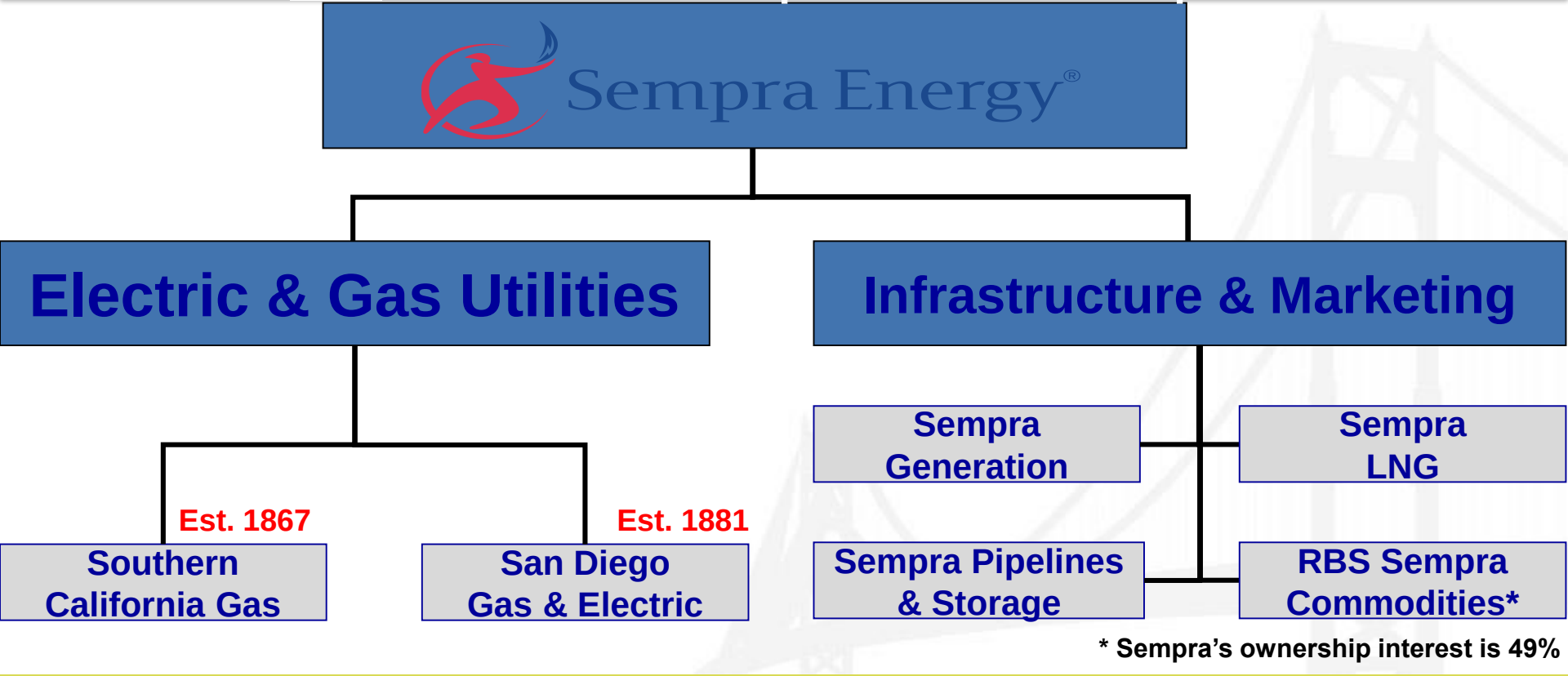
Operations & Decision Support for an Integrated Energy Business

Patrick Lee, Vice President-Energy Supply
Sempra Generation

Empowering Business in Real Time
PI Infrastructure for the Enterprise

Est. 1998 Pacific Enterprises + Enova Corp.



