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### PI System in Smart Grids, T&D and Power

Presented by

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Business Development – T&D Smart Grids

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- Smart Grid What does it really mean?
- Smart Grid Does it come with Directions?
- What are the Parts?
- What's important in a Smart Grid?
- End to End Visibility and Monitoring
  - PI System customer Use Cases
    - DTE
    - SEMPRA (SDG&E)
    - Xcel Smart Grid City
    - UCSD Micro Grid

- Does it mean AMI? Smart Meters?
- Does it mean HEMS?
- Does it mean DA/DMS?
- Does it mean PMUs?
- Does it mean DER?
- Does it mean Micro Grids?
- All of the above?
- Non of the above?
- Do we know our acronyms?



"The Smart Grid isn't a thing but rather a vision and to be complete, that vision must be expressed from various perspectives – its values, its characteristics, and the milestones for achieving it."

Joe Miller – Smart Grid News.com

- We know the following;
  - It must be more reliable
  - It must be more secure
  - It must be more economic
  - It must be more efficient
  - It must be more environmentally friendly
  - It must be safer

- 5 Key Technologies that enable the Smart Grid:
  - Integrated Communications
  - Sensing and Measurements
  - Advanced Components
  - Advanced Controls
  - Improved Interfaces and Decision Support



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### **Smart Grid – Does it come with Directions?**

- AMI and Smart Grid could be viewed like a box of Legos
- Legos are great, one can build most anything



### **Smart Grid – Does it come with Directions?**

Estimates For AMI / Smart Grid Generated Data

Potential data growth from Smart Grid – including home networks



AMI and Smart Grid will increase the amount of measurement and control points far beyond anything we have today – How we can leverage this data to compete?



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### **Smart Grid – Does it come with Directions?**

• And does not come with directions like Legos





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### What's important in a Smart Grid?





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### **DTE Energy**



#### Detroit Edison

- Michigan's largest electric utility with 2.2 million customers
- Over 11,080 MW of power generation, primarily coal fired
- 54,000 GWh in electric sales
- \$4.7 billion in revenue

DTE Energy - Detroit Edison

### DTE Energy – Crawl, Walk, Run



### DTE Energy – Raw Data Analysis

- Post trip Analysis
- Process Monitoring
- Optimization
- Early Warning

Distributed Control Systems (DCS)

Distributed OSIsoft PI Historians

Large Population of Data

Alarming



Post Event Analysis

DCS, PLC & PI

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### **DTE Energy – Fleet Performance Analysis**



