Determining True Age of Transformers Through Advanced Analytics PSE&G

Presented by **Angela Rothweiler**

Agenda

- Computerized Maintenance Management System (CMMS)
  - Business Challenges, Solution & Benefits
  - Data Collection
  - Condition Assessment
  - Alarming
  - Benefits
- Advanced Analytics
  - Data Collection
  - Analytics
  - Benefits

Computerized Maintenance Management System (CMMS)

What is CMMS

CMMS is a decision support system that assists in making repair, replace and maintenance decisions for our high profile assets:

- Transformers
- Load Tap Changers
- Breakers & Circuit Switchers
- Transmission OH and UG Assets
- 26 KV UG Transformers & Protectors

PSEG

Business Challenges

- No predictive maintenance program or strategy
- Formalizing the equipment replacement strategy
- Significant liability risk and system outage potential from old equipment vulnerable to failure
- Limited assessment tools for determining asset condition and maintenance efficiency
- Decreasing expertise in both field maintenance and engineering

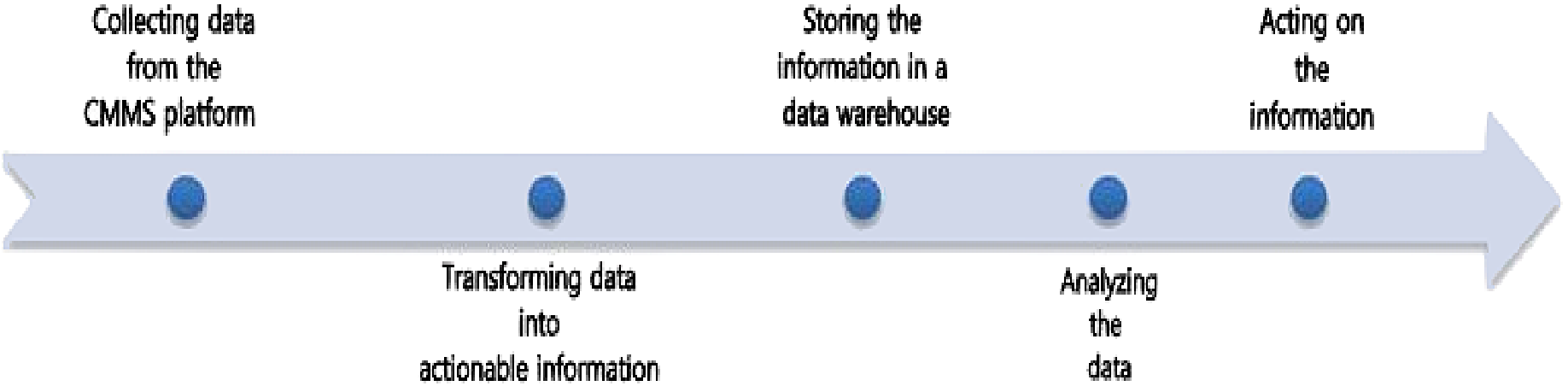
PSE&G

Solution & Benefits

- Centralize and correlate operational, diagnostic, real time sensor data, order history and asset characteristics/nameplate down to asset level within AF
- Create condition based and life cycle algorithms that turn data into actionable information.
- Perform the right maintenance at the right time, based on the *consistent* analysis of data
- Use data to drive business plans for asset replacement
- Avoid costly asset failures

