Regional Seminar Series

PI System in T&D and Wind Generation

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T&D and Wind Case Studies

- T&D
  - California ISO
  - Phasor Measurement Units and Wide Area Measurement System
  - PSE&G
- Wind Generation
  - Challenges
  - In market availability
  - MarketsS

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California ISO

- Performance metric approach to regulation
  - Improve the Quality of Regulation Service
    - Rank Regulation Performance
    - Share information with Generator Owners
    - May Eventually Penalize Poor Performers
  - Improve Reliability
    - Better Response to System Emergencies
    - NERC Control Performance Standards
  - Reduce Costs
    - Improve Efficiency of Regulation Service

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California ISO

- Approach—member requirements
  - Generators are integrated with CA ISO EMS
  - Two way communication
    - AGC Status
    - Generation set points
    - Performance trends
  - Certification of generators
    - Generator's ramp rate

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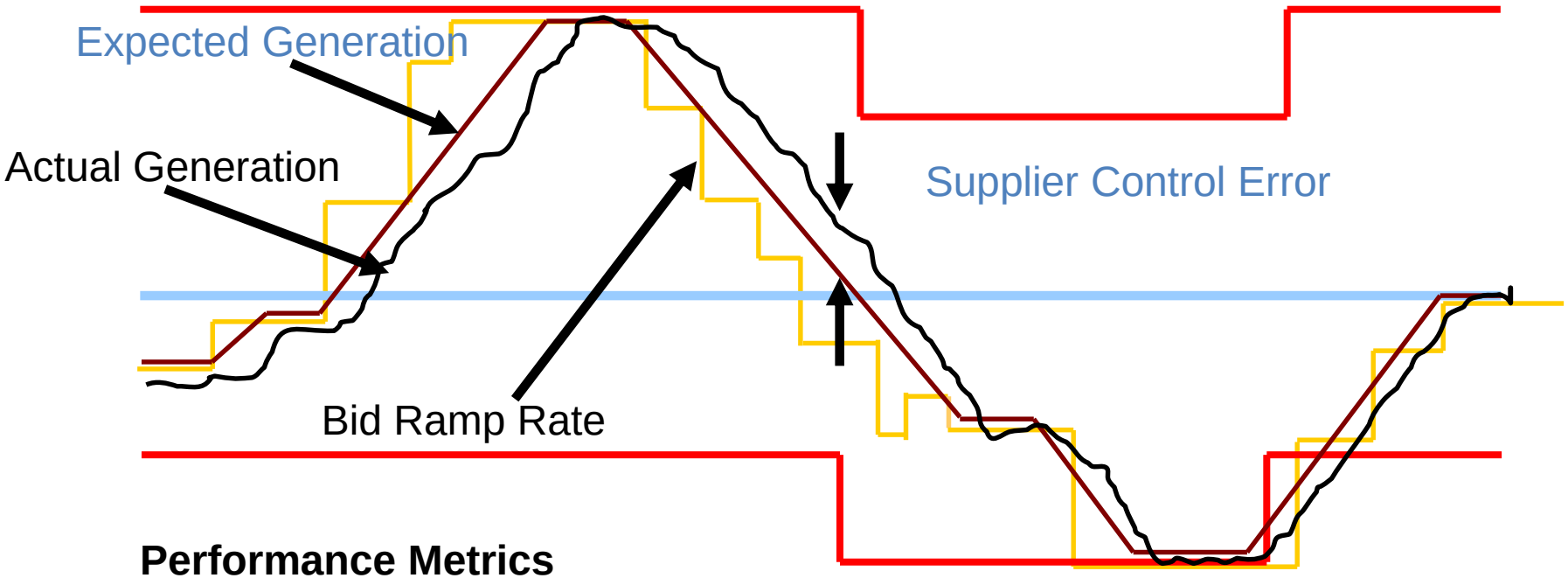
Performance Metric Calculation

Calculated with PI-ACE



Performance Metrics

1) Energy Calculations
2) Line Statistic Calculations

Calculation Period

- Instantaneous Value
- 10 Min Summation
- 1 Hr Summation

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Performance Metric Calculation

$$PerfMetric = \frac{(SCEPerf + StatPerf)}{N} * 100$$

Where:
N=1 if StdDevRatio or Correlation fail (StatPerf = 1)
N=2 if StdDevRatio and Correlation are good

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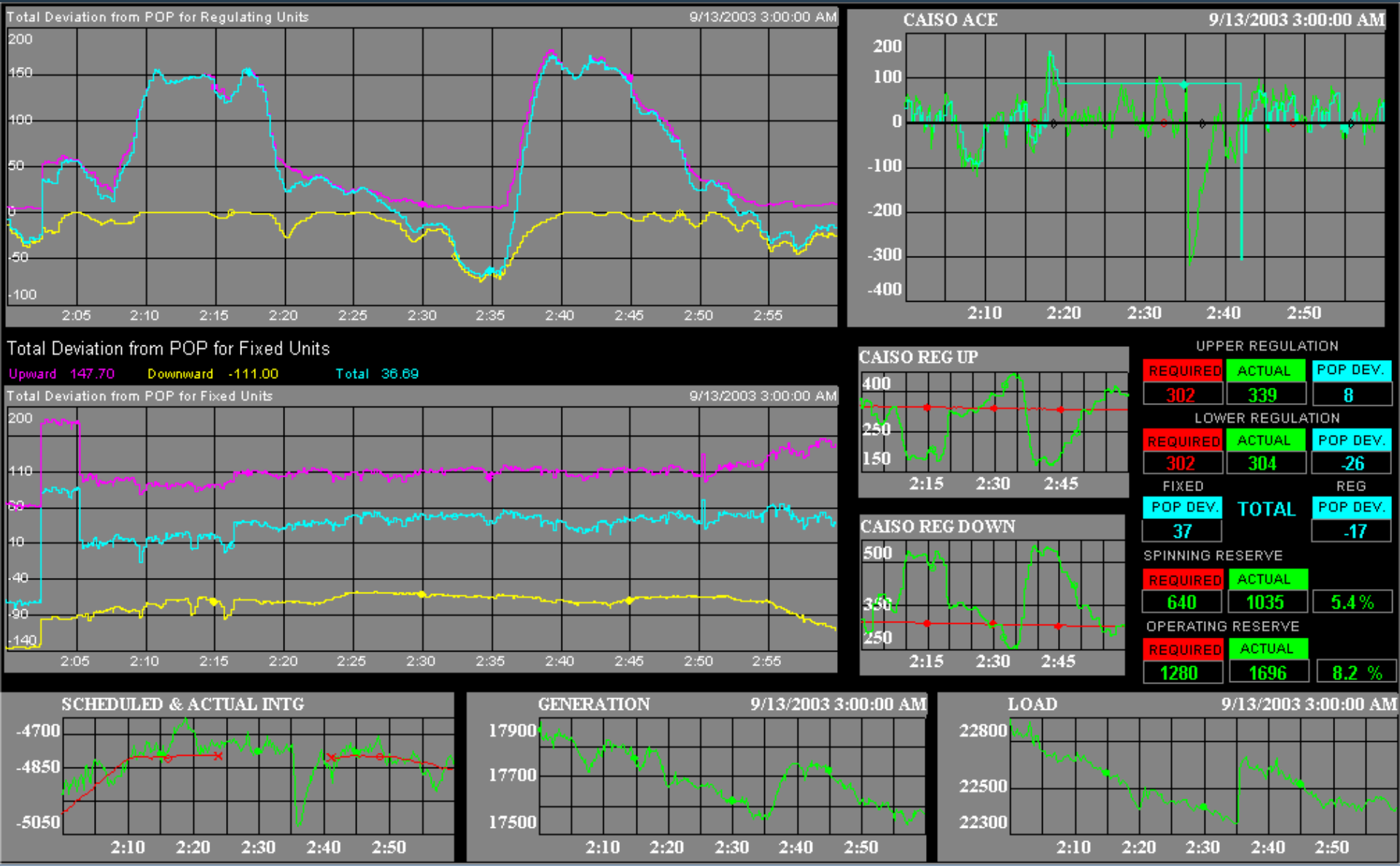
Regulation