* Sempra's ownership interest is 49%

Sempra LNG

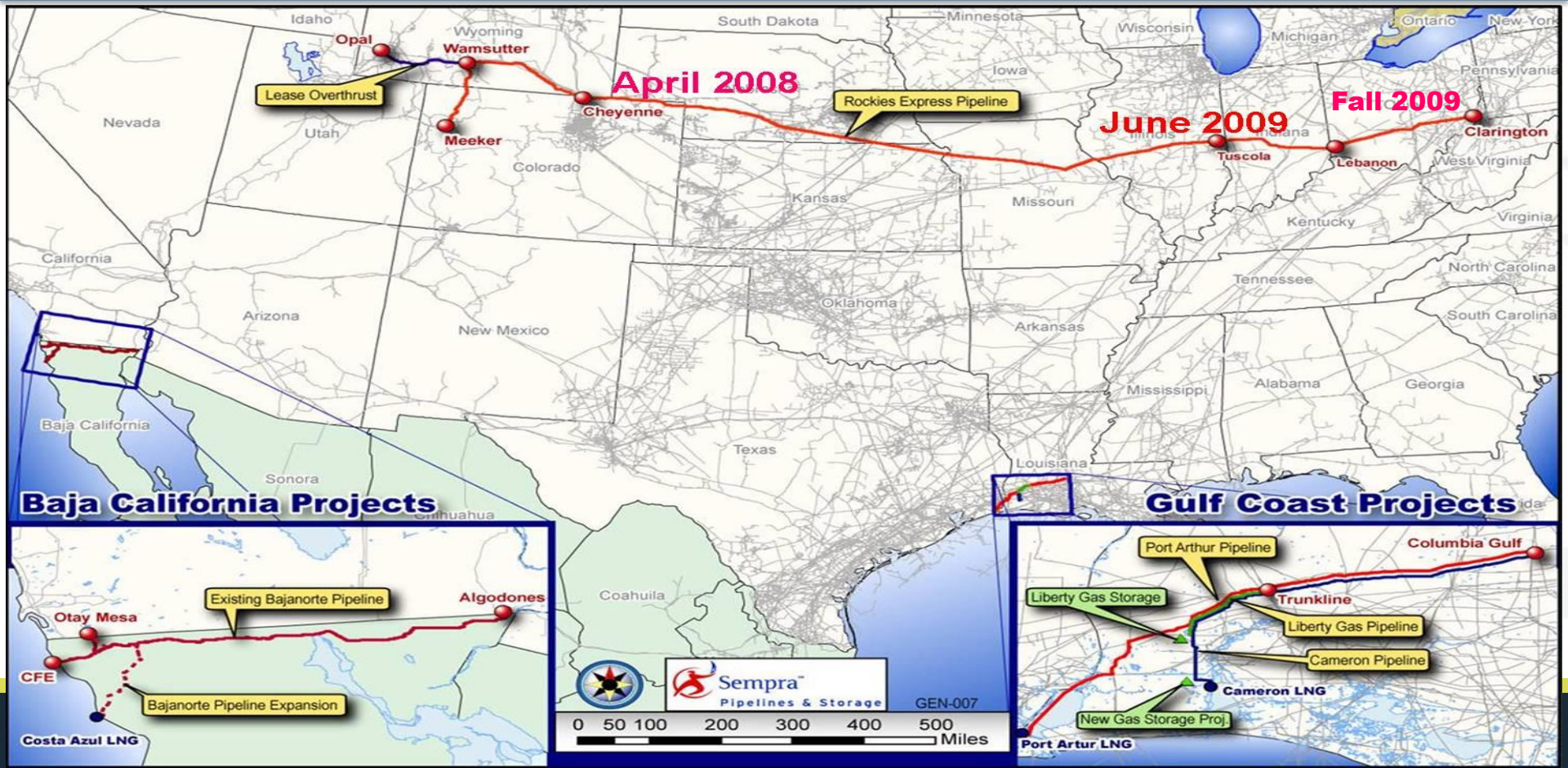
Sempra Energy®

- **Energía Costa Azul**
  - Operational Q2 2008, 100% ownership and 1.0 Bcf/d capacity
  - Nitrogen plant operational Q4 2009
  - Expansion operational beyond planning period

- **Cameron LNG**
  - Operational Mid 2009, 100% ownership and 1.5 Bcf/d capacity
  - Expansion operational beyond planning period
- **Port Arthur Marine Petroleum Terminal & Storage** (2011)
  - Joint Venture with Valero Energy Corp.

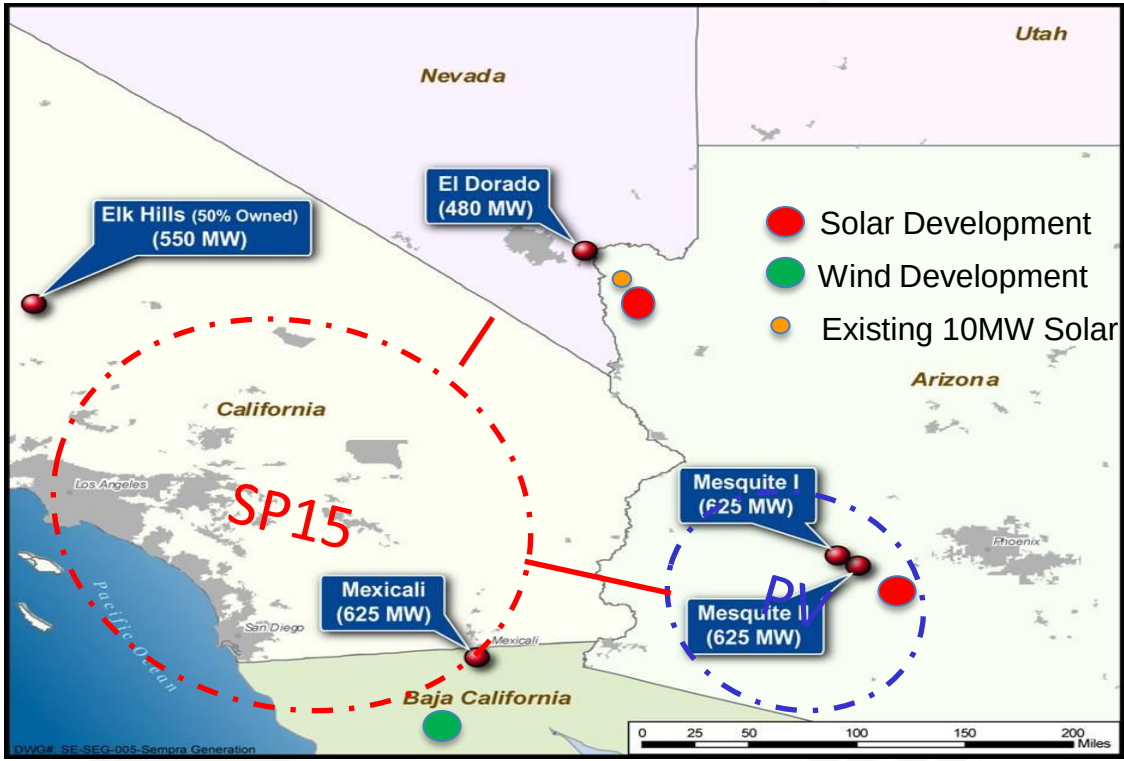
Sempra Pipelines & Storage

Sempra Energy®



Sempra Generation

- Existing Combined Cycle Fleet
  - Efficient
  - Low Emissions
  - High Availability
- Renewable
  - 10MW Solar PV Completed 12/2008
  - 48MW Solar PV Expected 6/2010
  - 500MW Solar in Development
  - 1000MW Wind in Development



SDG&E and SoCal Gas

Sempra Energy®

- 24 million consumers
- 24,000 square miles of service territory
- 6.5 million gas meters
- 1.4 million electric meters
- SoCal Gas is the largest natural gas distribution utility in USA

SDG&E Smart Meter Program

- $500 million capital project installing 1.4 million electric and 900,000 gas meters in service territory by Q1 2011
  - Two-way communication meters
  - Remote disconnect and Home Area Network capability
  - Opportunity for real-time pricing and in-home services

Initial Test Phase

5K Meters– Q4 / 2008

Future PI Applications:
- System Demand Forecast
- Demand Reduction Programs

2007 | 2008 | 2009 | 2010 | 2011

Final CPUC Decision- April 2007

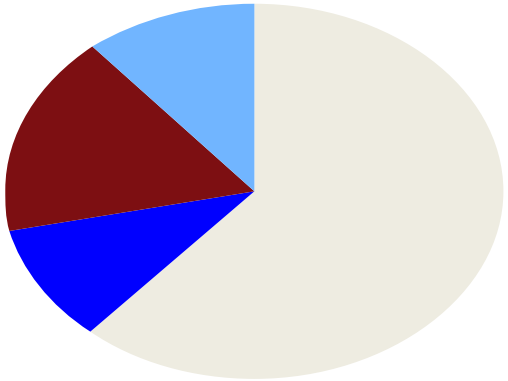
Begin Mass Meter Installation – Q1 / 2009

Complete Meter Installation - Q1 / 2011

Near Term Investments

Sempra Energy®

$11+ Billion Capital Plan



- Utilities
  - Distribution / AMI
  - Transmission
- Generation
  - Solar
  - Wind
- Pipelines & Storage
  - Rockies Express Pipeline
  - Liberty Gas Storage
- LNG
  - Re-gas terminals