PSEG

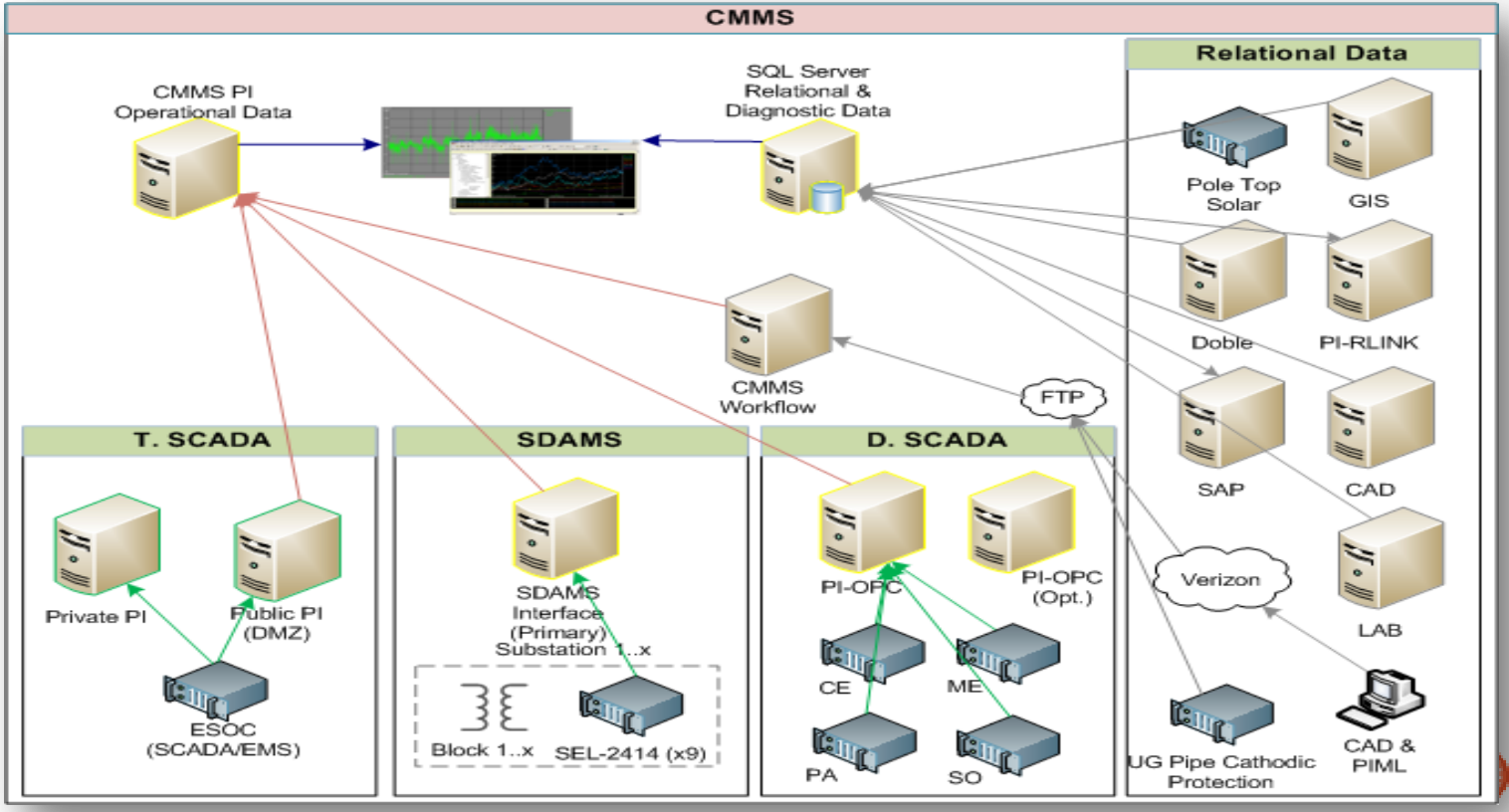
CMMS Strategy



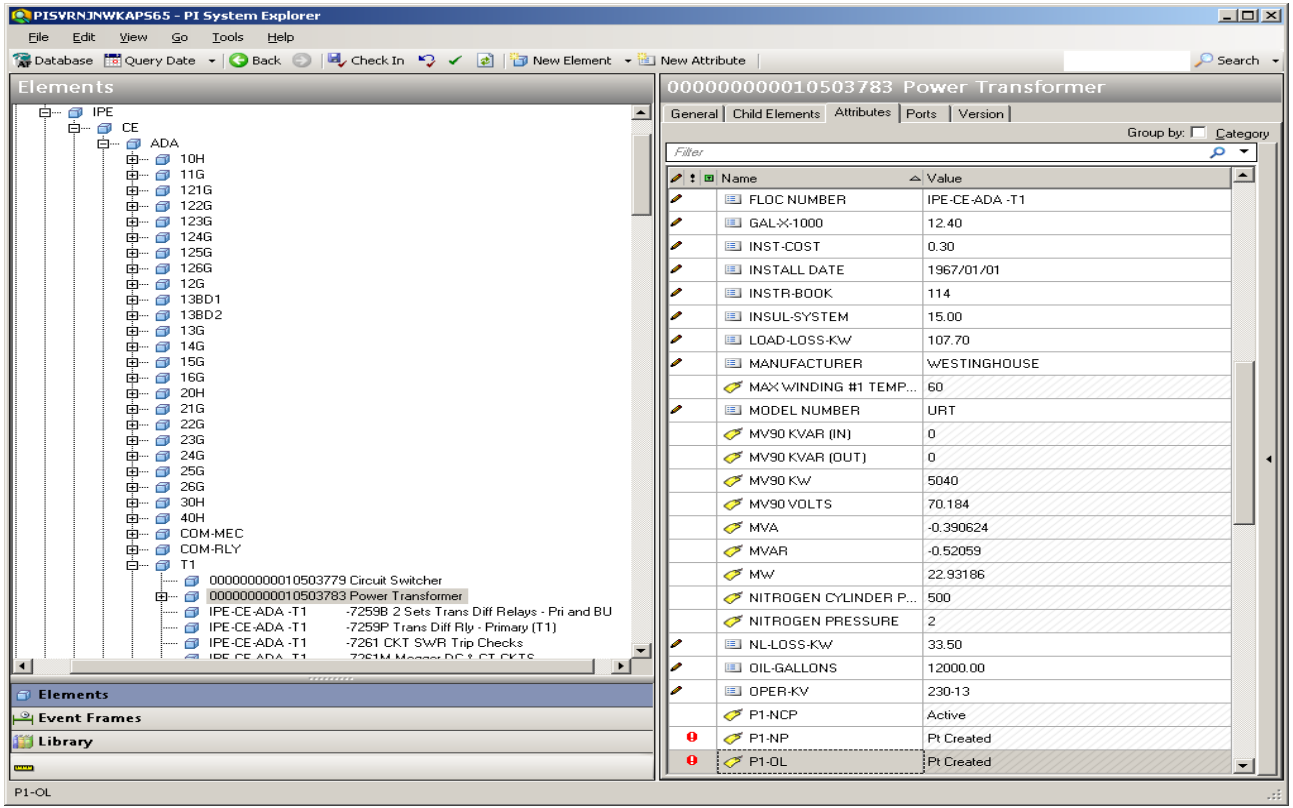
CMMS PI System

- PI Data Archive
- PI Asset Framework
- PI MDB
- PI ACE
- RLink
- PI Manual Logger
- Interfaces: PI DNP, PI OPC, PI to PI, PI UFL
- Client Apps:
  - PI Coresight, PI WebParts, PI Datalink, PI ProcessBook

Data Collection



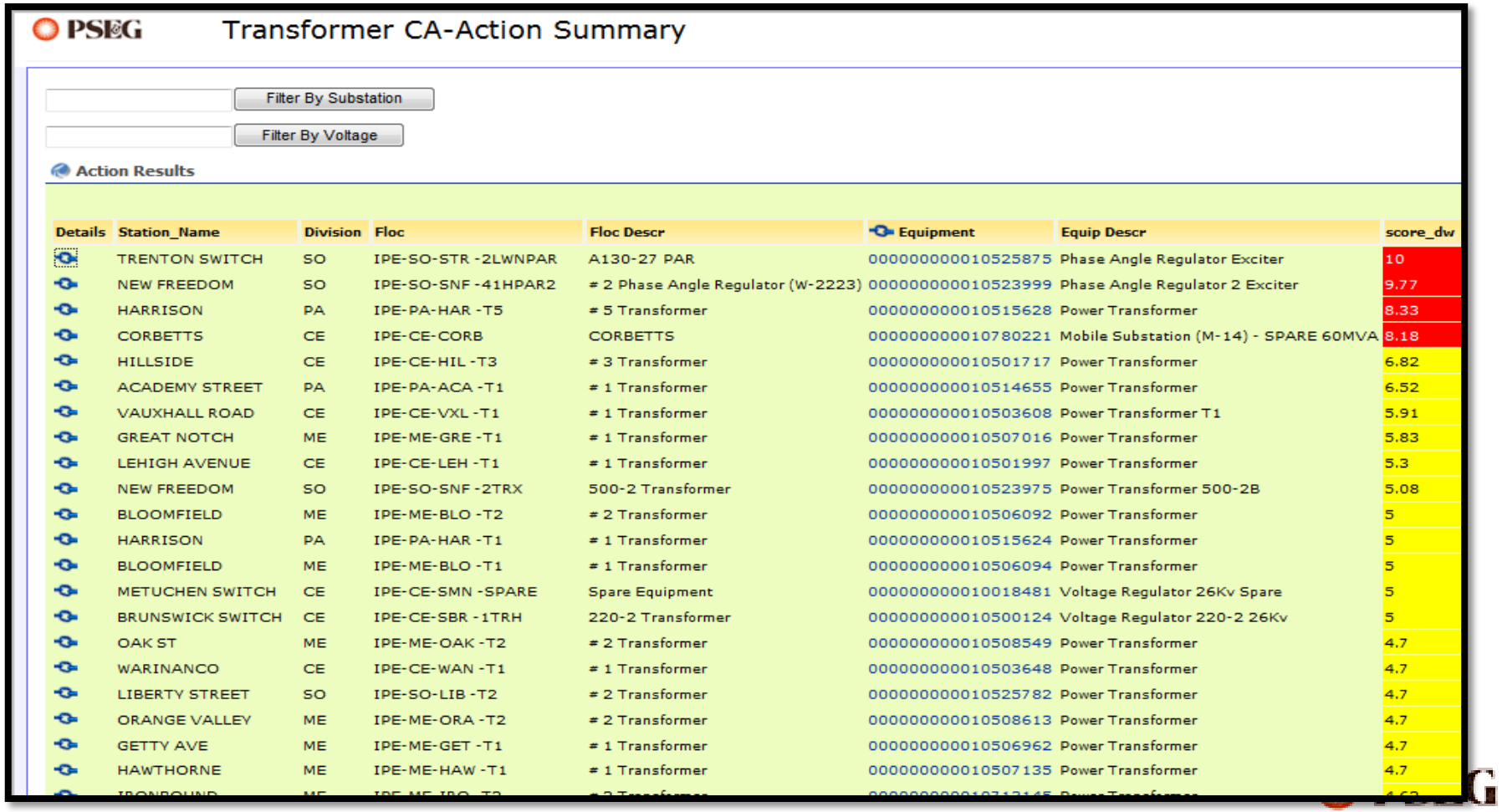
Correlate Data to Asset



Transformer Analytics

- Condition Based Algorithms based on
  - Detectable Acetylene
  - Moisture
  - Dielectric Strength
- Replacement Algorithm based on
  - Condition Score
  - Chronological Age
  - IEEE Loss of Life Aging Factor
- Weighted Algorithms
    - CA = F1*W1 + F2*W2 + Fn*Wn
- Apply calculations to peer groups by Voltage Class