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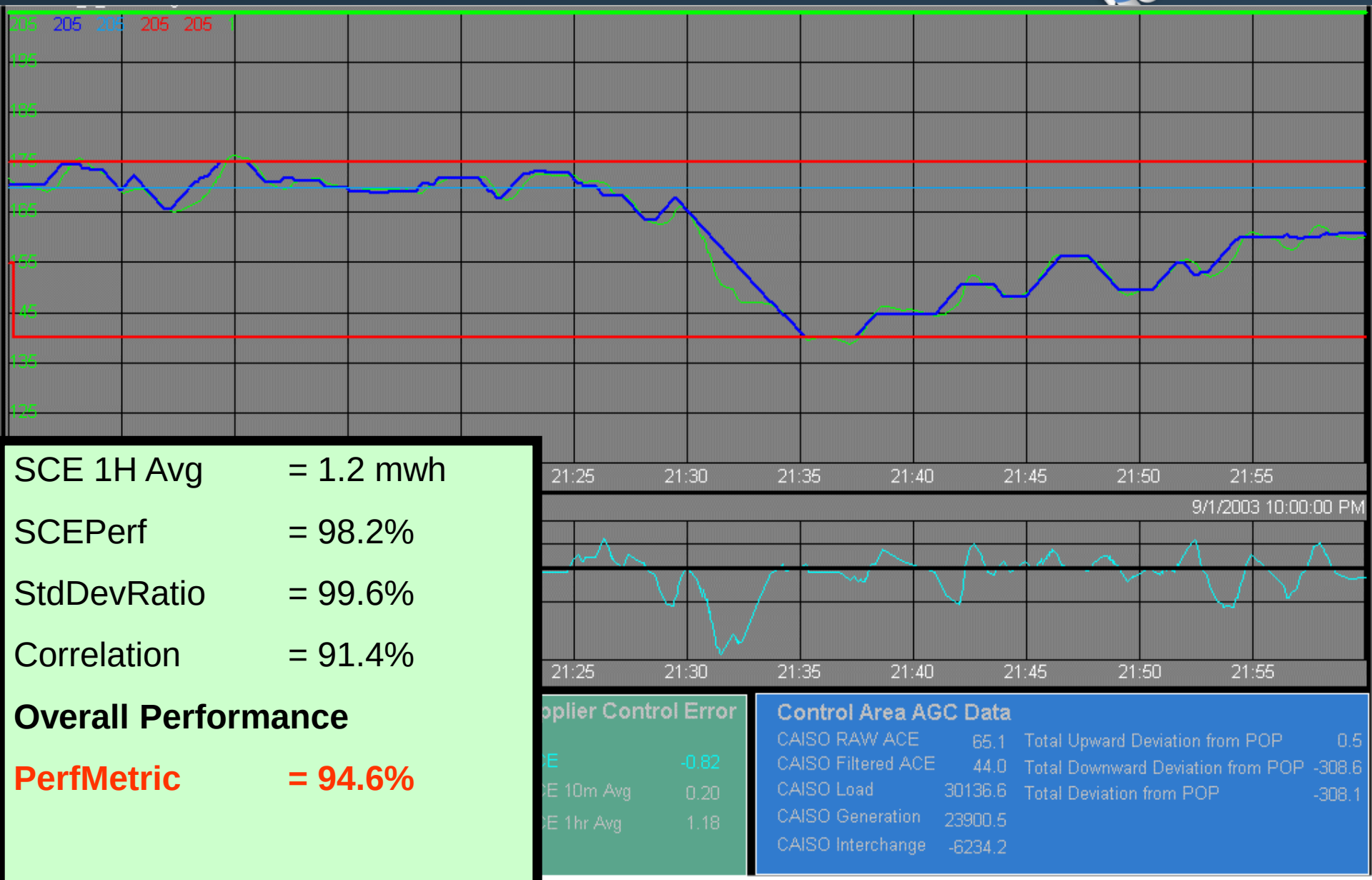
Good Performer



SCE 1H Avg	= 1.2 mwh
SCEPerf	= 98.2%
StdDevRatio	= 99.6%
Correlation	= 91.4%
Overall Performance	
PerfMetric	**= 94.6%**

Time.

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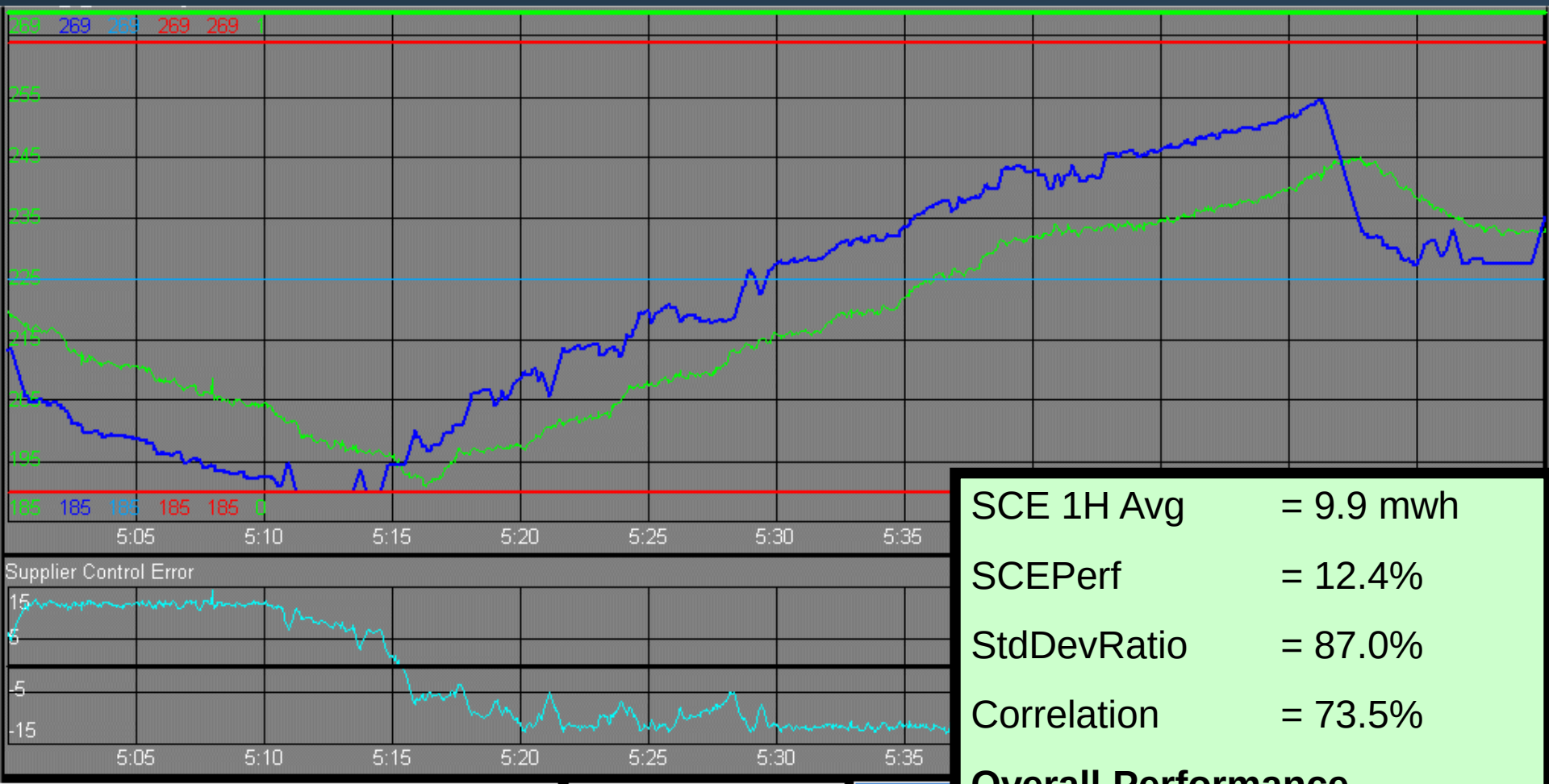
Poor Performer--Response



Individual Unit Data

AGC Status	Closed	AGC Set Point	244.7
Actual Ouput	233.0	Bid Up Regulation	39.0
Expected Gen.	235.1	Bid Down Regulation	-35.0
Eff. POP	226.0	Bid Up Ramp Rate	14.5
High Reg Limit	264.0	Bid Down Ramp Rate	14.5
Low Reg Limit	190.0		

Supplier Control Error

SCE	-2.26
SCE 10m Avg	1.29
SCE 1hr Avg	9.88

Contr

CAISO
CAISO
CAISO
CAISO
CAISO

SCE 1H Avg	= 9.9 mwh
SCEPerf	= 12.4%
StdDevRatio	= 87.0%
Correlation	= 73.5%

Overall Performance

PerfMetric = 38.1%

PMUs and WAMS

- Phasor Measurement Units
  - Widely available
  - SEL, GE and others
- Wide Area Measurement System
  - Leverage PMU data installed on grid

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PMU

- Frequency
- Voltage
- Real and Reactive Power
- Absolute phase angle
- Accessed via C37.118 protocol
  - OSIsoft Interface now available to all customers
  - Trained field service engineers for installation and configuration