### **DTE Energy – Digital Fuel System Tracking**



### **DTE Energy - NOx Emission Strategy**

#### \$2,200,000 Annual Savings



### **DTE Energy – Before Fuel Cost Framework**



### **DTE Energy – Fuel Cost Framework**

#### \$530,000 Annual Savings



### **DTE Energy – Fleet Status**

Unit	1	Net MW	TMC	TCAP	Unit	Net MW	TMC	TCAP	Unit	Net MW	TIMC	TCAP		oad Foreca	ast	
BR 1	1111	0	0	0	CC 15	66	95	95	HA 12-1	0	42	42	HE	Today	Tomorrow	
BR 2	Contra Co	609	635	635	CC 16	53	125	125	HA 12-2	0	42	42	0100	6041	3250	
FE 2	IIII	0	0	.0	0010				HB 11	0	4	4	0200	6015	7862	
MON 1		645	730	730	BR 12-1	77	77	77	MON 11	0	14	14	0300	5691	7505	
MON 2	RT-	745	755	760	BR 12-2	75	75	75	NE 11-1	0	17	17	0400	5967	7457	
MON 3	-	753	760	760	BRI 13	76	76	76	NE 11-2	0	16	16	0500	6212	7564	
MON 4	相	753	753	753	DLRY 11	0	67	67	NE 11-3	0	16	16	0600	6857	8010	
RR 2	Ŧ	245	255	255	DLRY 12	0	69	69	NE 11-4	0	16	16	0700	7250	3581	
RR 3	iiii	273	275	275	GW 11-1	77	77	77	NE 12	0	21	21	0800	7893	9103	
SC 1		105	105	135	GW 11-2	54	54	54	NE 13-1	0	21	21	1000	0573	10503	
SC 2	1	112	112	156	GW 12	19	19	19	NE113.1	Ô.	21	71		2010	10000	
SC 3		125	135	150	BR 11		C	DAL MILLS	FD PA	VS ID	Cond	FW PUMPS	BF	Cire V	P HDP	GB
SC 4	日	135	140	140	CC 11	M 1	123	1 5 6 7	NSNS	SAN NYN HE SE	NG	BNS	NR	NCSN	S C	
SC 6	112	2.55	255	280	CF 11	0 2	1 2 3	4 5 5 2	NSNS	N 5	NC	S IN IS	NE	NCEN	S N C 1	
SC 7	44	329	329	329	DA 11	N 2	1 2 3	4567	NENE	SAM NAN DE SE	NC		N 5	I C W N	SNCE	
TC 7		94	105	105	FE 11-1	4	1 2 5		NS NS	STATUS IN SE	NC		NE	EEWN		
TC 8	H.	73	80	80	FE 11-2	COLUMN STREET	-	-		_		-	-	-		
TC 9	1	460	500	500	FE 11-3	P 1				1 2 3 4						
GW 1	-	369	450	785	FE 11-4	R .										
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LUD 2		0	0	0	HA 11-3									3		
LUD 3		0	0	0	HA 11-4	1 1	1 2 2	1 5 6 2			NIS			KIR S	NI S	
LUD 4		-319	0	319	Ludinaton	C 2	ABC		NS	N 5				NCSN	S Ew	
LUD 5		0	0	222	DE EE 7293	R 2	1 2 2				<b>FEIRER</b>		C C W			
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Misc. Ger	nera	tion		85	Firm Sale	16	ABC		NS	N		212	NOS			
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				-		2	ABC		NS	NE	NC	NS	NB		E w	

### **Technology Frame Work – Complete Picture**







#### 'Regulated' Operations

#### **'Unregulated' Operations**



& Electric®

Southern California Gas Co.



Sempra Generation



Sempra Pipelines & Storage



Sempra LNG







"We turned all of our operators into **businessmen**." Vice-President Sempra Generation

"In every business I've been in where we put the PI System in...we made money." Senior Vice President, SoCalGas

# S

### San Diego Gas & Electric (SDG&E)



#### SDG&E Honored as Most Intelligent Utility in USA

 For the second straight year, Sempra Energy's San Diego Gas & Electric (SDG&E) has taken top honors as the most intelligent utility in the United States, according to the annual ranking undertaken by Intelligent Utility magazine and IDC Energy Insights, released today.



# Distribution Planning – Potential Overload Watch List

	30 X 2 00 0		× (3*					
Select a Substation Bank		W	atch Li	st			5 <i>/2/</i> 2005 12:13:	16 PM
CIR	CIR/BK	MW	A Phase	B Phase	C Phase	Rating	Forecast	% of Ratin Max(A.B.C
D: CIR -MW_3PH D: CIR -MW_3PH			(Amps)	(Amps)	(Amps)	(Amps/MVV)	(Amps/MW)	Or MW
D: CIR ~MW_3PH	ADD	5.84	285.00	289.20	287.40	660	413	44
DI CIRI EMWESPH	000							
D. CIRMW_3PH	CLR	6.06	235.20	246.40	240.00	614	391	40
D: _CIRMW_3PH D: _CIRMW_3PH	ADD .	10.05				20	22	26
D: CIR ~MW_3PH	CLR	10.00				29	22	35
	ADD	3.16	162.00	160.80	157.80	600	352	27
	CLR		112279220979205 1		0.112.001220	7651701		
	ADD	6.40	315.00	322.80	295.20	770	491	42
nk	CLR					454 (514) (5)		
DI XFMR_BK30~MW_3PH	ADD 5	2.84	136.80	169.20	151.20	600	266	28
D1 XFMR_BK31-MW_3PH D1 XFMR_BK32-MW_3PH	CLR		-					
D1_XFMR_BK33-MW_3PH	ADD							
	600							
	CLR							
	ADD							
	CLR							
	ADD	6.08	284.10	289.80	293.70	520	448	55
	CUR							

Ready

### Emergency Operations Load Curtailment – Rolling Blackout

- 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 Utility Commission and Regulator