PSEG



Details	Station_Name	Division	Floc	Floc Descr	Equipment	Equip Descr	score_dw
	TRENTON SWITCH	SO	IPE-SO-STR -2LWNPAR	A130-27 PAR	000000000010525875	Phase Angle Regulator Exciter	10
	NEW FREEDOM	SO	IPE-SO-SNF -41HPAR2	# 2 Phase Angle Regulator (W-2223)	000000000010523999	Phase Angle Regulator 2 Exciter	9.77
	HARRISON	PA	IPE-PA-HAR -T5	# 5 Transformer	000000000010515628	Power Transformer	8.33
	CORBETTS	CE	IPE-CE-CORB	CORBETTS	000000000010780221	Mobile Substation (M-14) - SPARE 60MVA	8.18
	HILLSIDE	CE	IPE-CE-HIL -T3	# 3 Transformer	000000000010501717	Power Transformer	6.82
	ACADEMY STREET	PA	IPE-PA-ACA -T1	# 1 Transformer	000000000010514655	Power Transformer	6.52
	VAUXHALL ROAD	CE	IPE-CE-VXL -T1	# 1 Transformer	000000000010503608	Power Transformer T1	5.91
	GREAT NOTCH	ME	IPE-ME-GRE -T1	# 1 Transformer	000000000010507016	Power Transformer	5.83
	LEHIGH AVENUE	CE	IPE-CE-LEH -T1	# 1 Transformer	000000000010501997	Power Transformer	5.3
	NEW FREEDOM	SO	IPE-SO-SNF -2TRX	500-2 Transformer	000000000010523975	Power Transformer 500-2B	5.08
	BLOOMFIELD	ME	IPE-ME-BLO -T2	# 2 Transformer	000000000010506092	Power Transformer	5
	HARRISON	PA	IPE-PA-HAR -T1	# 1 Transformer	000000000010515624	Power Transformer	5
	BLOOMFIELD	ME	IPE-ME-BLO -T1	# 1 Transformer	000000000010506094	Power Transformer	5
	METUCHEN SWITCH	CE	IPE-CE-SMN -SPARE	Spare Equipment	000000000010018481	Voltage Regulator 26Kv Spare	5
	BRUNSWICK SWITCH	CE	IPE-CE-SBR -1TRH	220-2 Transformer	000000000010500124	Voltage Regulator 220-2 26Kv	5
	OAK ST	ME	IPE-ME-OAK -T2	# 2 Transformer	000000000010508549	Power Transformer	4.7
	WARINANCO	CE	IPE-CE-WAN -T1	# 1 Transformer	000000000010503648	Power Transformer	4.7
	LIBERTY STREET	SO	IPE-SO-LIB -T2	# 2 Transformer	000000000010525782	Power Transformer	4.7
	ORANGE VALLEY	ME	IPE-ME-ORA -T2	# 2 Transformer	000000000010508613	Power Transformer	4.7
	GETTY AVE	ME	IPE-ME-GET -T1	# 1 Transformer	000000000010506962	Power Transformer	4.7
	HAWTHORNE	ME	IPE-ME-HAW -T1	# 1 Transformer	000000000010507135	Power Transformer	4.7
	IRONBOUND	ME	IPE-ME-IRO -T2	# 2 Transformer	000000000010713145	Power Transformer	4.62

PSEG

Transformer Action Details

Equipment Nameplate

Oneline	Division	Station Code	Station	Station Type	Floc Descr	Equipment	Equipment Descr	Equipment Type	Construction Year	Serial Number	Manufacturer	Model Number
	Southern	STS	STATE STREET	A	# 4 Transformer/8041	000000000010524286	Unit Transformer	E-TRF-UNT	1972	C0441153	MCGRAW EDISON	550C

Content Editor Web Part

- Equipment Home Page
- View and Trend Equipment PI Points
- SAP Order Details
- CA Comment History
- CA Transformer Action Algorithm Rules

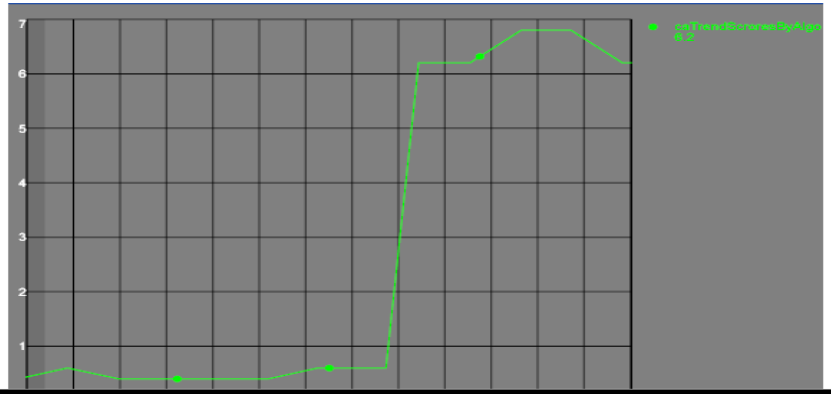
Algorithm Factors by Peer Group

Factor	Raw Value	Case Value	Weight %	Score
Detectable Acetylene	614	10	25	2.5
Gas Rate of Change	375	10	15	1.5
High Total Gas	2971	5	20	1
Low Dielectric	38.4	0	10	0
Top Oil Temperature	30.72	4	10	0.4
Water Content	21	4	20	0.8

CA Score

Score	maxScore	Ranking(%)	Peer Group
6.2	6.6	93.94	26-68KV

CA Score History



DGA Tests

Details	ApprType	Sample Date	CO	H2	Acetylene	Ethane	Ethylene	Methane	Combustible Gas	Water
	TRN	06/28/2008	730	605	614	70	527	425	2971	21
	TRN	06/27/2008	545	586	623	37	470	335	2596	18
	TRN	06/16/2008	355	375	417	28	329	182	1686	15
	TRN	05/15/2007	104	0	0	2	3	3	112	11
	TRN	04/19/2006	104	8	0	3	4	3	122	15
	TRN	06/07/2005	210	14	0	20	6	26	276	17
	TRN	06/16/2004	49	0	0	5	5	2	61	7
	TRN	03/24/2003	62	0	0	4	6	7	79	5
	TRN	02/28/2002	52	8	0	25	2	17	104	13
	TRN	06/26/2001	254	34	0	4	8	12	312	15
	TRN	09/29/2000	305	40	0	7	8	15	375	11
	TRN	07/24/2000	265	43	0	2	6	7	323	6
	TRN	11/12/1999	270	37	0	3	5	11	326	9
	TRN	08/04/1997	189	33	0	3	6	5	236	13
	TRN	08/09/1995	222	23	0	2	5	5	257	

Showing 1 to 15 of 17

Fluid Tests

Details	Apprtype	Sample Date	Fluid Temp (C)	D877	D1816
	TRN	04/17/2014	30		38.4
	TRN	06/25/2008	25		25.4
	TRN	06/16/2004			31.5
	TRN	09/29/2000			32.7
	TRN	07/24/2000			24.8
	TRN	09/08/1997			31
	TRN	08/09/1995			32

Cooling Performance

Time	Value	status
11/2/2014 3:00:00 PM	17.4	Good
10/26/2014 9:00:00 AM	26.8	Good
10/19/2014 10:00:00 AM	30.7	Good
10/12/2014 10:00:00 AM	24.8	Good