Sempra Commodities

- RBS joint venture

Tightly Integrated Business Units

Sempra Energy®

New Supplies

- Leading developer of LNG import facilities

Transportation & Storage

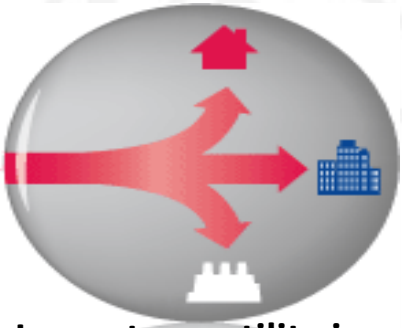
- Rockies Express is the largest pipeline built in 20 years
- 150 Bcf of natural gas storage

Marketing

Sempra Commodities

- Leading natural gas marketer in North America

Distribution & Generation



- Largest gas utility in the U.S.
- Serve 29 million consumers
- 2,600 MW of natural gas-fired generation

OSIsoft PI Deployment in Sempra

Sempra Energy®

Power & Gas Utilities

- Southern California Gas
  - •Gas storage fields
- San Diego Gas & Electric
  - •Generation
  - •Transmission
  - •Distribution

Infrastructure & Marketing

- Sempra Generation
  - •Combined Cycle Units
  - •Solar & Wind
- Sempra LNG
  - •Re-gasification Process
  - •Plant Operations
- Sempra Pipelines & Storage
  - •Gas storage/trans.
- RBS Sempra Commodities*