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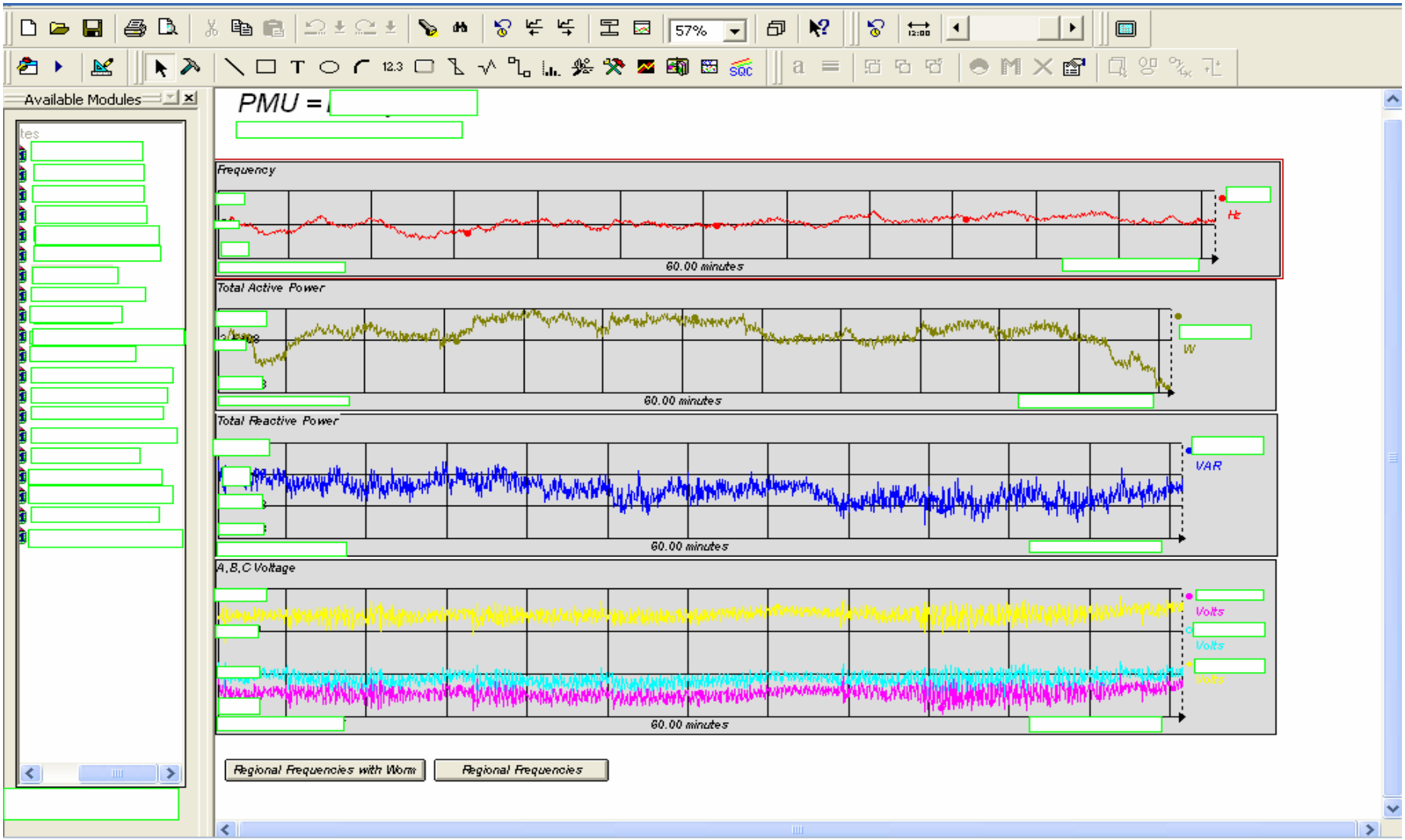
Examples



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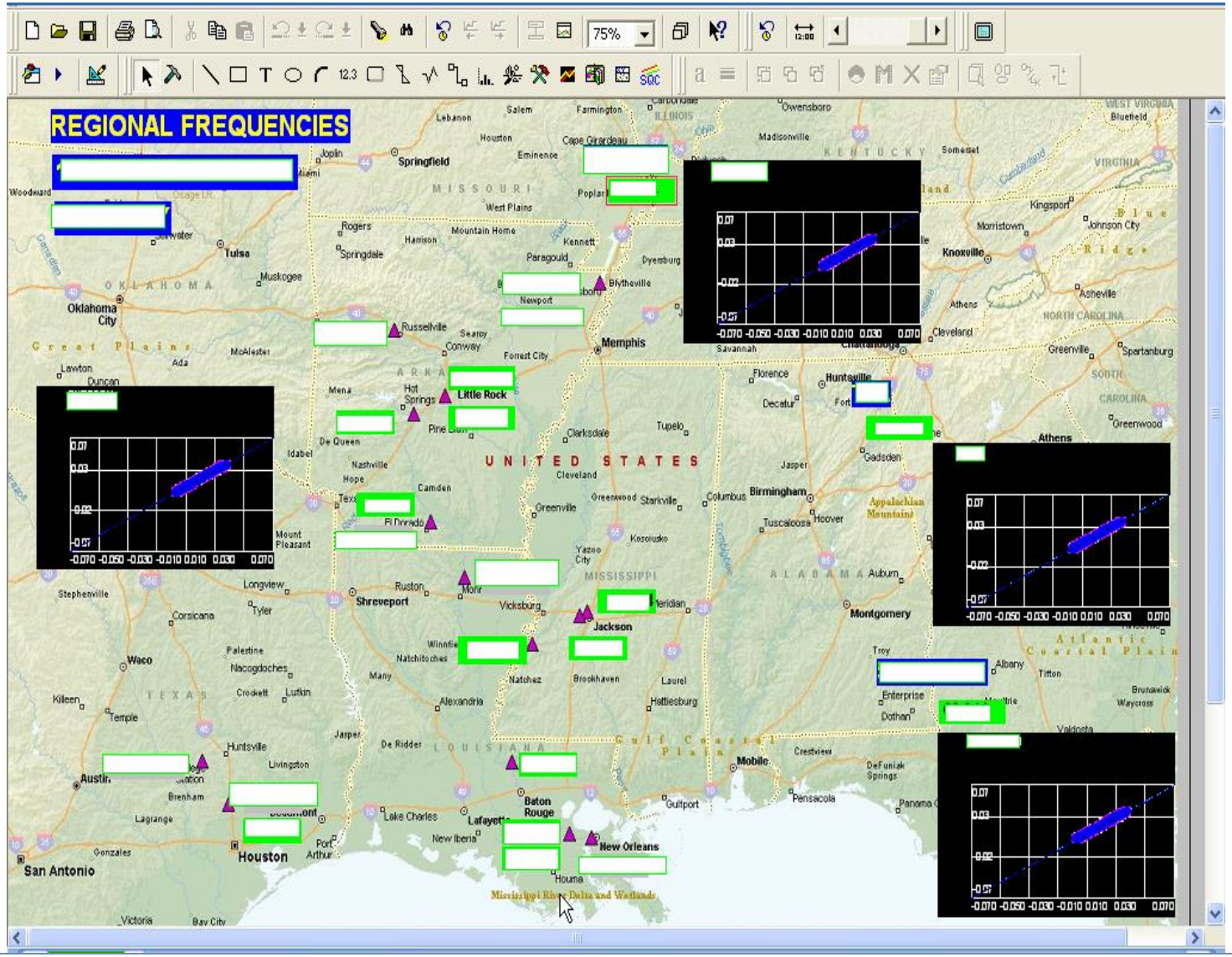
Frequency Overview



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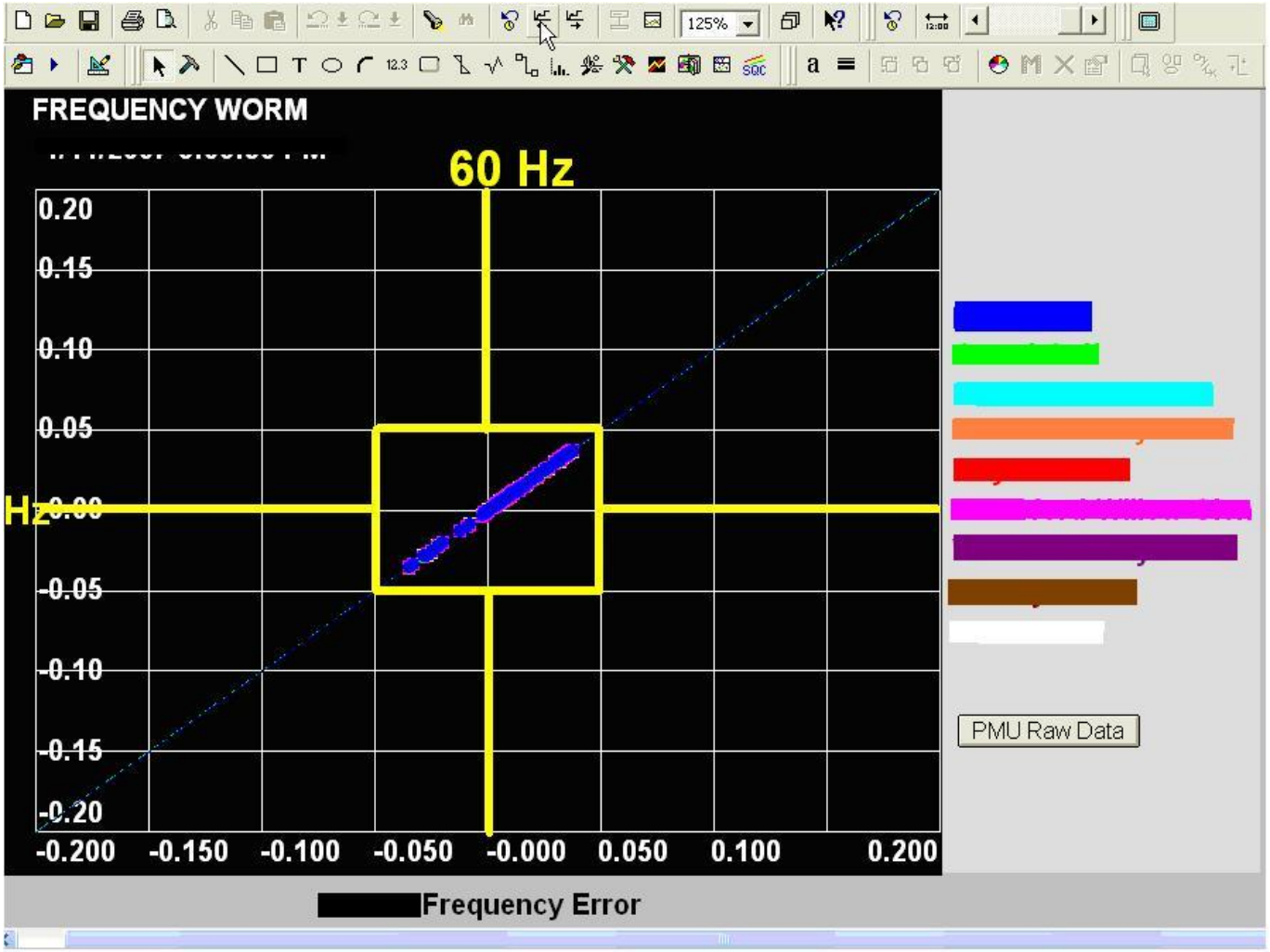
Frequency Error