DeltaX Gas Test Results

Serial_Num	Equipment	Location	Designation	ApprType	Sample Date	Fluid Temp (C)	Equipment Condtion	CO	CO2	N2	H2	O2	Acetylene	Ethane	Ethylene	Methane	Combustible Gas	Water	Total Gas	C
403962	403962	ACADEMY ST No. 1		TRN	01/22/2015	30	1	708	3388	89380	103	2779	6	6	12	19	854	17	0.885	L
403962	403962	ACADEMY ST No. 1		TRN	11/07/2014	35	1	646	3655	84951	91	5818	5	6	11	18	777	28	0.815	L
403962	403962	ACADEMY ST No. 1		TRN	08/13/2014	31	1	675	3512	83812	96	4259	6	7	15	18	817	35	0.884	L
403962	403962	ACADEMY ST No. 1		TRN	06/18/2014	40	2	632	3355	85552	81	6737	6	7	12	18	756	43	0.784	L
403962	403962	ACADEMY ST No. 1		TRN	02/24/2014	25	1	683	3891	86942	100	3144	0	7	12	20	822	16	0.867	L
403962	403962	ACADEMY ST No. 1		TRN	04/26/2013	30	1	665	4904	86246	87	4052	5	7	15	19	798	24	0.832	L
403962	403962	ACADEMY ST No. 1		TRN	03/25/2013	20	1	687	4184	96730	98	5855	5	10	11	21	832	16	0.773	L
403962	403962	ACADEMY ST No. 1		TRN	03/22/2012	38	1	698	3659	92672	89	4043	3	7	10	19	826	24	0.817	L
403962	403962	ACADEMY ST No. 1		TRN	05/10/2011	30	1	727	3917	90556	105	3846	3	9	16	21	881	26	0.888	L
403962	403962	ACADEMY ST No. 1		TRN	03/09/2010	39	1	751	3772	84862	108	2465	0	9	12	22	902	19	0.979	L
403962	403962	ACADEMY ST No. 1		TRN	03/04/2009	35	1	1363	5500	82323	98	2238	6	15	19	37	1538	10	1.679	L
403962	403962	ACADEMY ST No. 1		TRN	02/20/2008	25	1	669	3678	84364	107	3134	3	10	12	24	825	13	0.896	L
403962	403962	ACADEMY ST No. 1		TRN	03/27/2007	25	1	691	3812	91470	113	3858	3	12	13	27	859	18	0.859	L
403962	403962	ACADEMY ST No. 1		TRN	03/14/2007	20	1	673	3841	93147	109	5775	3	12	13	27	837	15	0.807	L
403962	403962	ACADEMY ST No. 1		TRN	04/11/2006	30	1	622	3726	87545	98	3143	2	12	12	39	785	20	0.825	L
403962	403962	ACADEMY ST No. 1		TRN	04/05/2005	22	1	539	3403	80570	90	2554	0	11	10	25	675	14	0.773	L
403962	403962	ACADEMY ST No. 1		TRN	04/07/2004	35	1	566	3170	83943	108	3362	0	12	12	28	726	18	0.795	L
403962	403962	ACADEMY ST No. 1		TRN	04/16/2003	40	1	587	3546	89763	106	1931	0	17	13	36	759	29	0.791	L
403962	403962	ACADEMY ST No. 1		TRN	04/11/2002	35	1	519	3506	81801	95	2023	0	14	14	28	670	27	0.762	L
403962	403962	ACADEMY ST No. 1		TRN	06/11/2001	30	1	494	2533	83481	93	5342	0	16	11	31	645	32	0.701	L
403962	403962	ACADEMY ST No. 1		TRN	05/17/2001	35	1	550	2663	85525	108	3094	0	15	12	32	717	31	0.779	L
403962	403962	ACADEMY ST No. 1		TRN	05/13/2000	30	1	538	2920	85385	106	2185	0	17	13	35	709	29	0.777	
403962	403962	ACADEMY ST No. 1		TRN	04/06/1999		1	564	3477	95179	105	594	0	22	17	42	750	17	0.75	
403962	403962	ACADEMY ST No. 1		TRN	09/16/1998		2	592	2997	87219	139	971	0	26	16	41	814	47	0.885	
403962	403962	ACADEMY ST No. 1		TRN	08/27/1998	50	2	665	3328	97622	157	936	0	29	17	46	914	46	0.89	

DeltaX Fluid Test Results

Equipment	Designation	ApprType	Sample Date	Fluid Condition	IFT	D1816	D877	PF25	PF100	Water	Comment	Reason
403962	No. 1	TRN	06/18/2014	2	23.4	28.6		0.158		38	LT 40	ROUTINE
403962	No. 1	TRN	04/26/2013	2	22.1	27.8		0.186		27	LT 30	ROUTINE
403962	No. 1	TRN	03/25/2013	2	22.5	30.3		0.115		17	LT 20	ROUTINE
403962	No. 1	TRN	03/22/2012	2	23.6	39.8		0.123		24	LT 38	ROUTINE
403962	No. 1	TRN	05/10/2011	2	21.4	26.6		0.141		37	LT 30	ROUTINE
403962	No. 1	TRN	03/09/2010	1	25.7	38.8		0.115		20	LT 39	ROUTINE
403962	No. 1	TRN	03/04/2009	2	23.3	45.4		0.14		14	LT 35	ROUTINE
403962	No. 1	TRN	02/27/2008	2	22.8	44.3		0.125		14	LT 25	ROUTINE
403962	No. 1	TRN	03/27/2007	2	21.6	41.5		0.107		21	LT 25	ROUTINE
403962	No. 1	TRN	04/11/2006	1	24.1	33.5		0.12		20	LT 30	ROUTINE
403962	No. 1	TRN	04/05/2005	2	22.5	30.1		0.122		17	LT 22	ROUTINE
403962	No. 1	TRN	04/16/2003	2	22.8	29.6		0.105		28	LT 40 ; PCB < 50 TK CBD	ROUTINE
403962	No. 1	TRN	04/11/2002	2	23.4	31.5		0.092		25	LT 35	ROUTINE
403962	No. 1	TRN	06/11/2001	2	25.3	32.7		0.11		39	LT=30	ROUTINE
403962	No. 1	TRN	05/17/2001	1	24.6	30.7		0.097		30		ROUTINE
403962	No. 1	TRN	05/13/2000	1	25.6	30.3		0.102		28	TEMP=30C	ROUTINE
403962	No. 1	TRN	04/06/1999	1	26.4	32.2		0.121		16		ROUTINE
403962	No. 1	TRN	09/02/1998	2	23.8	15.1		0.093		39		ROUTINE
403962	No. 1	TRN	08/27/1998	2	25.8	16.1		0.1		52	TEMP=50C	ROUTINE
403962	No. 1	TRN	03/04/1997	1	26.1	34.9		0.086		16		ROUTINE
403962	No. 1	TRN	06/12/1996	2	23.1	15.9		0.091		43		ROUTINE
403962	No. 1	TRN	07/03/1995	2	22	20		0.094				
403962	No. 1	TRN	06/30/1995	2	21	13		0.1				
403962	No. 1	TRN	05/23/1995	2	20	18		0.098				

Equipment Order History

Time Range

Start Time *-5y End Time * Apply

Nameplate

Oneline	Division	Station Code	Station	Station Type	Floc Descr	Equipment	Equipment Descr	Equipment Type	Construction Year	Serial Number	Manufacturer	Model Number
	Southern	SNF	NEW FREEDOM	X	500-2 Transformer	000000000010523975	Power Transformer 500-2B	E-TRF-TRF	1970	D596878	GENERAL ELECTRIC	LRS 700

PM Teco Orders

Order	Order Description	Priority	Work Center	Status	Planned Cost	Actual Cost	Completion Date
000100834035	Southern TFMR 230kV-500kV 1yr	1	SO-ME	TECO	2894.7	241.28	5/20/2014 12:00:00 AM
000100736713	Southern TFMR 230kV-500kV 1yr	1	SO-ME	CLSD	1392.5	611.27	2/10/2013 12:00:00 AM
000100767593	DGA Sample	C	SO-ME	CLSD	0	107.55	11/23/2012 12:00:00 AM
000100748889	DGA Resample	C	SO-ME	CLSD	0	165.1	7/30/2012 12:00:00 AM
000100679524	Southern TFMR 230kV-500kV 1yr	1	SO-ME	CLSD	4292.5	336.91	4/28/2012 12:00:00 AM
000100614164	So. Transf.-230kv -500KV 2yr	1	SO-ME	CLSD	1320.8	84.22	4/28/2012 12:00:00 AM
000100614428	Southern TFMR 230kV-500kV 1yr	1	SO-ME	CLSD	4032.1	1130.8	5/8/2011 12:00:00 AM