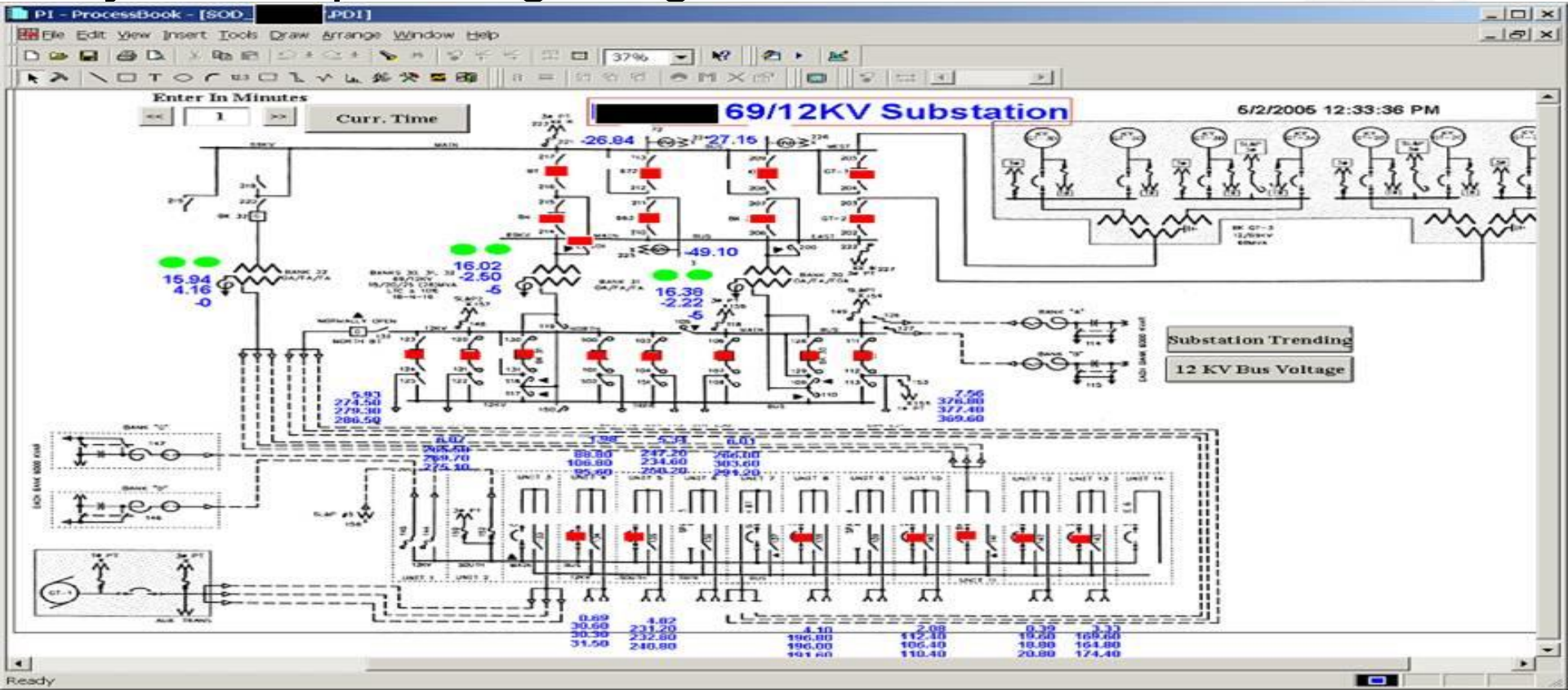
* Sempra's ownership interest is 49%

Sempra Energy PI Examples

T&D System Operations

Sempra Energy®

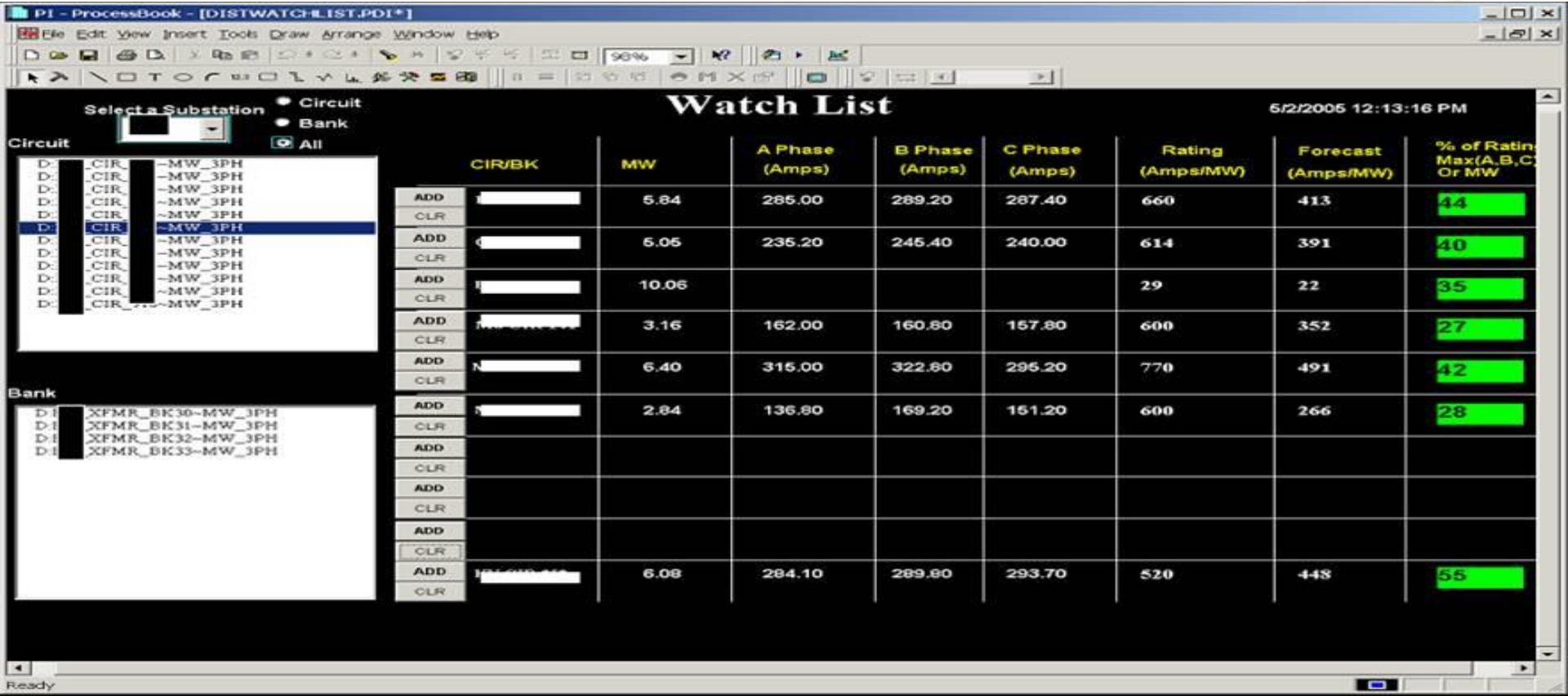
System Operating Diagram



Distribution Planning

Sempra Energy®

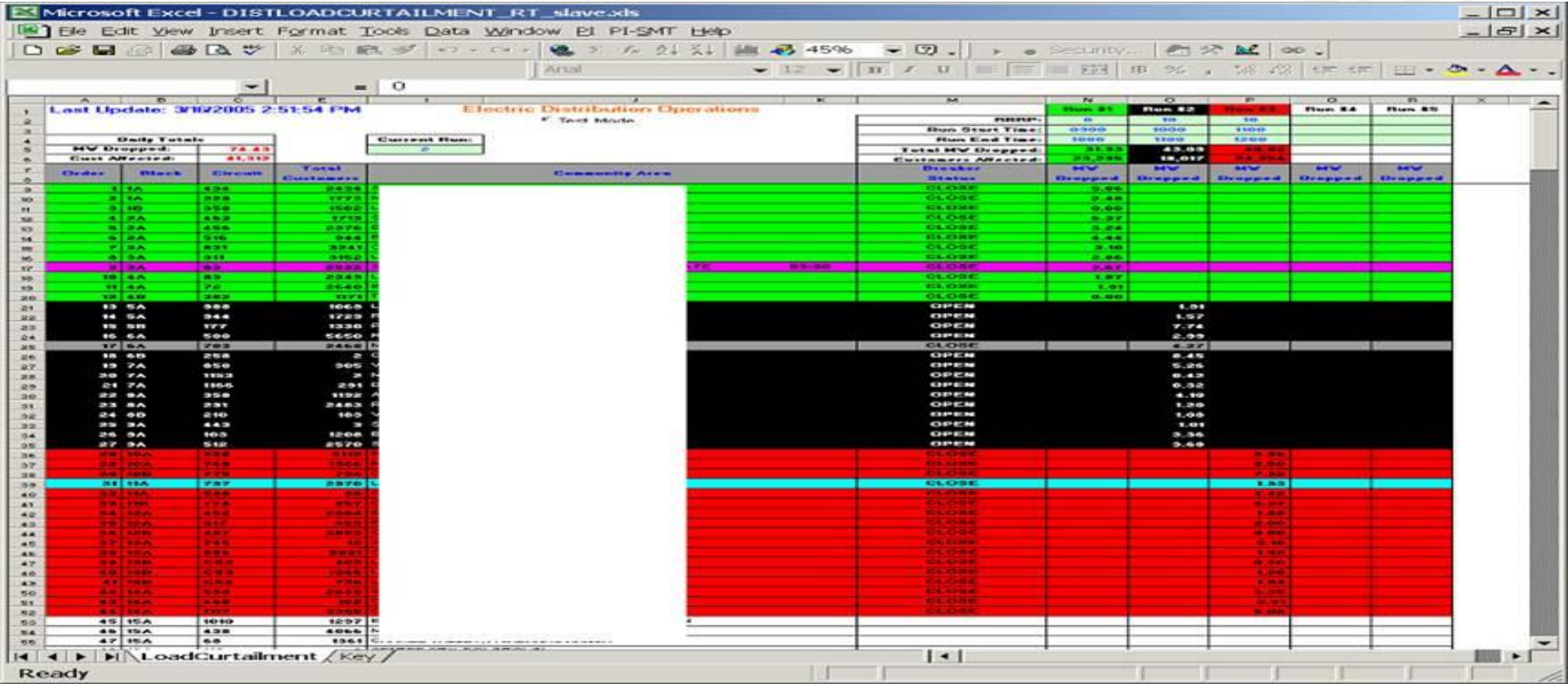
Potential Overload Watch List



Emergency Operations