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eady		_								evers (min)		ISO Requested MV:	25.00	25.00	
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rder Block	Circuit	Station	Customers		STECKET O	latas rag		Ť	ag	MY	Time	Status	Dropped	Dropped	Dre
14	434	SS	2470	D:SS_CIR_4	34-BRKR	_3PH	D:S	6_CIR_434*M	¥_3PH	4.60		CLOSE	4.60		
2 1A	229	MR	1808	D:MR_CIR_	229"BRKI	3PH	D:M	CIR 250-M	1¥_3PH / 3PH	2.87		CLOSE	2.87		-
4 2A	463	SYO	1760	D:SYO_CIR	463-BRK	B_3PH	D:S	O_CIR_463	MV_3PH	5.76		CLOSE	5.76		
5 2A	456	AS	2407	D:AS_CIR_4	56"BRKF	_3PH	D:A	6_CIR_456~M	V_3PH	3.05		CLOSE	3.05		
6 2A	516	ESCO	934	D:ESCO_CI	R_516*BR	KB_3PH	D:E	SCO_CIR_516	MV_3PH	4.13		CLOSE	4.13		-
8 3A	311	LNL	3163	D:LNL CIB	_831"BRK	3 3PH	D:N	L CIB 311"N	WV_3PH	2.63		CLOSE	2.63		-
9 3A	63	DM	2524	D:DM_CIR_	63-BRKR	3PH	D:D	M_CIR_63-M	V_3PH	3.73		CLOSE	3.73		
10 4A	83	MY	2354	D:MY_CIR_	83"BRKR	_3PH	D:M	Y_CIR_83~M	/_3PH	1.79		CLOSE		1.79	
11 4A	72	EC	2587	D:EC_CIR_3	2-BRKR	3PH	D:E	CIR_72*M	/_3PH	1.99		CLOSE		1.99	-
13 5A	988	MAB	1243	D:MAR CIP	988"BR	KR 3PH	D:M	AR CIR 988	MV 3PH	1.92		CLOSE		1.92	
14 5A	944	TC	1735	D:TC_CIR_S	44"BRKF	_3PH	D:T	C.CIR_944-M	₩_3РН	1.57		CLOSE		1.57	
15 5B	177	PO	1335	D:PO_CIR_1	77-BRKR	_3PH	D:P	D_CIR_177*M	V_3PH	7.00		CLOSE		7.00	
16 6A	740	PI	2761	D:CC_CIR_	A0"BRKE	(_3PH 3PH	D:C	CIB 740*M	W 3PH	3.47		CLOSE		3.47	-
18 6B	258	MG	2	D:MG_CIR_	258-BRK	R_3PH	D:M	G_CIR_258*N	IV_3PH	1.02		CLOSE		0.20	
19 7A	850	SH	410	D:SH_CIR_8	50°BRKF	_3PH	D:SI	I_CIR_850*M	₩_3РН	4.60		CLOSE			
20 7A	1153	EG	2	D:EG_CIR_1	153-BRKF	3_3PH	D:E	G_CIR_1153~N	I¥_3PH	0.00		CLOSE			_
21 7A 22 8A	358	AL	314	D:AL CIB 2	58"BRKR	3PH	D:LI D:A	_CIR_1166-M	V 3PH	4.42		CLOSE			-
23 8A	291	BE	2051	D:BE_CIR_2	91-BRKR	3PH	D:B	_CIR_291-M	V_3PH	3.82		CLOSE			
24 8B	210	VB	192	D:VR_CIR_	210 <b>~</b> BRKF	_3PH	D:¥	R_CIR_210*M	¥_3PH	0.88		CLOSE		_	
25 9A	443	SYU	5	D:SYU_CIR	443"BHK	2PH	0:5	U_CIR_443*	MV_3PH	0.95		CLOSE			-
27 9A	512	DM	2578	D:DM CIR	512"BRKF	3 3PH	D:D	M CIR 512-M	V 3PH	3.42		CLOSE			-
28 10A	290	BE	3127	D:BE_CIR_2	90~BRKF	_3PH	D:B	E_CIR_290*M	₩_3PH	2.33		CLOSE			
29 10A	768	TB	1393	D:TB_CIR_3	68-BRKF	_3PH	D:T	3_CIR_768*M	V_3PH	2.58		CLOSE			
30 10B 31 11A	797	LNL	2767	D:LNL CIR	_175-BH	R 3PH	D:M	an_cin_775* IL CIR 797*1	AV 3PH	2.18		CLOSE			1
32 11A	588	PAB	101	D:PAR_CIR	588-BRI	R_3PH	D:P	AR_CIR_588*	MV_3PH	3.44		CLOSE			
33 11B	774	MSH	478	D:MSH_CIR	774-BR	(B_3PH	D:M	SH_CIR_774*	MV_3PH	6.84		CLOSE			-
34 12A 35 12A	452	AS	3102	D-ESCO CIR_4	62"BRKF	L3PH KB 3PH	D:A	5_CIH_452*M SCO_CIB_517	¥_3PH •MW_3PH	2.35		CLOSE			⊢
36 12B	487	MH	1667	D:MH_CIR	487-BRKI	R_3PH	D:M	H_CIR_487*M	IV_3PH	2.24		CLOSE			<u> </u>
37 13A	745	GE	17	D:GE_CIR_	45~BRKF	_3PH	D:G	E_CIR_745*M	₩_3PH	4.50		CLOSE			
38 13A	986	MAB	2843	D:MAB_CIP	_986~BR	KB_3PH	D:M	AR_CIR_986*	MV_3PH	2.20		CLOSE			-
40 14A	590	PY	1341	D:PY CIR !		I 3PH	D:C		W 3PH	2.94		CLOSE			1
41 14A	468	UB	112	D:UB_CIR_	68"BRKF	_3PH	D:U	3_CIR_468*M	V_3PH	2.21		CLOSE			<u> </u>
42 14A	1117	BQ	3865	D:BQ_CIR_	117-BRKF	3PH	D:B	2_CIR_1117*M	V_3PH	4.30		CLOSE			-
43 15A	296	SM	3175	D-SS_CIP_4	296"BRKF	(_3PH	D:SI	M_CIR_296*N	IV_3PH	2.77		CLOSE			1
45 15A	68	DM	1479	D:DM_CIR	68-BRKR	3PH	D:D	M_CIR_68-M	V_3PH	3.77		CLOSE			<u> </u>
46 16A	112	в	2	D:B_CIR_11	PBRKR_	BPH	D:B	CIR_112*MV	_3PH					-	
47 16A	947	GA	0	D:GA CIR :	H7"BRKF	3_21 C	D:G	A CIR 947"M	W_3PH					T	( <sup>–</sup>