PM Teco Order Operations

Operation	Description	Planned Hours	Actual Hours	Sub-Operation
0010	TRF (ALL) Desicant System - Transm 1yr		1	0.5 0000
0020	TRF (ALL) Cooling System - Transm 1 yr		16	0.5 0000
0030	TRF (ALL) Gas in Oil Test - Transm 1yr		1	0.5 0000
0060	MTS-Transf. (ALL) 1 Yr. Oil Test		0	0 0000

PM Open Orders

Order	Order Description	Priority	Work Center	Status	Planned Cost	Actual Cost	Due Date
000100902409	Transformers 69KV-500KV Transm 4yr	1	SO-ME	OPEN	0	0	7/1/2016 12:00:00 AM
000100851772	Southern TFMR 1230V-500kV 1yr	1	SO-ME	OPEN	3123.9	0	5/20/2015 12:00:00 AM

PM Open Order Operations

Operation	Description	Planned Hours	Actual Hours	Sub-Operation
0010	69KV-500KV Phys Oil Test - Transm 4yr		6	0 0000
0020	MTS-Physical Oil Test - Transm 4yr		0	0 0000

Maintenance Cycles

Last_Comp_Date	Next_Sched_Date	Maint_Cycle
2009-03-18	2019-03-18	10
2013-12-12	2017-12-12	4
2012-04-28	2014-04-28	2
2010-03-09	2014-03-09	4
2010-03-09	2012-03-09	2

PM Actual Cost

Total PM Cost
2677.1

PM Actual Hours

Total PM Hours
12.3

CM Actual Cost

Total CM Cost
8253.7

CM/PM Ratio

Total PM Cost	Total CM Cost	CM-PM Ratio
2677.1	8253.7	3.08

Equipment PI Points

Nameplate

Division	Station Code	Station	Station Type	Floc Descr	Equipment	Equipment Descr	Equipment Type	Construction Year	Serial Number	Manufacturer	Model Number
Southern	SNF	NEW FREEDOM	X	# 2 Phase Angle Regulator (W-2223)	000000000010523999	Phase Angle Regulator 2 Exciter	E-TRF-PAR	1973	K546937	GENERAL ELECTRIC	2 X LR400G

Max Value

Time	Max
3/16/2015 9:26:46 PM	1461.

Min Value

Time	Min
2/20/2015 3:40:18 PM	1400.

Average Value

Time	Average
4/20/2015 8:54:54 AM	1440.84

Standard Deviation

Time	Standard Deviation
4/20/2015 8:54:54 AM	8.49

Archive Values

|< < > >|

Time	Status	Value
4/16/2015 11:19:02 AM	Good	1443.
4/16/2015 10:40:10 AM	Good	1443.
4/16/2015 10:39:29 AM	Good	1443.
4/16/2015 10:39:29 AM	Good	1443.
4/16/2015 10:32:15 AM	Good	1443.
4/16/2015 10:29:49 AM	Good	1443.
4/16/2015 10:08:25 AM	Good	1443.
4/16/2015 10:08:25 AM	Good	1443.
4/15/2015 10:48:05 AM	Good	1443.
4/15/2015 10:45:06 AM	Good	1443.
4/15/2015 9:03:44 AM	Good	1443.
4/15/2015 9:03:44 AM	Good	1443.
4/15/2015 8:58:11 AM	Good	1444.
4/15/2015 8:45:36 AM	Good	1443.
4/15/2015 8:45:36 AM	Good	1443.
4/15/2015 8:23:09 AM	Good	1443.
4/6/2015 12:44:42 PM	Good	1443.
3/31/2015 10:33:35 AM	Good	1443.
3/28/2015 6:41:25 AM	Good	1446.

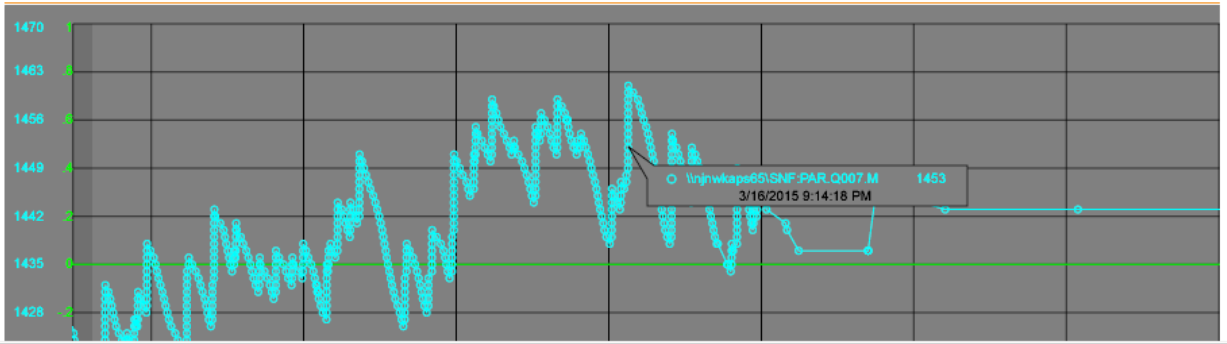
PI Data Time Range

Start Time *-60d End Time * Apply

PI Points

Alias	Descriptor	Tag Name	Units	Source	Time	Current Value
COUNTER	#2 PAR AUTO GRD DEV CTR	SNF:PAR.R002.M	Ctrs	Inspection	4/15/2015 12:00:00 PM	
ESOC LOAD IN MVA	NEWFREEDOM W-2223 PAR MVA	SNF:PAR.E002.Q	MVA	ESOC	4/15/2015 8:58:11 AM	0
GAS DETECTION RELAY	#2PAR W-2223 GAS DET RLY EXC	SNF:PAR.P005.M		Inspection	4/15/2015 12:00:00 PM	
HYDRAN PPM	NFREEDOM 2PAR EXCITER GAS	SNF:PAR.Q007.M	PPM	ESOC	4/16/2015 11:19:02 AM	1443
HYDRAN ROC	# 2 Phase Angle Regulator (W-2223) Hydran PPM	SNF:PAR.Q007.N1	Deg C		3/20/2015 3:00:00 AM	0
MAX LIQUID #2 TEMP	#2PAR W-2223 MAX LIQ #2 EXC	SNF:PAR.T005.M	Deg F	Inspection	4/15/2015 12:00:00 PM	
MAX WINDING TEMP	#2 PARH W-2223 MAXWDG #1TMP	SNF:PAR.T007.M	Deg F	Inspection	4/15/2015 12:00:00 PM	
MAX WINDING # TEMP	#2 PARH W-2223 MAXWDG #1TMP	SNF:PAR.T007.M	Deg F	Inspection	4/15/2015 12:00:00 PM	
MAX WINDING #2 TEMP	#2 PARH W-2223 MAXWDG #2TMP	SNF:PAR.T008.M	Deg F	Inspection	4/15/2015 12:00:00 PM	
PIML COOLING PERFORM	#2 PAR EXC W-2223 OIL/AMB DIFF	SNF:CPR.T011	Deg C		4/15/2015 12:00:00 PM	5
SF-6 GAS PRESSURE	#2 PAR GRD DEV GAS PRES	SNF:PAR.P002.M	psi	Inspection	4/15/2015 12:00:00 PM	
TANK OIL LEVEL	#2 PARH W-2223 OIL LVL	SNF:PAR.L001.M		Inspection	4/15/2015 12:00:00 PM	
W-2223 PAR MVA	NEWFREEDOM W-2223 PAR MVA	SNF:PAR.E002.Q	MVA	ESOC	4/15/2015 8:58:11 AM	0
W-2223 PAR MVAR	NEW FRDM W-PAR MVAR	SNF:PAR.E004.Q	MVAR	ESOC	4/15/2015 8:58:11 AM	0
W-2223 PAR MW	NEW FRDM W-PAR MW	SNF:PAR.E002.W	MW	ESOC	4/15/2015 8:58:11 AM	0