Sempra Energy®

Rolling Blackout/Load Curtailment

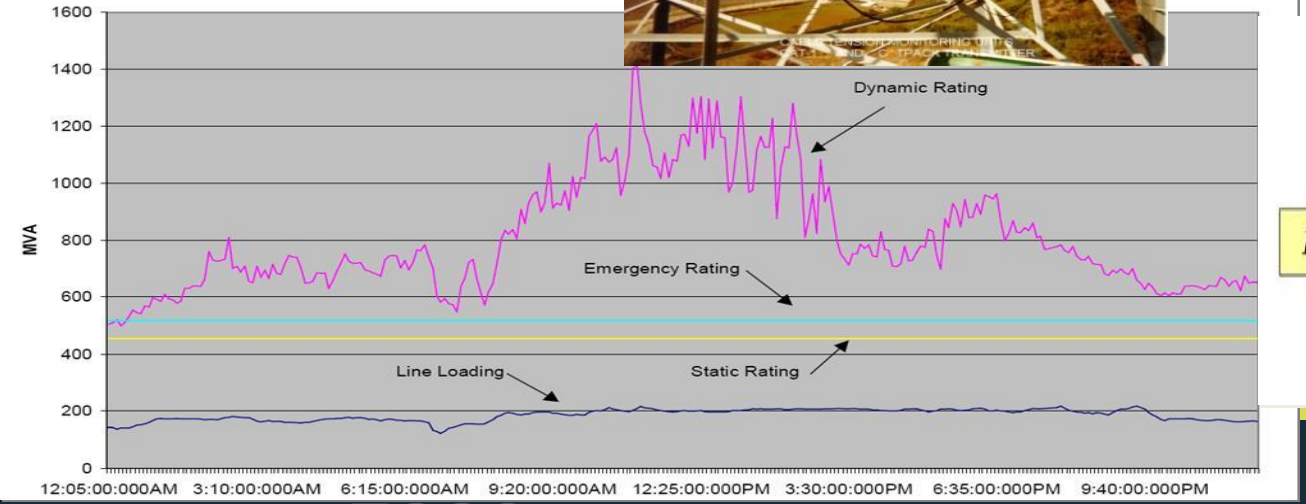


Dynamic Transmission Rating

Sempra Energy®

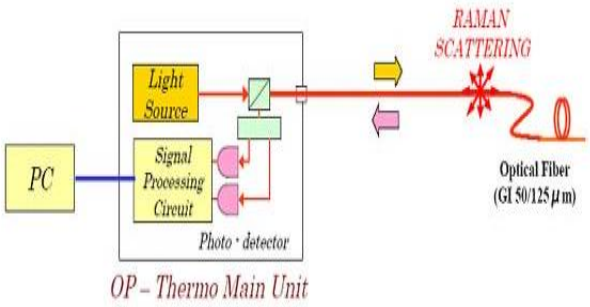
OH Transmission Dynamic Rating vs. Static Rating

- Ruling span concept
- Load Cells for measuring cable tension
- Cable Tension (CAT) Monitoring Unit
- Radio transmitter