- X-Y Plot of deviation of base station vs. reference



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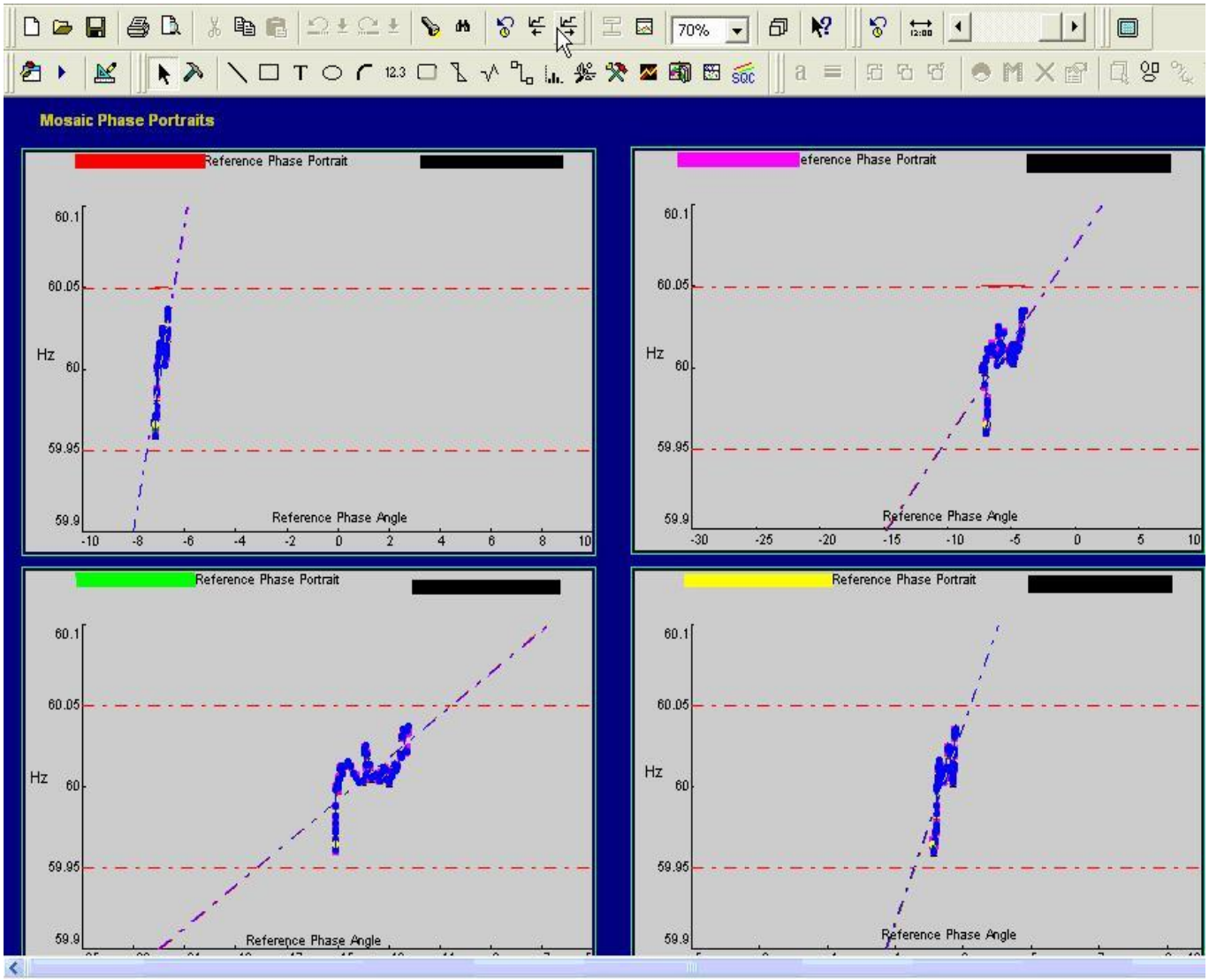
Frequency vs. Angle X-Y



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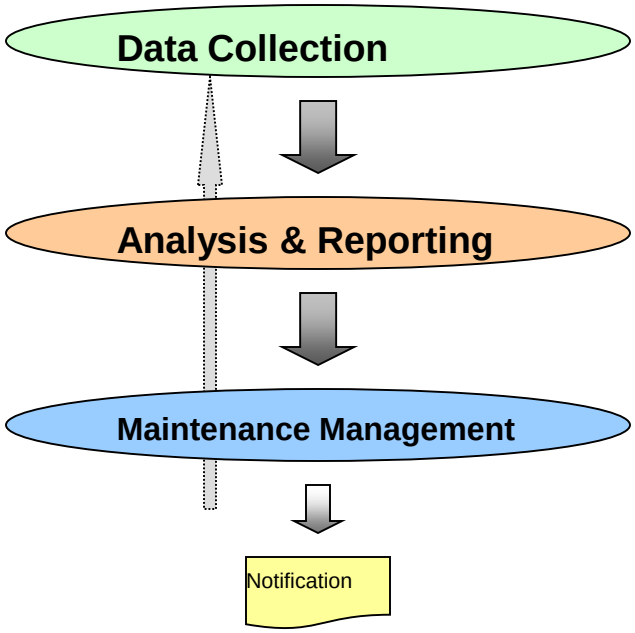
- Condition Based Maintenance
  - Calculation Structure
    - CA = F1(M1) + F2(M2) + F3(M3) + …
    - Condition & Criticality
    - Factors driven by data available
    - Example Factors
      - CM Cost & Count for Past 6 Months
      - Operation Count for Past 6/12 Months
      - Gas Analysis – Change over time
      - Average Load over Time
  - Peer Groups
    - Apply calculations by peer group
    - Voltage, Class, Type
    - Example Groups:
      - 26KV – 69KV GCB
      - 138KV+ Power Transformer
      - LTC Vacuum Tanks



