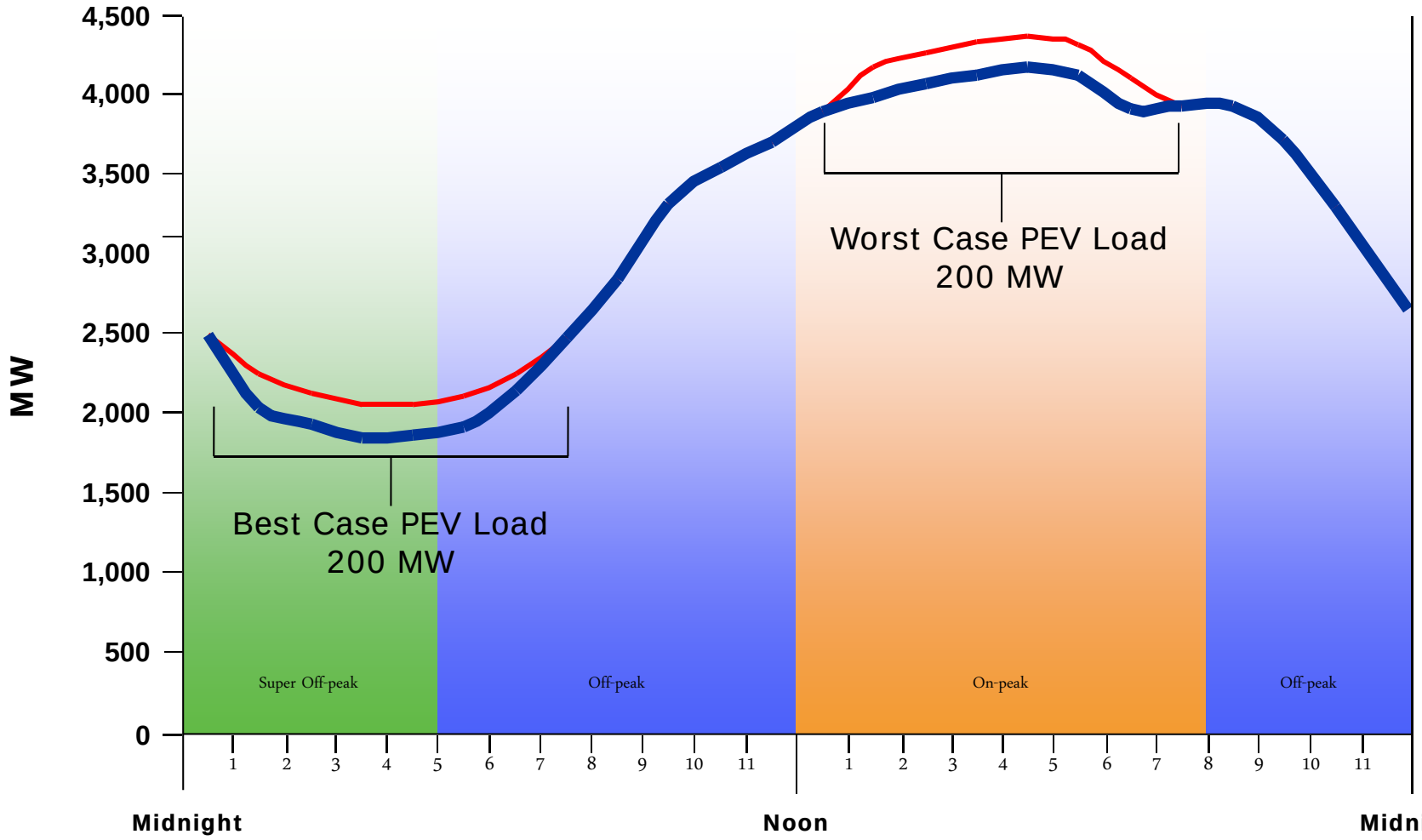
Budget:	$7.5M DOE and $2.8M CEC plus matching funds from SDG&E and partners
Benefits:	▪ Integrate and leverage various generation and storage configurations ▪ Reduce the peak load of feeders and enhance system reliability ▪ Enable customers to become more active participants in managing their energy use

Other Microgrid Types and Variations

- Loads and/or generation with special needs
- Residential (e.g. HAN)
- Commercial or industrial facilities
- Commercial or industrial campuses (multiple facilities/loads)
- Larger campuses (e.g. Universities)
- Clearly delineated distribution systems and/or generation (e.g. portions of cities, military bases)
- Utility/Grid integrated
- Primary distribution system for developing or remote areas

Electric Vehicles: Smart Grid Will Encourage Off-Peak Charging

Example Summer Daily Load Profile



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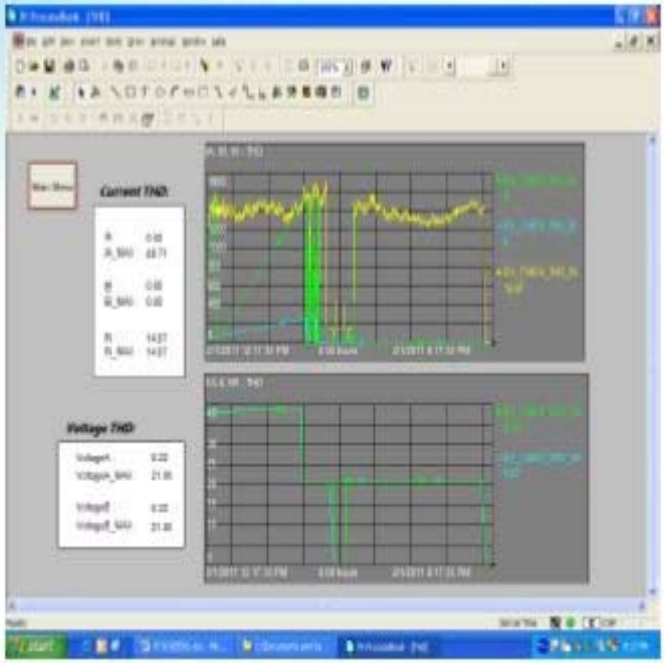
Innovation does not wait…

SDGE connected
A Sempra Energy utility

EV Analytics



THANK YOU

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