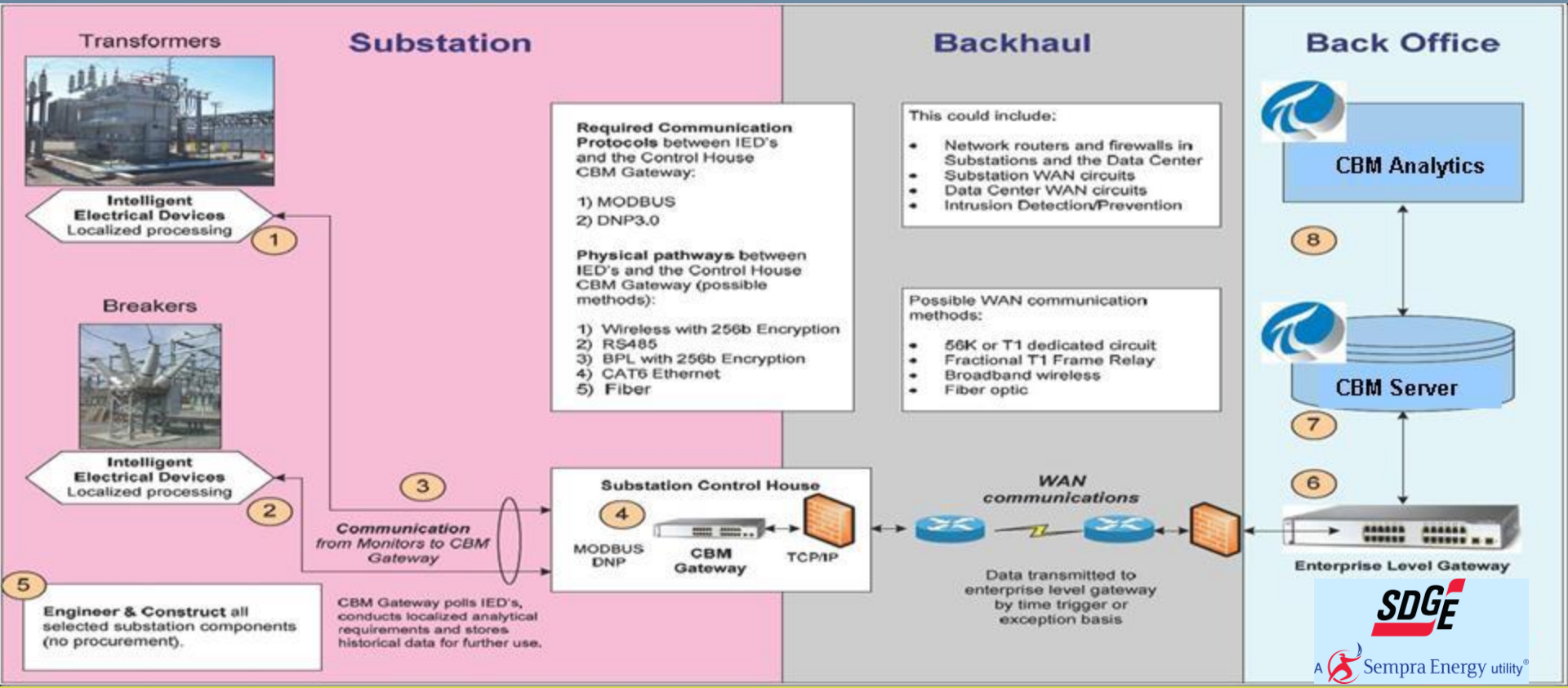
230KV UG Cable

- Fiber optic sensors
- Real-time modeling
- Dynamic rating



Substation Real-Time CBM at SDG&E

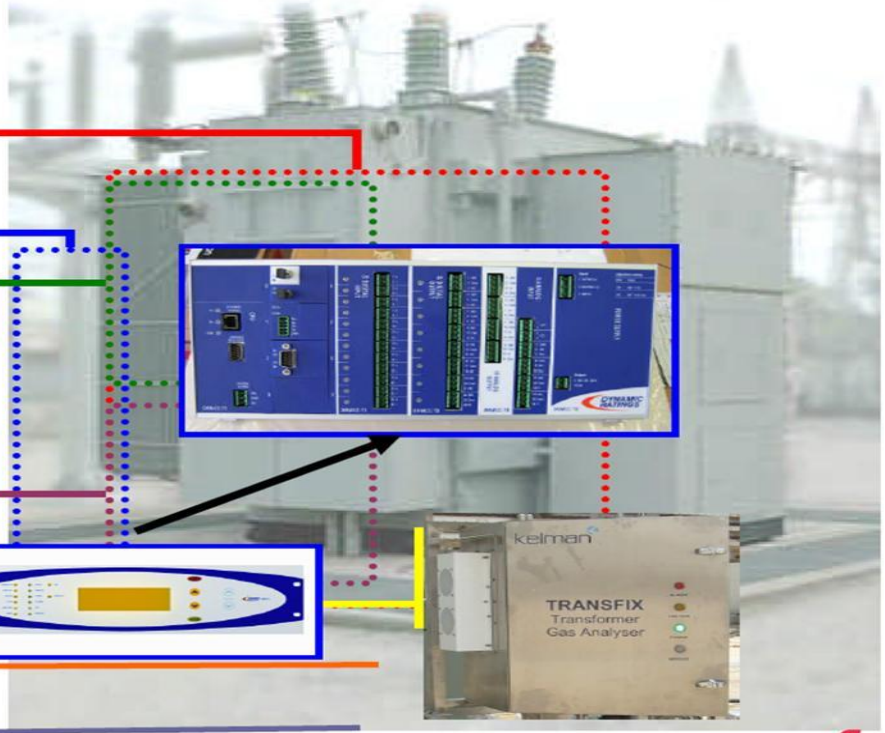
Sempra Energy®



Substation CBM Real-Time Data

Sempra Energy®

- PI for Transformer Monitoring



SDGE

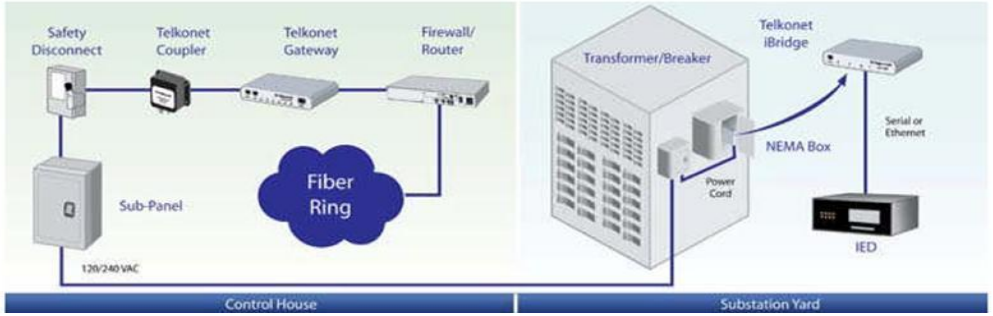
Substation CBM Real-Time Analysis

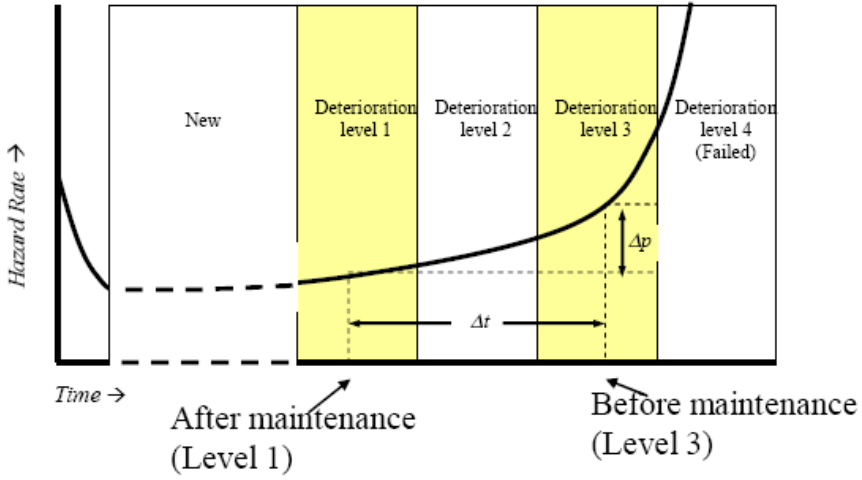
Sempra Energy®

- PI for Circuit Breakers Monitoring

Density Monitor Provides

- Real time monitoring
- Elimination of false Alarms
- Leak Trending Data
- Accurate Density Calculation
- Employee safety
- Prediction of future alarms



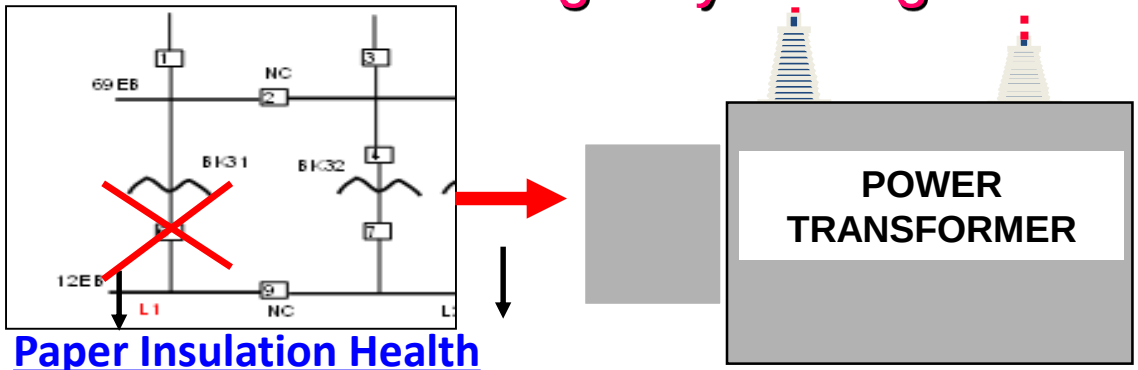


SDGE

Operations Decision Support

Sempra Energy

Transformer at Emergency Rating ?



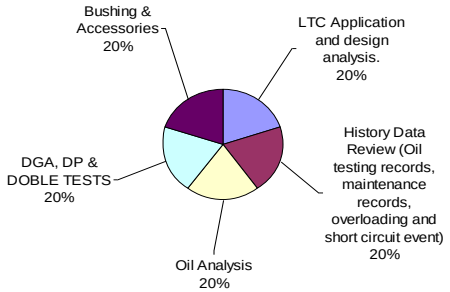
TRANSFORMER Health Indices

- 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

Sempra Energy

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

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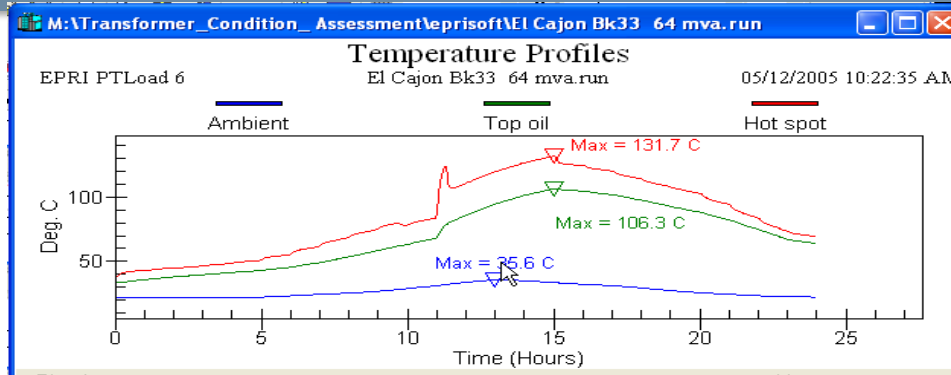