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CA Records

Details	Division	Floc	Floc Descr	Equipment	Equip Descr	Score	Person	Status	Manufacturer	Type	ApprType	Serial Number	Timestam
	CE	IPE-CE-POH -T1	# 1 Transformer	000000000010504694	Load Tap Changer (UVT)	6.25			ABB	UVT	LTC	SLM56073	Jul 11 20
	CE	IPE-CE-SDN -1TRX	500-1 Transformer	000000000010505424	Load Tap Changer A (LRS700)	4.9	George	Pending Action	GENERAL ELECTRIC	LRS700	LTC	D596884	Jul 11 20
	SO	IPE-SO-SLA -T1LTC	220-1 Transformer Tap Changer	000000000010526193	Load Tap Changer SEL 220-1	4.4	Mark	Pending Action	MOLONEY	SRTMHD	SS	P680443	Jul 11 20
	ME	IPE-ME-HAW -T2	# 2 Transformer	000000000010507132	Load Tap Changer	3.1	Paul	OK	WESTINGHOUSE	URT	SS	6994647	Jul 11 20
	CE	IPE-CE-SDN -1TRX	500-1 Transformer	000000000010505426	Load Tap Changer C (LRS700)	3	George	Pending Action	GENERAL ELECTRIC	LRS700	LTC	D596886	Jul 11 20
	CE	IPE-CE-SDN -2TRX	500-2 Transformer	000000000010505430	Load Tap Changer C (LRS700)	3	Mark	Pending Action	GENERAL ELECTRIC	LRS700	LTC	D596887	Jul 11 20
	CE	IPE-CE-SDN -2TRX	500-2 Transformer	000000000010505427	Load Tap Changer A (LRS700)	3	Mark	Pending Action	GENERAL ELECTRIC	LRS700	LTC	D596885	Jul 11 20
	PA	IPE-PA-HOE -T1	# 1 Transformer	000000000010542713	Load Tap Changer B	3	Paul	Pending Action	ABB	UVT	LTC	MLM56682-B	Jul 11 20
	CE	IPE-CE-WOR -T3	# 3 Transformer	000000000010540520	Load Tap Changer (LR 200)	3	George	Pending Action	GENERAL ELECTRIC	LRT200-2	LTC	M162459A	Jul 11 20
	PA	IPE-PA-NEW -T40	# 40 Transformer	000000000010542737	Load Tap Changer	3	Paul	Pending Action	GENERAL ELECTRIC	LRT200	LTC	M122649A	Jul 11 20
	CE	IPE-CE-SBB -2TRX	500-2 Transformer	000000000010621130	Load Tap Changer C	3	George	Pending Action	VA TECH JST	MRMI1500 300/C	SS	50237	Jul 11 20
	CE	IPE-CE-SDN -1TRX	500-1 Transformer	000000000010505425	Load Tap Changer B (LRS700)	3	George	Pending Action	GENERAL ELECTRIC	LRS700	LTC	D596883	Jul 11 20
	CE	IPE-CE-GSE -31G	26-3 Transformer	000000000010023775	Load Tap Changer	2.8			GENERAL ELECTRIC	LRC	SS	8285144	Jul 11 20
	CE	IPE-CE-SOS -T2	# 2 Transformer	000000000010503189	Load Tap Changer (URT)	2.65	George	Pending Action	WESTINGHOUSE	URT	SS	6994649	Jul 11 20
	PA	IPE-PA-SWK -4PAR	# 4 PAR E-2257	000000000010542778	Load Tap Changer 4A	2.65			WESTINGHOUSE	UVT	LTC	7002037-A	Jul 11 20
	CE	IPE-CE-GSE -132-7	132-7 Transformer	000000000010501565	Load Tap Changer	2.6	Mark	Pending Action	WESTINGHOUSE	URT	SS	7000445	Jul 11 20
	SO	IPE-SO-MAR -T2	# 2 Transformer	000000000010522898	Load Tap Changer Vacuum	2.5	George	Pending Action	ABB	UVT	LTC	SLM56081	Jul 11 20
	SO	IPE-SO-SNF -4TRX	500-4 Transformer	000000000010523970	Load Tap Changer 500-4A	2.5			WESTINGHOUSE	UTH	SS	7001831	Jul 11 20
	SO	IPE-SO-MRO -T1	# 1 Transformer	000000000010525854	Load Tap Changer	2.5	Mark	Pending Action	GENERAL ELECTRIC	LRT200-2	LTC	M162110B	Jul 11 20
	PA	IPE-PA-HOM -T3	# 3 Transformer	000000000010515806	Load Tap Changer	2.4			WESTINGHOUSE	UVT	LTC	SLM52092	Jul 11 20
	CE	IPE-CE-SDN -3TRX	500-3 Transformer	000000000010505433	Load Tap Changer C (LRS700)	2.4	Paul	Pending Action	GENERAL ELECTRIC	LRS700	LTC	K547114	Jul 11 20
	CE	IPE-CE-GSE -21G	26-2 Transformers	000000000010501561	Load Tap Changer	2.1			GENERAL ELECTRIC	LRC	SS	8285145	Jul 11 20
	CE	IPE-CE-HAT -T2	# 2 Transformer	000000000010542874	Load Tap Changer (LR 200-2)	2.1			GENERAL ELECTRIC	LRT200-2	LTC	M162110D	Jul 11 20
	CE	IPE-CE-SBW -2TRH	220-2 Transformer	000000000010505224	Load Tap Changer 220-2 26Kv (SRT-MH-D)	2.1	Mark & Dick	OK	MOLONEY	SRTMHD	TS	P670635	Jul 11 20
	SO	IPE-SO-DVB -T2	# 2 Transformer	000000000010542963	Load Tap Changer	2.1			GENERAL ELECTRIC	LRT200	LTC	M162241A	Jul 11 20
	CE	IPE-CE-SDH -T2	# 2 Transformer	000000000010505289	Load Tap Changer on T2 (LRT200-2)	2.1			GENERAL ELECTRIC	LRT200-2	LTC	M122618C	Jul 11 20
	CE	IPE-CE-SLI -132-5	132-5 Transformer	000000000010023211	Load Tap Changer 132-5 26Kv	2.1	Paul	OK	WESTINGHOUSE	URT	SS	6532766	Jul 11 20
	CE	IPE-CE-SOS -T1	# 1 Transformer	000000000010503188	Load Tap Changer (URT)	2.1	Mark	OK	WESTINGHOUSE	URT	SS	6994648	Jul 11 20

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LTC CA New Action Algorithm Details

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Nameplate

Oneline	Division	Station Code	Station	Station Type	Floc Descr	Equipment	Equipment Descr	Equipment Type	Construction Year	Serial Number	Manufacturer	Model Number
	Central	POH	POLHEMUS LANE	H	# 1 Transformer	000000000010504694	Load Tap Changer (UVT)	E-LTC	1988	SLM56073	ABB	UVT

Content Editor Web Part

- View and Trend Equipment PI Points
- CA LTC New Action Algorithm Rules

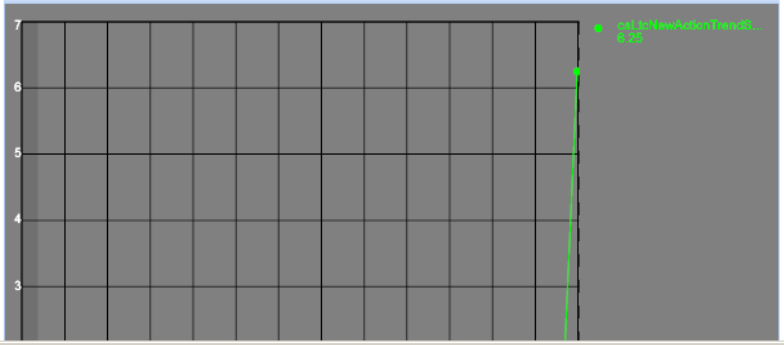
Algorithm Factors

Factor	Raw Value	Case Value	Weight %	Score
Detectable Acetylene	4915	10	25	2.5
Gas Rate of Change	6.08	5	15	0.75
High Total Gas	270243	10	20	2
High Water	48	0	10	0
Low Dielectric	34.4	0	10	0
LTC Operations	95	0	10	0
LTC THRU NEUTRAL	1	10	10	1

CA Score

Score	maxScore	Ranking(%)	Peer Group
6.25	6.25	100	VACUUM

RtTrend



DeltaX Total Combustible Gas

Details	ApprType	Sample Date	CO	H2	Acetylene	Ethane	Ethylene	Methane	Combustible Gas
	LTC	07/06/2009	475	305	4915	40865	2.1297E+05	10714	2.7024E+05
	LTC	04/05/2007	47	0	0	1	4	2	54
	LTC	08/29/2006	168	37	0	1	3	3	212
	LTC	05/11/2006	10	0	0	1	0	2	13
	LTC	04/28/2006	48	0	0	8	28	5	89

Showing 1 to 5 of 23

DeltaX Water

Details	Apprtype	Sample Date	Fluid Temp (C)	Water
	LTC	07/06/2009	45	48
	LTC	04/05/2007	35	21
	LTC	08/29/2006	47	38
	LTC	05/11/2006	42	7
	LTC	04/28/2006	31	28

Showing 1 to 5 of 23

DeltaX Fluid

Details	Apprtype	Sample Date	Fluid Temp (C)	D877	D1816
	LTC	05/11/2006		34.4	
	LTC	08/07/2002		43.7	
	LTC	07/11/2000		37.5	
	LTC	01/14/1998			29.9
	LTC	03/10/1997		42.4	42.4

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6 Months Counter Operations

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DeltaX Diagnostic Data

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Nameplate

Location	Designation	Equipment	Serial_Num	Equipment Type	Manufacturer Year	Model	Rated Kv	Rated MVA
POLHEMUS LANE	No. 1 LTC	SLM56073	SLM56073	LTC	1988	UVT	230	
POLHEMUS LANE	No. 1	SLM56073	SLM56073	TRN	1988	UVT	230	27