PI Data Trend



PSEG

Transformer Alarming in ACE

- Event Based Calculations
  - Low Nitrogen Pressure
  - Low Nitrogen Cylinder Pressure
  - High / Low Oil Levels
- Scheduled Calculations
  - Daily Combustible Gas Rate of Change
  - Weekly Combustible Gas Rate of Change
- Inputs SCADA or Weekly Inspection data collected by operators
- Output is email to Asset Engineers or SAP notification for Maintenance Supervisor

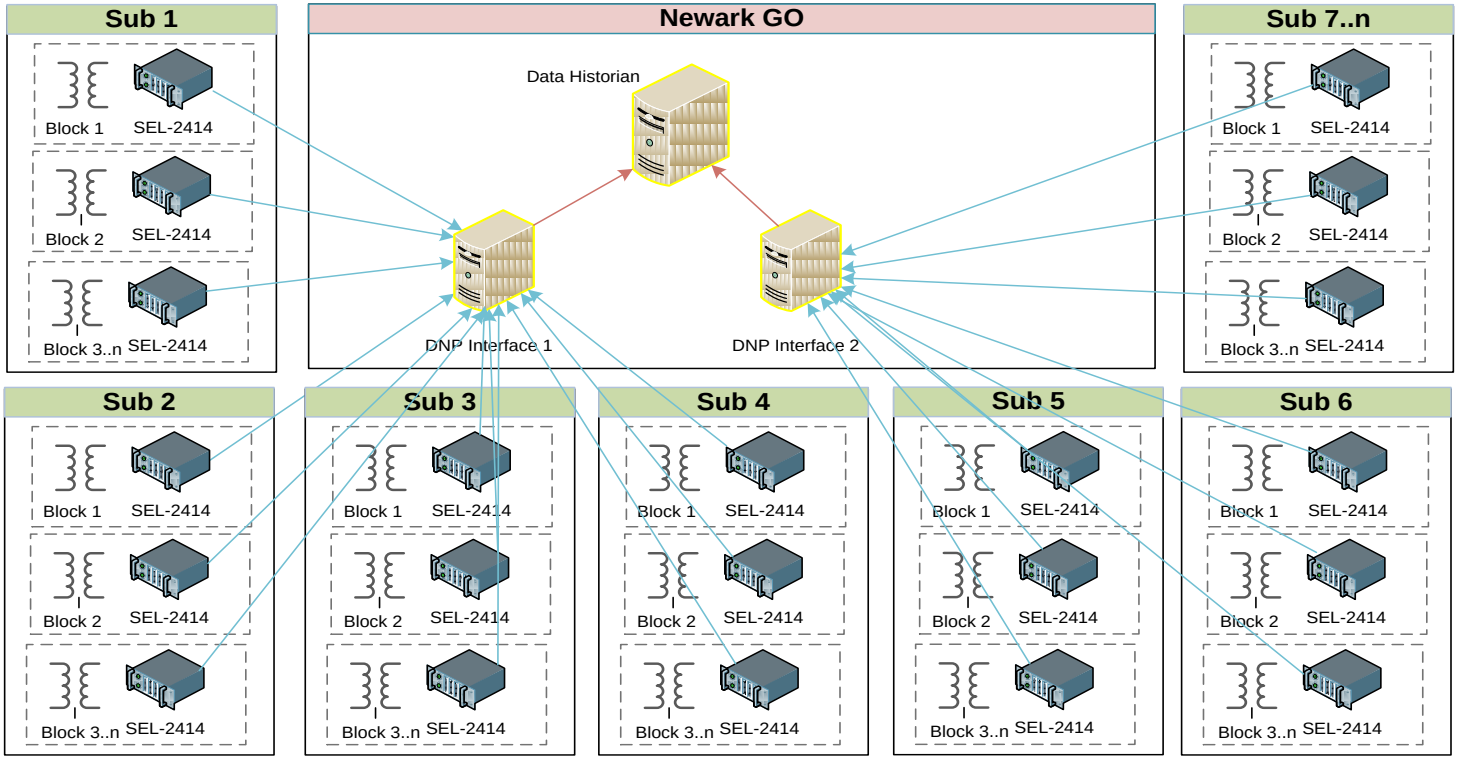
PSEG

Benefits

- Have been very successful in the past 13 years identifying problems and remediating issues before a failure
- Extremely valuable system when you have
  - $5 B of installed assets with a replacement value > 9B
  - Average age of the assets exceeds 40 years
  - All equipment is expected to be **used and useful** all the time
- Justify millions of dollars in saving over past 13 years in equipment failure avoidance
- No secret sauce for success – program success is contributed to Asset Engineer's commitment to program and data owners ensuring data integrity

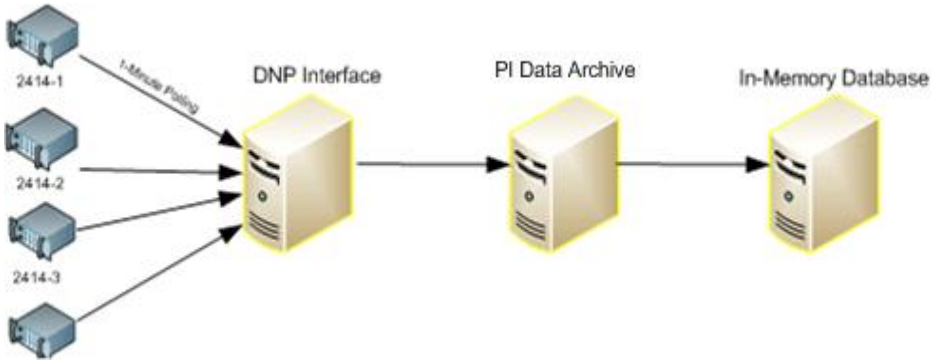
Advanced Analytics on Real Time Sensor Data

Non-Operational Data Collection



Advanced Analytics

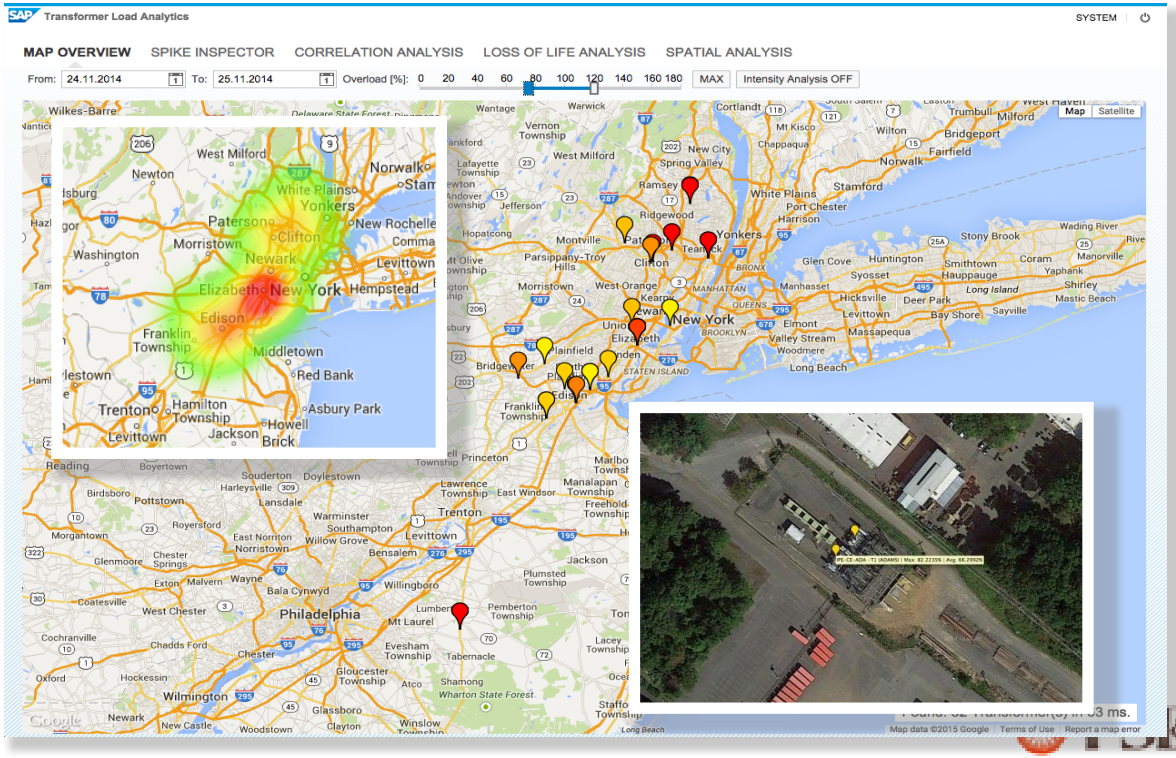
- Geographical view of Transformer Loading and Loss of Life (LOL) Situation
- Calculates Transformer LOL based on IEEE C57.91-2011