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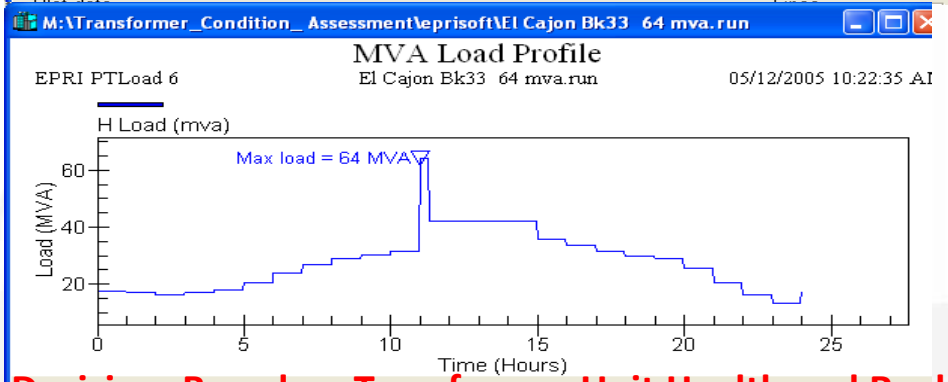


Decision: Based on Transformer Unit Health and Real Time Conditions

CBM PI Notifications Email Alert

Sempra Energy®

From: [redacted]@semprautilities.com
To: CBM-XfmrLv4 Ack
Cc:
Subject: [redacted]_BK71_THER_AlarmLevel4

Sent: Wed 1/21/2009 11:57 AM

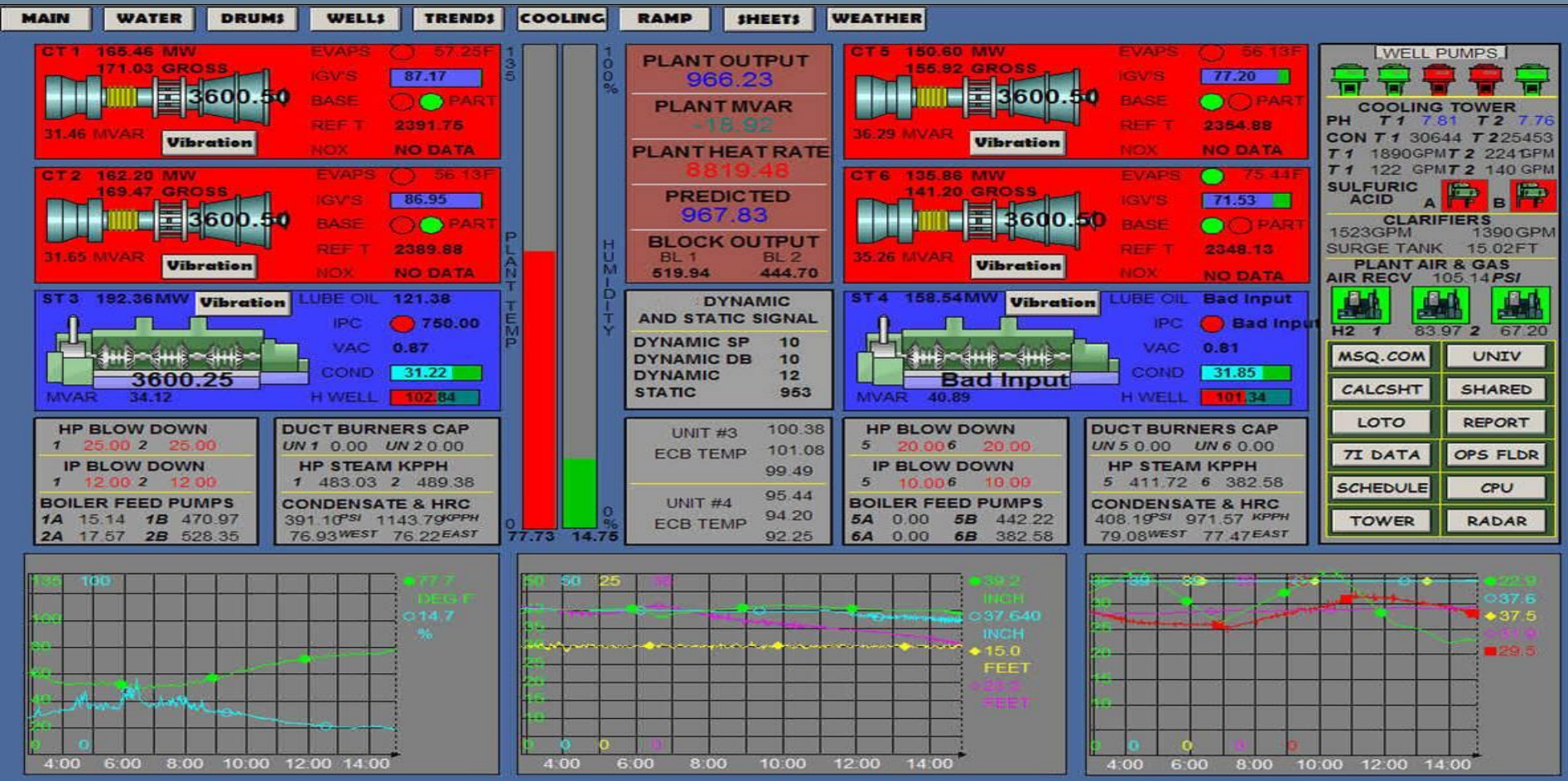
Name: [redacted]BK71_THER_AlarmLevel4
Description: [redacted] Bank 71 Thermal Alarm Level 4
Server: [redacted]T-P01
Database: CBM2
Start Time: 1/21/2009 11:56:24 AM Pacific Standard Time (GMT-08:00:00)
Trigger Time: 1/21/2009 11:56:24 AM Pacific Standard Time (GMT-08:00:00)
Target: [redacted]T-P01\CBM2\SISCO Managed Models\SDGE_CBM\ClassView\thermal[redacted]1 Thermal
Value: Alarm 4
Priority: Normal