DeltaX Fluid Test Results

ApprType	Equipment	Designation	Sample Date	Fluid Condition	IFT	PF25	D1816	D877	PF100	Water	Comment	Rea
LTC	SLM56073	No. 1 LTC	05/11/2006	2	22.8	0.086		34.4		15	LT 42	ROU
TRN	SLM56073	No. 1	05/11/2006	1	33.2	0.129	35.5			21	LT 42	ROU
LTC	SLM56073	No. 1 LTC	08/07/2002	2	23.8	0.067		43.7		41		ROU
TRN	SLM56073	No. 1	08/07/2002	2	31.6	0.155	30.2			36	LT 34	ROU
LTC	SLM56073	No. 1 LTC	07/11/2000	2	28.5	0.046		37.5		44		ROU
TRN	SLM56073	No. 1	07/11/2000	1	38.2	0.059	35.7			21		ROU
LTC	SLM56073	No. 1 LTC	01/14/1998	1	28.3	0.039	29.9			5	Particle Count Per 10ml >3 microns = 905 >5 microns = 613 >10 microns = 374 >20 microns = 133 >50 microns = 10 >100 microns = 1	ROU
LTC	SLM56073	No. 1 LTC	03/10/1997	1	35		42.4	42.4		9		ROU
LTC	SLM56073	No. 1 LTC	02/20/1997	2	18.7	0.153		24.4		40		ROU
TRN	SLM56073	No. 1	02/20/1997	1	35.2	0.14	37.1			13		ROU
TRN	SLM56073	No. 1	05/09/1994	2	26		15					
TRN	SLM56073	No. 1	04/11/1994	2	22			47				

DeltaX Gas Test Results

ApprType	Equipment	Designation	Sample Date	Fluid Temp (C)	Equipment Condtion	CO	CO2	N2	H2	O2	Acetylene	Ethane	Ethylene	Methane	Combustible Gas	Water	Total Gas	Comment	Sampled By	Reason
LTC	SLM56073	No. 1 LTC	07/06/2009	45	4	475	6186	76391	305	1181	4915	40865	2.1297E+05	10714	2.7024E+05	48	76.34	LT=45 ; RS=33.0%	STEVE DAROCI	ROUTINE
LTC	SLM56073	No. 1 LTC	04/05/2007	35	1	47	1521	81763	0	29462	0	1	4	2	54	21	0.048	LT=35 ; RS=20.9%	STEVE DAROCI	ROUTINE
LTC	SLM56073	No. 1 LTC	08/29/2006	47	2	168	1543	81787	37	20457	0	1	3	3	212	38	0.204	LT=47 ; RS=24.3% ; HY=8	STEVE DAROCI	ROUTINE
LTC	SLM56073	No. 1 LTC	05/11/2006	42	1	10	92	15331	0	1764	0	1	0	2	13	7	0.072	LT=42 ; HY=8 ; RS=5.3%	STEVE DAROCI	RUSH
LTC	SLM56073	No. 1 LTC	04/28/2006	31	1	48	2037	78424	0	24251	0	8	28	5	89	28	0.084	LT=31 ; RS=32.5% ; HY=11	STEVE DAROCI	RUSH
LTC	SLM56073	No. 1 LTC	08/29/2005	50	2	254	3130	76571	78	17905	0	11	44	7	394	51	0.403	LT=50 ; RS=29.4% ; HY=8	STEVE DAROCI	ROUTINE
LTC	SLM56073	No. 1 LTC	07/19/2004	45	2	76	1886	72042	41	24251	2	16	82	5	222	38	0.225	LT=45; RS=26.1%	STEVE DAROCI	ROUTINE
LTC	SLM56073	No. 1 LTC	06/12/2003	50	1	81	1834	70633	34	15205	4	20	151	38	328	30	0.373	LT=50 : RS=17.3%	STEVE DAROCI	ROUTINE
LTC	SLM56073	No. 1 LTC	12/03/2002	16	1	76	2309	74227	27	22143	0	2	9	6	120	31	0.122	LT=16 : RS=66.6%	STEVE DAROCI	ROUTINE
LTC	SLM56073	No. 1 LTC	08/07/2002		2	184	2628	79050	104	14024	0	2	5	3	298	42	0.31		STEVE DAROCI	ROUTINE
LTC	SLM56073	No. 1 LTC	08/01/2001	50	2	190	2210	76734	141	12716	0	1	3	4	339	48	0.368	LT=50	STEVE DAROCI	RUSH
LTC	SLM56073	No. 1 LTC	09/14/2000	40	1	53	193	43650	5	4895	1	0	1	1	61	22	0.125	LT=40	KAHLER	RUSH
LTC	SLM56073	No. 1 LTC	09/06/2000		1	153	529	81776	149	1374	0	6	1	11	320	24	0.38		KAHLER	RUSH
LTC	SLM56073	No. 1 LTC	07/22/2000		1	0	0	0	0	0	0	0	0	0	0	7	0	Not enough gas	KAHLER	RUSH
LTC	SLM56073	No. 1 LTC	07/11/2000		2	211	1663	94514	272	1261	0	30	6	42	561	45	0.573		KAHLER	DIAGNO

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Results

- LTC Stationary & Moving Contacts Burned
- Next PM Due 2015
- LTC & Transformer would have failed before next PM
- Conservatively Saved $2M Transformer
- 2008 National Reliability Excellence Award
  - America's most reliable electric utility
  - 3rd time they received this award

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Wind Generation and PI

- Industry primary challenges
  - Asset utilization
    - Availability
    - Efficiency
  - Sell power at highest rates
    - Grid integration
    - Forecasting
    - Scheduling
    - Trading
  - Warranty management

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Wind Generation and PI

- Industry primary challenges
  - Enterprise integration
    - Heterogeneous assets
  - Security
    - NERC CIP
  - Regulations and Compliance
    - Reporting

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Value of Availability

Hours	TurbineClass (kW)	Capacity Factor	Availability	Annual Expected Output (kWh)*	Busbar Price /kWh	Annual Cash Flow per WTG
8760	600	33%	100%	1,734,480	0.0425	$ 73,715.40
8760	1000	33%	100%	2,890,800	0.0425	$ 122,859.00
8760	1500	33%	100%	4,336,200	0.0425	$ 184,288.50
8760	2000	33%	100%	5,781,600	0.0425	$ 245,718.00
8760	2500	33%	100%	7,227,000	0.0425	$ 307,147.50
8760	5000	33%	100%	14,454,000	0.0425	$ 614,295.00

**Formula = Hours * Generator Capacity * Capacity Factor * Availability*

- A typical utility scale wind farm may have 30 to 200 Turbines
- Large owners (e.g. Iberdrola – 3500MWs) may have thousands of turbines
- A single percentage point gain/loss of "in-market" availability (e.g. turbines available to operate when the wind is blowing) for
  - Iberdrola **Total Fleet** would result
    - in a 1st Year ROI/loss of **$4.3MUSD**.
    - NPV over 5 Years = **$13.5MUSD** @ 18% Discount Rate
    - Based on US prices, power rate in Spain is .07 to .10/kWh produced
  - For a **Single Wind Farm of 150MWs**:
    - In a 1st year ROI of $185,000
    - NPV over 5 years = $576,000 @ 18% Discount Rate

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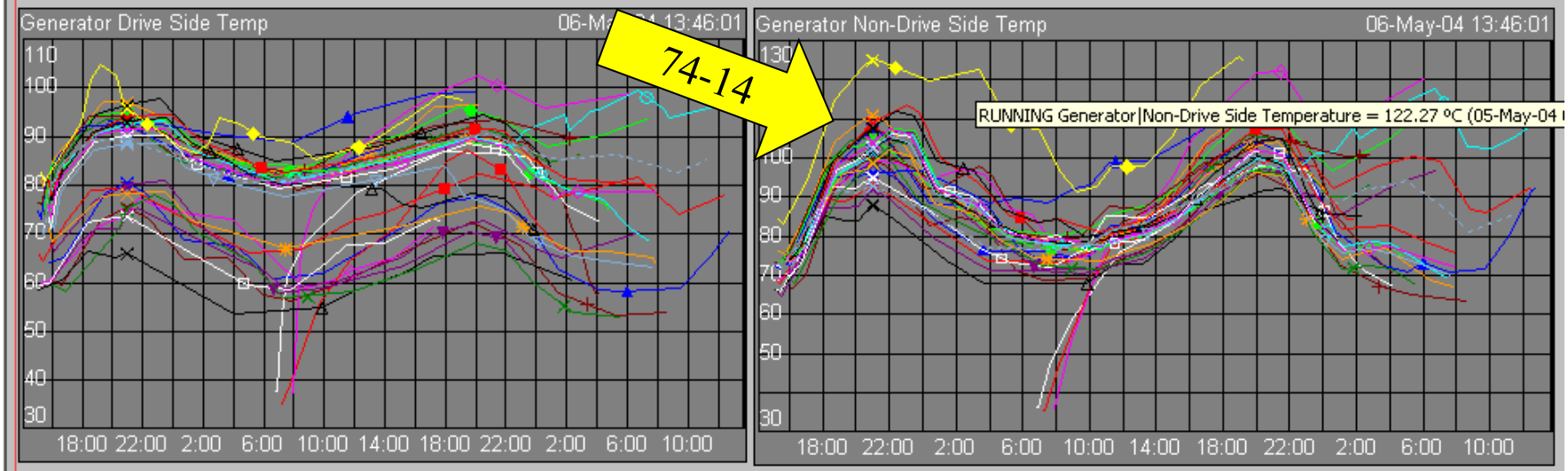
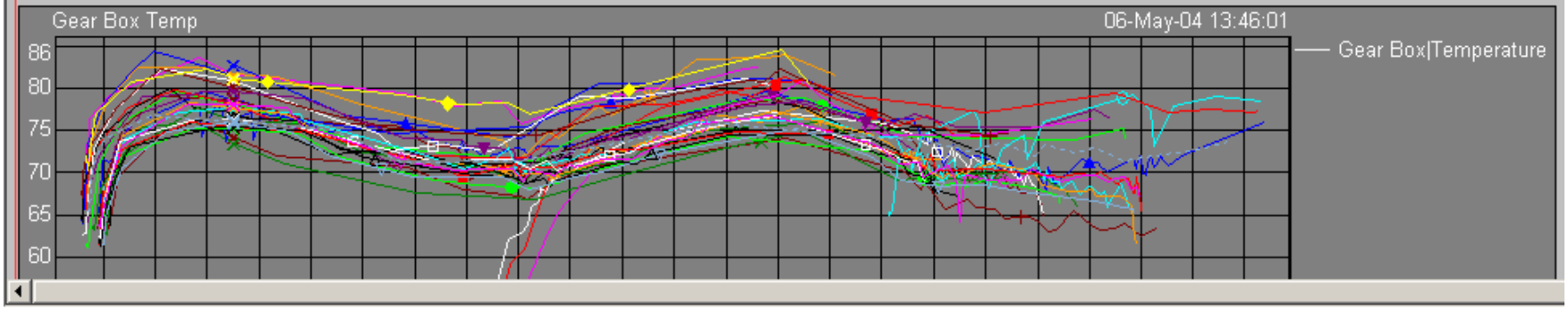
Gearbox Example