PSEG

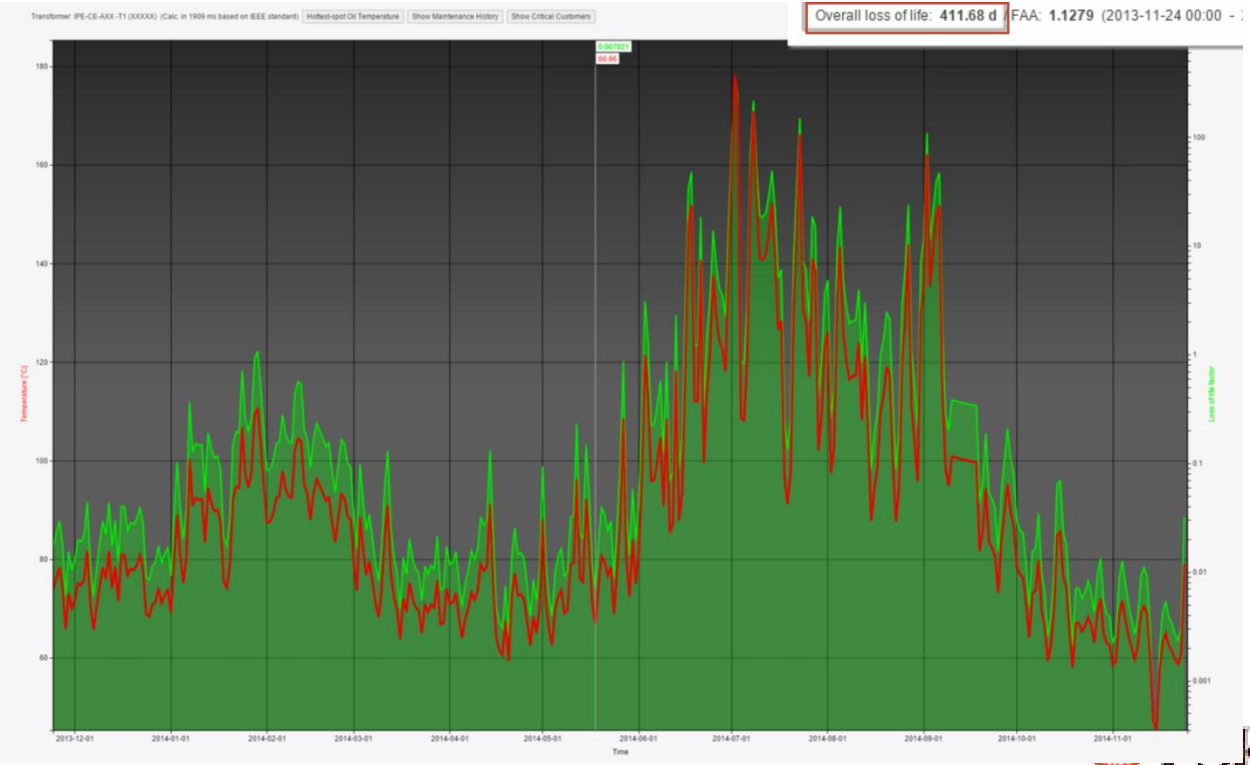
Transformer Load & LOL Situation

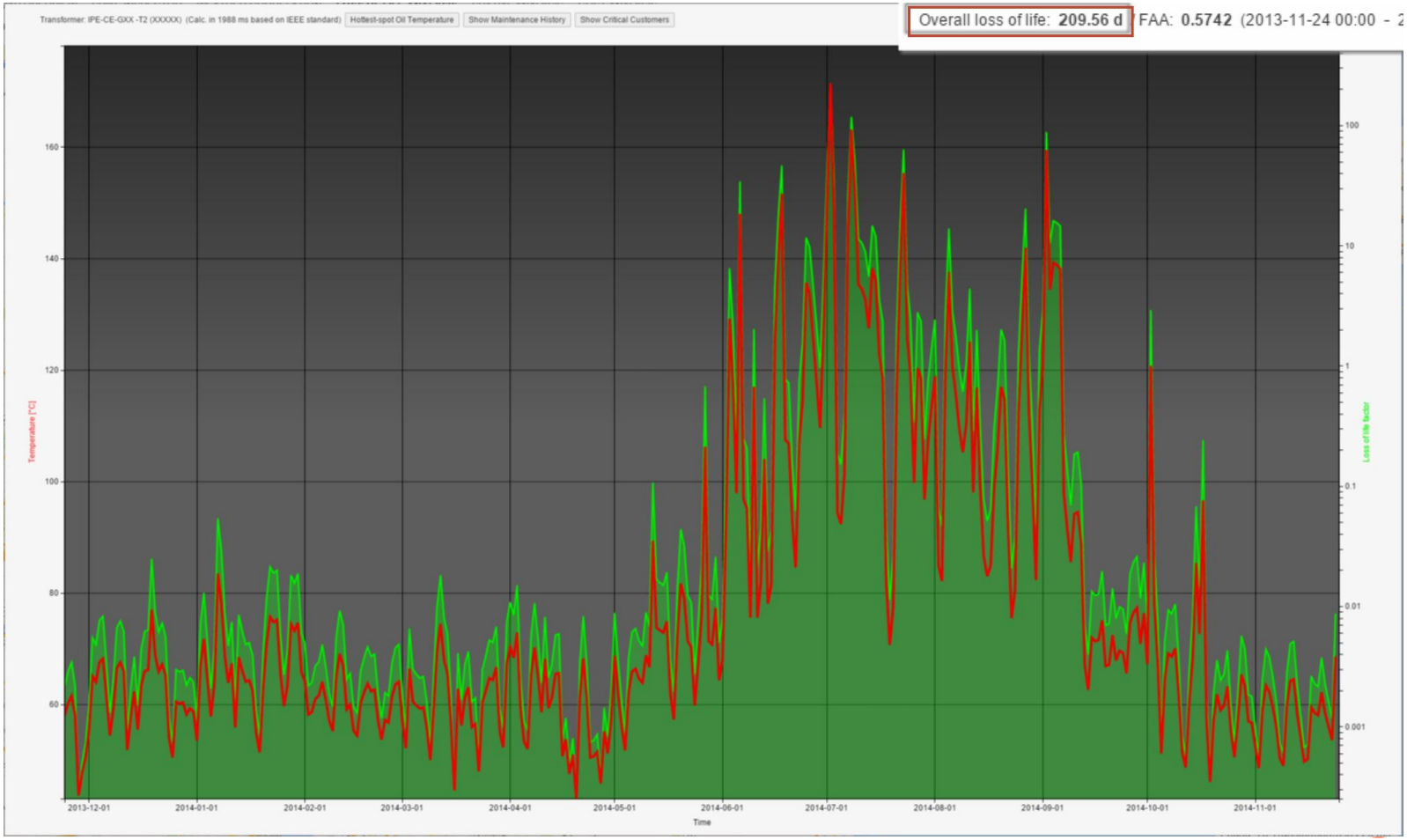
- Map overview of load or LOL situation
- Based on load maximum or averages
- Satellite view
- Heatmap representation instead of pins
- Satellite view of substation