### **CCGT Plant Operation**



### **Substation Condition Based Maintenance**





### Condition Based Monitoring – PI Notifications Email Alert

From: CBM-XfmrLv4 Ack Cc: Subject: BK71_THER_AlarmLevel4	Sent: Wed 1/21/2009 11:57 AM
Name: BK71 THER AlarmLevel4	
Description: Bank 71 Thermal Alarm Level 4	
Server: T-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-08:00:0	00)
Target:	ClassView\thermal 1 Thermal
Value: Alarm 4	Arguelle de la companya de la company
Priority: Normal	
Link:	
- BK71 - Thermal	
Actions:	
Acknowledge	
Acknowledge with comment	



### **Condition Based Monitoring – Transformers**



### **Operations Decision Support – Transformer at Emergency Rating?**



#### **Paper Insulation Health**



#### TRANSFORMER Health Indices Insulation Power Factor LTC Application & Design Oil Conditions Bushing & Accessories Operating History & Conditions

	Location of Paper Sample	Degree of Polymerization (DP)
	NLTC – Phase A	586
	NLTC – Phase B	737
ĺ	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



### **Solar Field Monitoring**

- Performance Monitoring
  - DC and AC Output
  - Inverter Operating Conditions
- Weather Conditions

3.78MW	
Field Power Rating:	
Hours of Operation:	

4.75 Hours

Total Power produced:

Today





### Solar Generation Applications - Irradiance Analysis (Historical, Predicted, and Actual)

#### National Renewable Energy Lab (NREL)

Typical Meteorological Year (TMY)
TMY2 and TMY3 Data Sets





### Weather Intelligence



- More than 90 pole mounted weather stations to support fire operations and Smart Grid vision
- Currently the 4th largest privately owned weather station network in US; the densest weather station network in the world
- Locations selected by SDG&E's Meteorologist, based on topography, field observations, and fire hazard

### **Weather Station Network Project**

- Real-time weather data every 10 minutes (wind direction, wind speed, wind gust, temperature, and relative humidity, etc.) to provide SDG&E with a better tool to maintain and operate the system safely
- Viewing winds in areas that have never been monitored to help to "harden" overhead electric system with larger conductors and steel poles to better withstand high winds
- Sharing data with the public, local universities and posting on the National Weather Service (NWS) Site and MesoWest
- San Diego First Responders (Fire Agencies) have been provided a mobile SDG&E weather station application and website to access to all SDG&E weather station data and maps



### **SDG&E RDSI Project**



### **Microgrid Applications**



### SDG&E's End-to-End Energy Value Chain



# Quotes: Patrick Lee, Vice-President Energy Supply, SDG&E

"Data is in silos today...Smart Grid will drive end-to-end data integration!"