MV_I_74-12	05-May-04 07:13:24	06-May-04 01:59:02	18:45:39		None
MV_I_74-14	04-May-04 15:21:04	05-May-04 19:15:28	1d 03:54...		None
MV_I_74-15	04-May-04 15:19:52	05-May-04 17:16:27	1d 01:56...		None
MV_I_89-03	05-May-04 06:49:08	06-May-04 04:14:50	21:25:43		None
MV_I_89-04	04-May-04 15:46:55	06-May-04 04:14:56	1d 12:28...	A40,A41,	None
MV_I_89-07	04-May-04 15:48:11	06-May-04 12:46:01	1d 20:57...	A40,A41,	None
MV_I_89-09	04-May-04 16:06:54	06-May-04 08:37:29	1d 16:30...	A04,A41,	None





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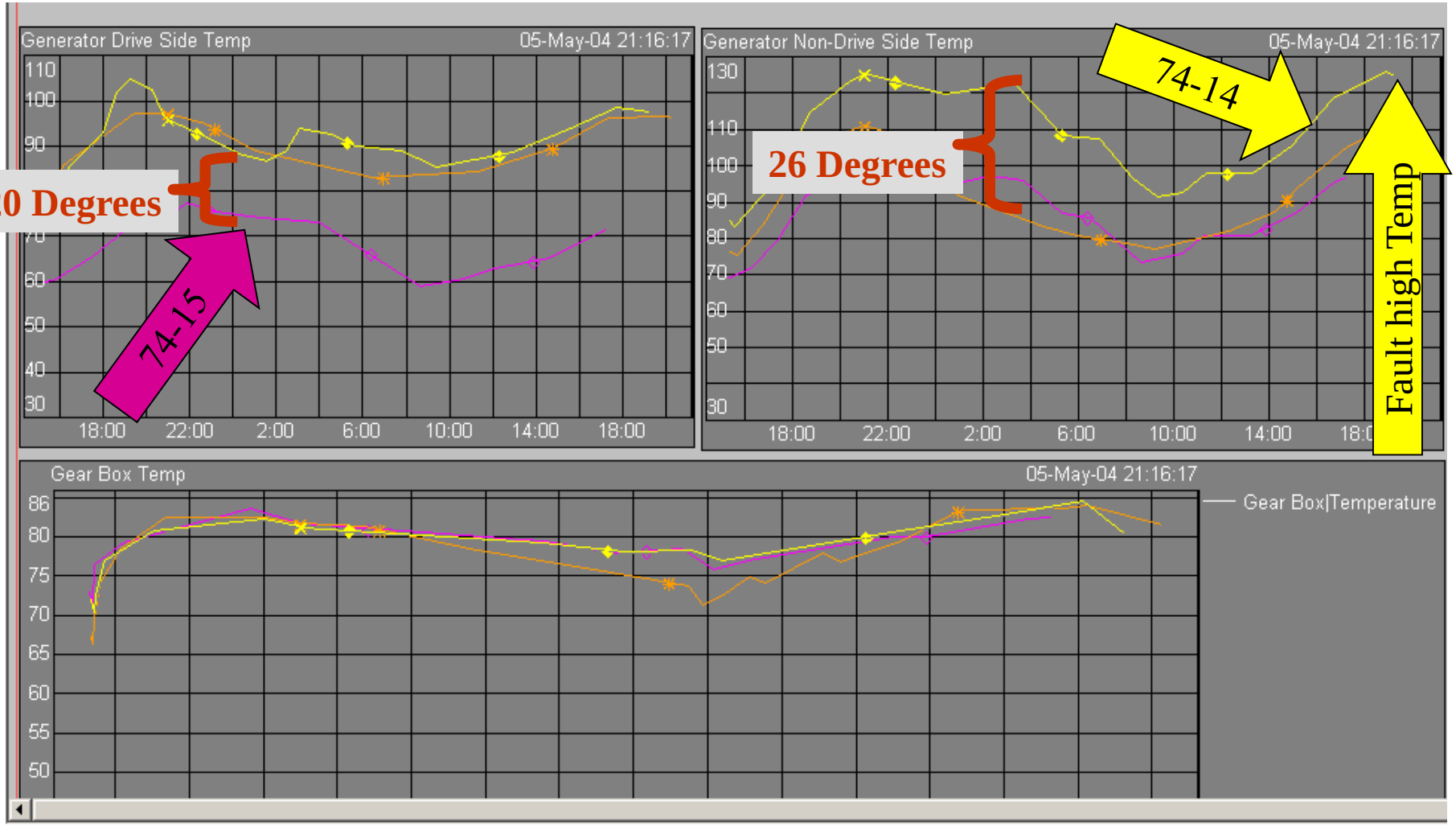
Gearbox Example



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Gearbox Example

Date	Time	Hours Lost	Production Lost	Fault
5/5/04	19:15	11.90	6,627	Gen Temp High
5/9/04	20:29	11.93	7,200	Gen Temp High
5/16/04	18:25	17.32	10,297	Gen Temp High
6/29/04	16:14	382.57	157,665	Generator R&R, Gen Alignment
7/16/04	6:43	1.05	700	Nacelle Reassembly after R&R Gen
Total		424.77	182,489	**$10,024 lost revenue from 1 turbine over 2 month period**