Transformer Loss-of-Life (LOL) Calculation

- Calculate transformer loss-of-life using IEEE C57.91-2011 (for 1 year with 1-minute measurements)
- Calculate using load or actual measured winding hot spot temperature.
- See development of resulting hottest-spot oil temperature (red) and loss-of-life factor (green) over the year

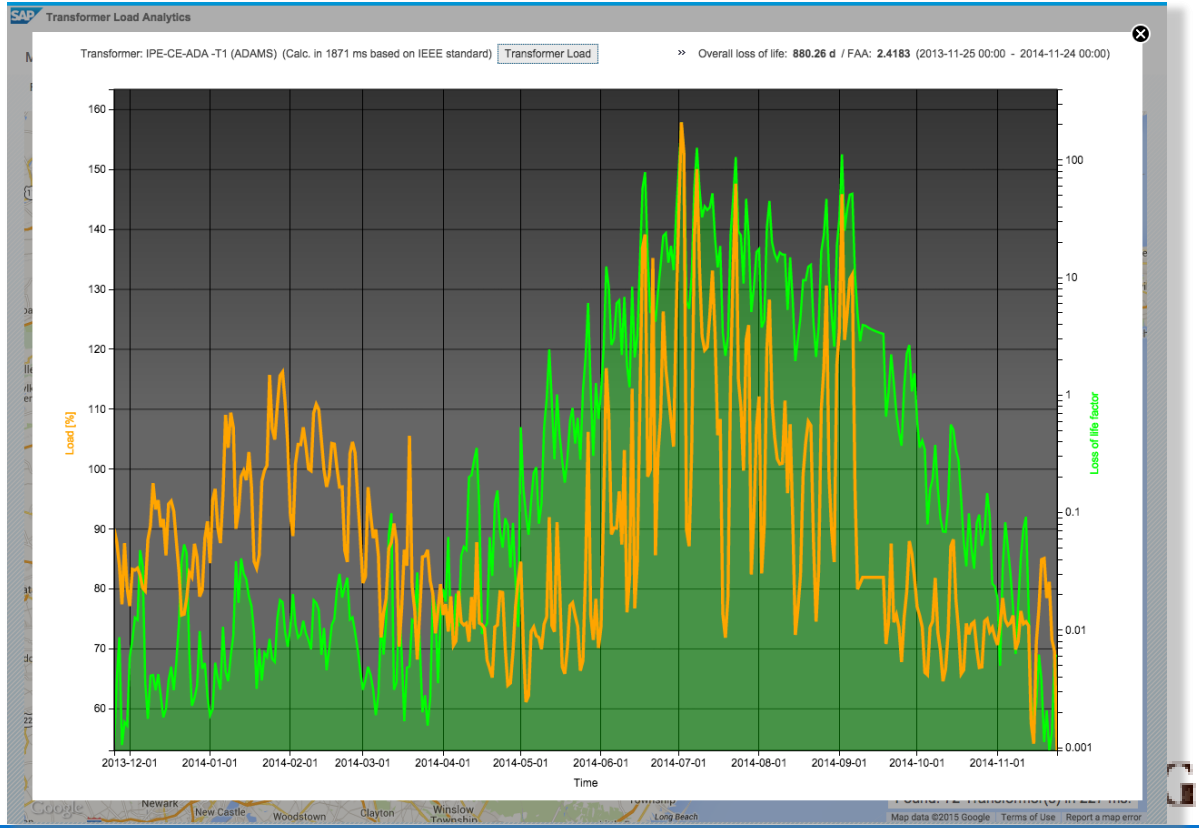




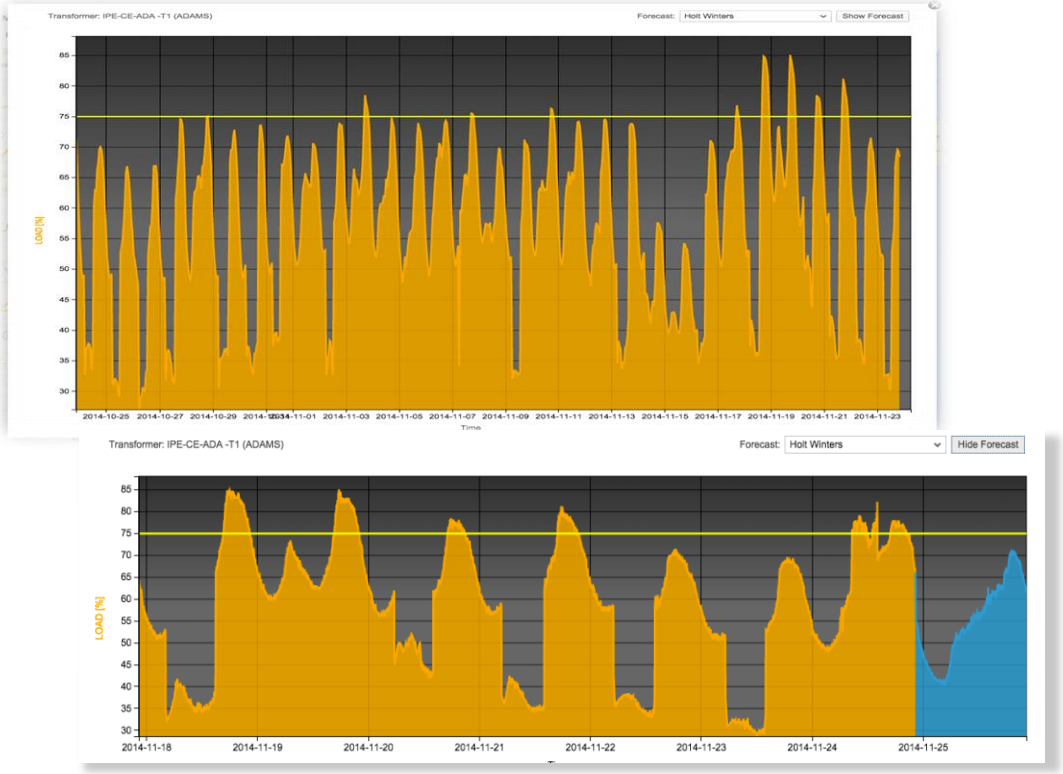
PSEG

Transformer Loss-of-Life Calculation

- Display load curve and see relationship between load and loss-of-life factor
- Here:
  - impact of colder winter months on loss-of-life
  - combined effect of higher load and higher ambient temps in summer



Investigating Individual Load Curves



- Display percent current load to nameplate rating
- Conduct forecasting of the next day‘s load (blue color, on the right

Benefits

- Calculate **true age** of the transformer using IEEE C57.91-2011 Loss of Life
- Use true aging factor to drive replacement algorithm
- Provides engineers with load & loss of life profiles
- Extrapolate/forecast data into future and past
- Excellent tool for calculating transformer end of life for future engineers (installing monitoring devices on new transformers

PSEG

- Angela.rothweiler@pseg.com
- Principal Engineer
- Public Service Electric & Gas (PSE&G)

THANK YOU

Brought to you by