"As you have seen in some of our applications using the OSIsoft PI System, I believe we have only scratched the surface in turning available data into valuable and relevant information. We will continue to expand our data collection, analysis, and modeling capabilities at Sempra Energy. *We believe a successful company must have the ability to make good judgment decisively.* This core capability is best augmented by a powerful data and information system. We believe the OSIsoft PI System is a key component of this data system."



### **Opportunities For Future Applications in PI** System

- More renewable energy development
- Electric vehicles planning
- Roof top solar and electric vehicles integration
- Roof top solar PV monitoring
- Smart meters
- Renewable and distributed systems integration (RDSI)
- Microgrid
- Energy market assessment & transaction
- Create synergy across the integrated business

### **Smart Grid City – Xcel Boulder CO**



### Meter to Cash and Smart Grid with Meter Data

- Primary Reason for AMI
  - Billing
  - Customer Service
  - Metering Efficiencies
- Secondary Reasons for AMI
  - Operations
  - Voltage/PQ
  - TLM
  - Outages

### **Operational Data Management – What is it?**

- Operational Data Management System
  - Blend of Meter and Operational data in one system
  - Provides end to end seamless view of the Grid
  - Data Base of record for time series data
  - Meter and Substation data Management
  - Visualization with Situational awareness



### **Smart Meter Data Value – Outage Management**

### Outages

- Remote meter reading
- Assist in Identifying Nested Outages
- Data Base of record for time series data
- Reduces "Ok on arrival" calls
- Fewer Truck rolls



### Smart Meter Data Value – Low Voltage Monitoring

- Voltage
  - Enhance Power Quality
  - Improved Customer Service
  - Better Grid Efficiency



### Smart Meter Data Value – Low Voltage Monitoring



#### **Voltage Problem Resolution**

Data: YTD, June 2009



CL existing: Existing issue monitoring CL new: Detected issue SI voltage: Service investigation needed



RESPONSIBLE BY NATURE™

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### **Smart Meter Data Value – Low Voltage Monitoring**

#### **Reduced Customer Complaints**

Data: YTD, June 2009





RESPONSIBLE BY NATURE"



### Smart Meter Data Value – Transformer Loading from AMI Data

- Outage Avoidance
  - Early Detection of Problems
  - Shorter and few outages if they occur
  - Improve maintenance



### Smart Meter Data Value – Transformer Loading from AMI Data



### Smart Meter Data Value – Transformer Loading from AMI Data



#### **Transformer Overload Detection**

Data: YTD, June 2009

YEAR	UNPREDICTED FAILURES	CURRENTLOOK DETECTIONS	BOULDER TOTAL
2005	7	NA	7
2006	13	NA	13
2007	6	NA	6
2008	6	3	9
2009	0	4	4



RESPONSIBLE BY NATURE"



### **PI System Value Proposition**

- Improve real-time & historical data analysis & modeling
- Increase timely decision making capability
- Enable energy market assessment & transaction
- Improve abilities for new business development
- Extract value from capital investments
- Support innovation
- Optimize operations and maintenance costs
- Improve system performance and reliability
- Increase productivity
- Improve customer satisfaction
- Improves safety and environmental compliance
- Enable end-to-end integration

### Conclusion

- PI System delivers value out of the box and over time
- Customers can improve their businesses in silos
- PI System can deliver value in 'regulated' or 'unregulated' operations
- Acceleration of PI System expansion can occur with cooperation between operating units, IT and leadership
- Enterprise agreements can help customers accelerate end-to-end integration
  - Enterprise Project Manager and Account Manager
  - Access to Center of Excellence (Max VALUE from PI System)
  - PI System monitoring
  - Lose the "tag" constraint mentality and think "eat more PI"



## Thank you