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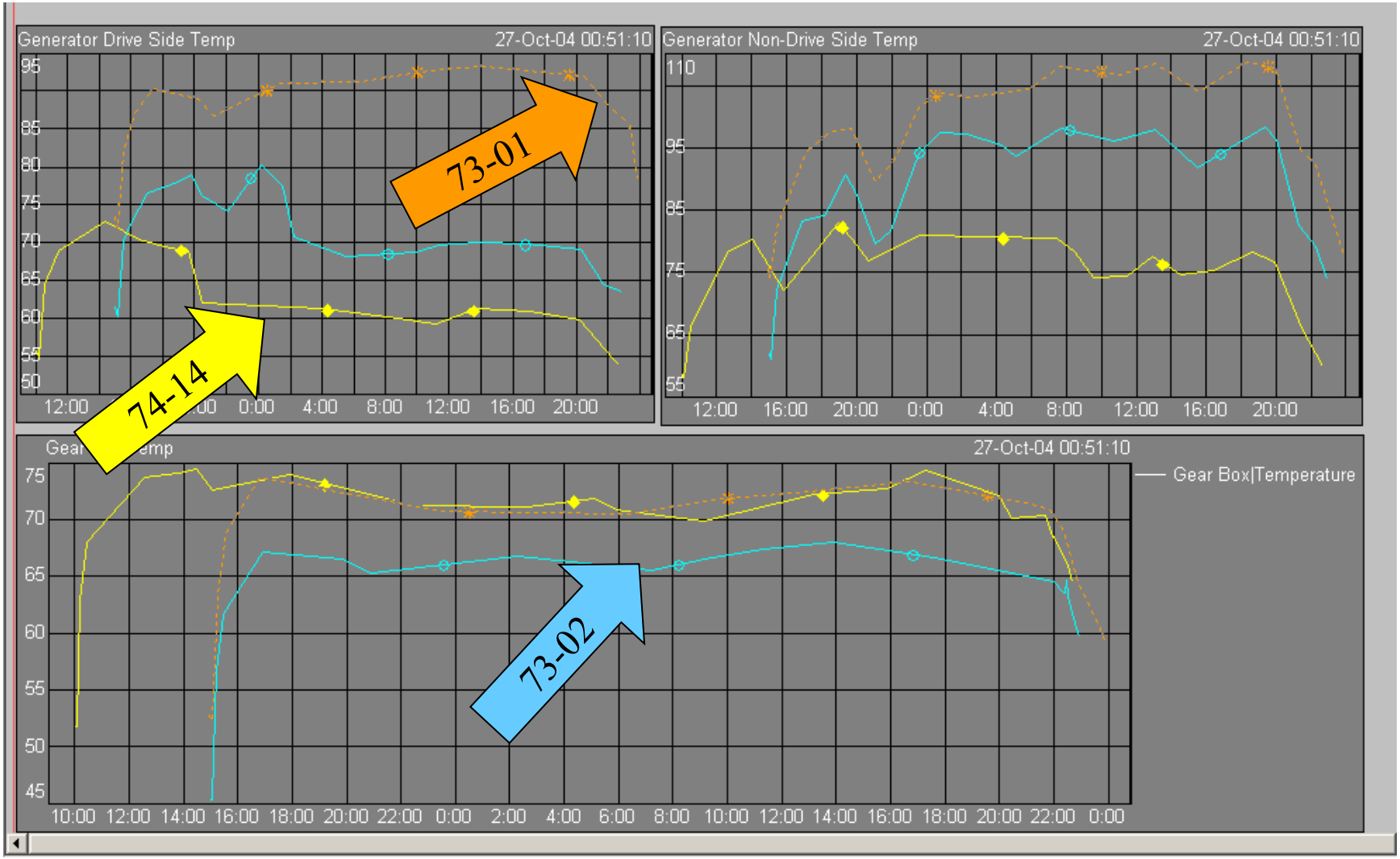
Gearbox Example



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Power Curve Analysis

PowerCurve_9Apr2008.xlsx - Microsoft Excel

Home | Insert | Page Layout | Formulas | Data | Review | View | Add-Ins | PI

Current Value | Archive Value | Compressed Data | Sampled Data | Timed Data | Calculated Data | Time Filtered | Insert Trend | Tag Search | Connections | Point ID to Tag | Attribute Mask to Tag | Tag Attributes | Module Browse | Alias to Tag | Property to Value | Settings | About | Help

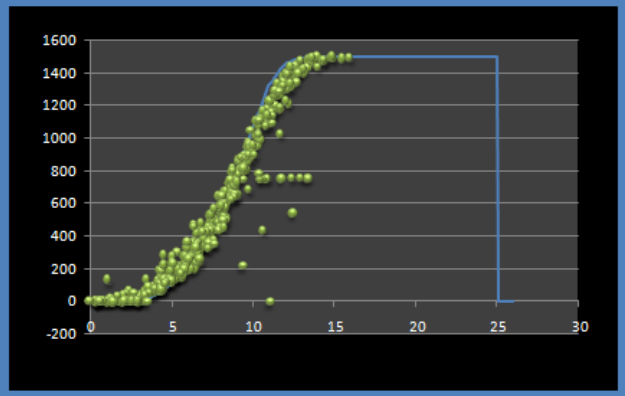
Single Value | Multiple Value | Calculation | Tools | Tag Information | Module Database | Resources

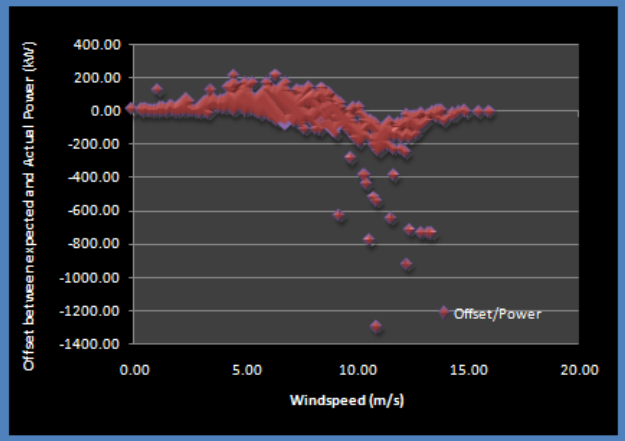
Turbine | GE09

Turbine Power Curve Analysis

Turbine:	GE09	Average Output	280.45 kW
		Avg. Exp. Output	339.24 kW
Period (days):	1	Average Offset	-58.79 kW
Offset (days)	0		
		Actual Generation (kWh)	201926.76
Start Time:	9/1/2008 0:00	Expected Generation	244252.20
EndTime:	10/1/2008 0:00	Daily Energy Offset	-42325.43
Sample frequency	1.44h	Unit Efficiency	82.67%
		Price per kilowatthour ($)	0.145
		Over/Under Production Cost	-$6,137.19

Time	Wind Speed	Meter Output	Expected Outpu	Delta
01-Sep-08 00:00:00	11.74	1023.0	1418	-395.03
01-Sep-08 01:26:24	10.65	432.5	1220.6	-788.09
01-Sep-08 02:52:48	11.10	1191.4	1327	-135.63
01-Sep-08 04:19:12	10.22	1003.3	1114.2	-110.93
01-Sep-08 05:45:36	11.20	1194.5	1353	-158.45
01-Sep-08 07:12:00	12.25	1205.6	1464.2	-258.63
01-Sep-08 08:38:24	10.96	-6.5	1300.4	-1306.86
01-Sep-08 10:04:48	12.33	535.7	1467.8	-932.08
01-Sep-08 11:31:12	13.45	751.2	1496.4	-745.16
01-Sep-08 12:57:36	13.28	749.2	1495.2	-745.96
01-Sep-08 14:24:00	12.46	750.5	1471.4	-720.93
01-Sep-08 15:50:24	12.96	750.6	1490.2	-739.59
01-Sep-08 17:16:48	10.86	744.3	1273.8	-529.49
01-Sep-08 18:43:12	11.62	748.7	1405	-656.32
01-Sep-08 20:09:36	10.96	749.5	1300.4	-550.89
01-Sep-08 21:36:00	10.38	741.6	1140.8	-399.16
01-Sep-08 23:02:24	10.51	743.8	1194	-450.19
02-Sep-08 00:28:48	8.95	634.9	734.4	-99.48
02-Sep-08 01:55:12	7.27	393.1	371.2	21.85
02-Sep-08 03:21:36	8.30	520.9	564.2	-43.28
02-Sep-08 04:48:00	9.79	679.7	973.4	-293.73
02-Sep-08 06:14:24	9.31	215.5	853	-637.48
02-Sep-08 07:40:48	10.47	770.6	1167.4	-396.83
02-Sep-08 09:07:12	11.50	1261.7	1379	-117.33
02-Sep-08 10:33:36	11.21	1222.4	1353	-130.57
02-Sep-08 12:00:00	11.52	1286.5	1392	-105.50





Calculated Data

PI Tag
PI Expression

PI Server (optional): 192.168.3.12

Tagname(s): Analysis!$M$3

Start Time: Analysis!$C$8

End Time: Analysis!$C$9

Time Interval (optional): Analysis!$C$10

Filter Expression(optional):

Conversion Factor: 1

Calculation Mode: average

Advanced

Output Cell: Analysis!$A$17

show start time
show end time
show min/max time
show percent good
column

Analysis | Manufacturer Power Curve | Power Curve Graphic

Ready

ved.

Markets

- PPM—Scotty Gilbert
  - 14 day forecasts; about best at this time
  - 24 hour forecasts—climatology and park data
    - They bank on this—trading is done 24 hours in advance.
    - Supply vs. buy decisions

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Markets

- PPM—Scotty Gilbert
  - At end of day reconcile reality with forecast
    - Did you get the fuel predicted?
    - Did you convert to power as predicted?
  - Evaluate Market exposure
    - Were assumptions true?
  - Imperative to go back and understand and improve.

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Markets

- Scotty Gilbert's words of wisdom
  - Collect all the information
    - True production vs. predicted
    - Evaluate reasons
    - Evaluate where to invest to improve
    - Answer questions in real time.
      - Don't take weeks to answer the CEO's questions
  - "Have the courage use the historical data to evaluate performance"

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Credits

- Midwest ISO
  - http://videostar.osisoft.com/Regional_Seminars/2009/STL/PPTs/RS2009_STL_MISO_Hunter.pdf
- California ISO
  - http://videostar.osisoft.com/t_dwest2003/03/03_files/Default.htm
- PSE&G
  - http://videostar.osisoft.com/Regional_Seminars/2009/Boston/PPTs/RS2009_Boston_CBM_PSEG_Gopal_Rothweiler.pps
- PPM (Iberdrola)
  - http://videostar.osisoft.com/uc2007/video/MO-02-05B_Gilbert_PPM/MO-02-05B_Gilbert_PPM_files/Default.htm

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Thank you

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