Link:
[redacted]- BK71 - Thermal

Actions:
Acknowledge
Acknowledge with comment

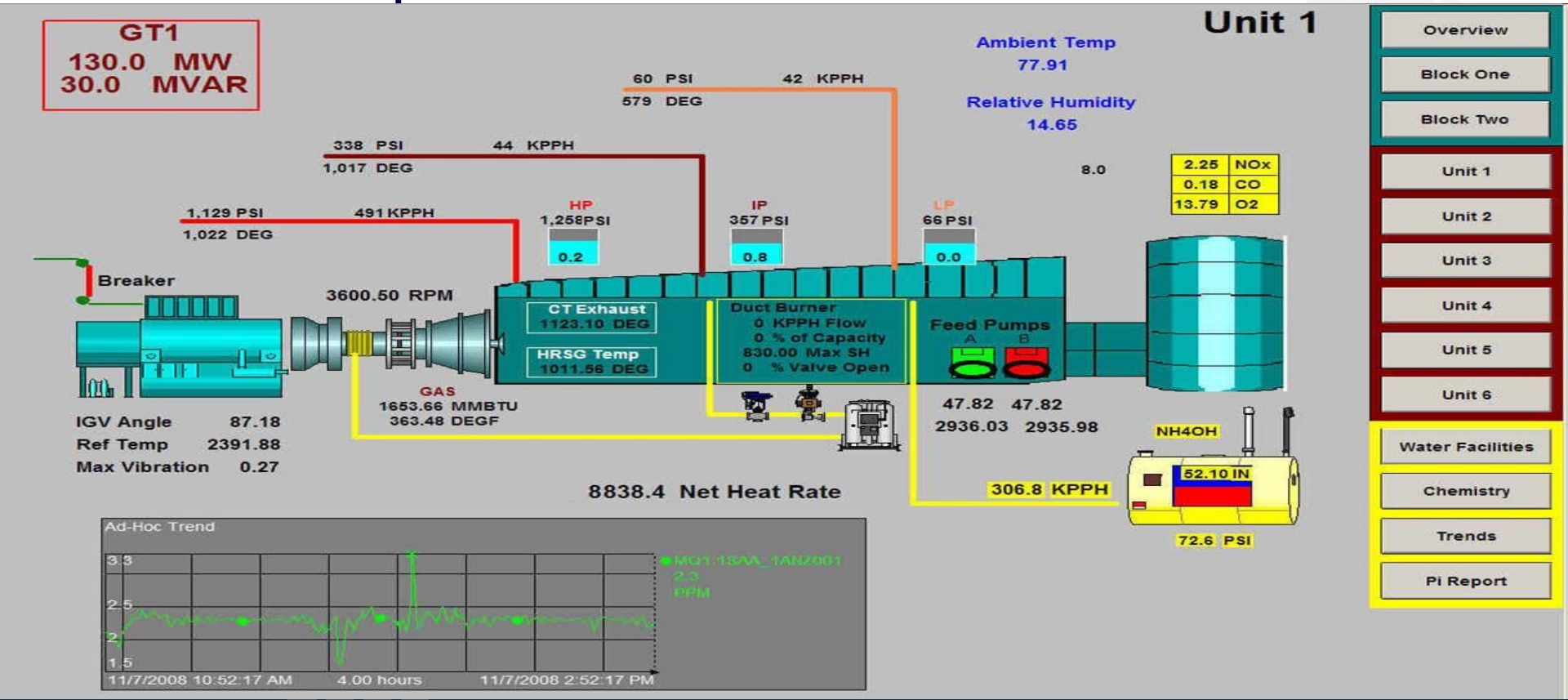
CCGT Plant Operations

Sempra Energy®



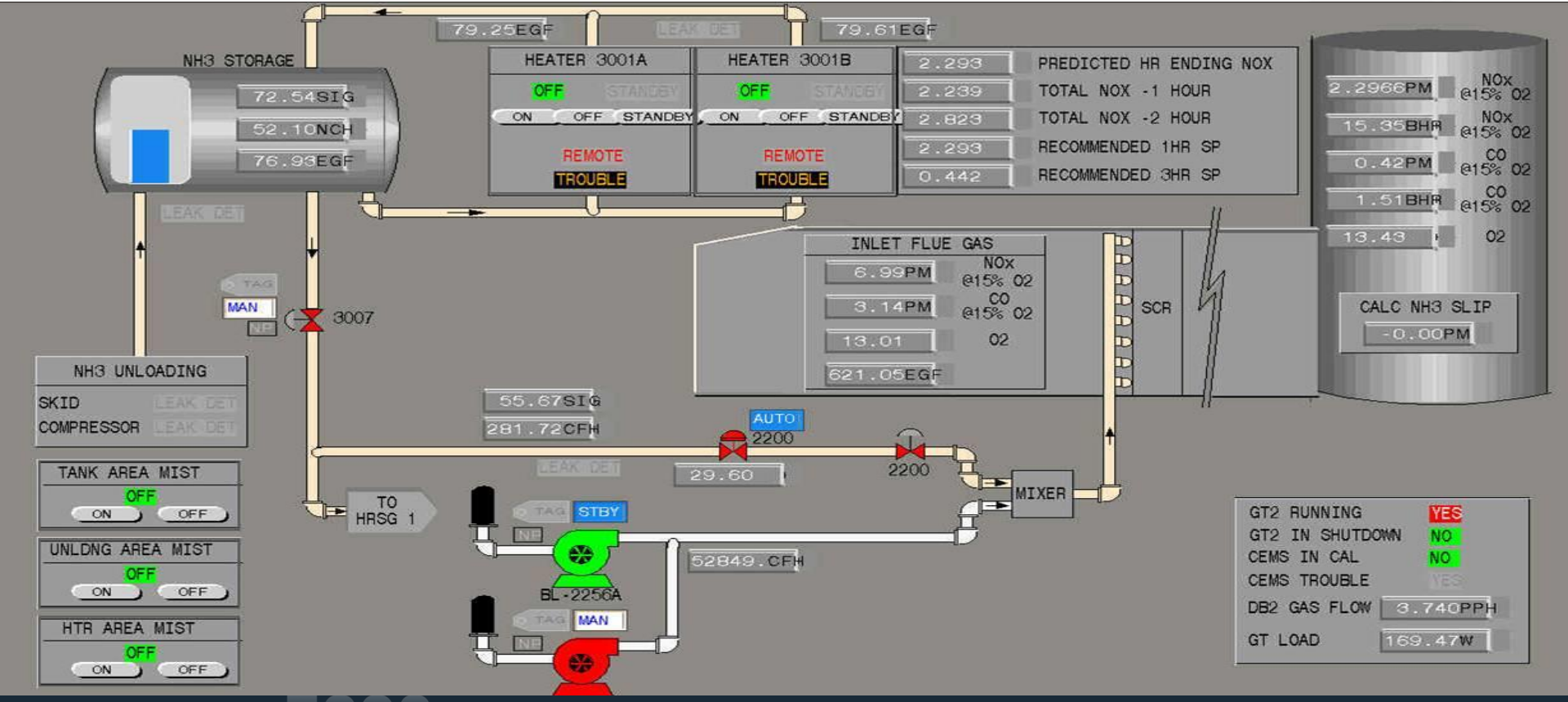
Gas Turbine Monitoring

- Turbine Operations



Real-time Emission Monitoring

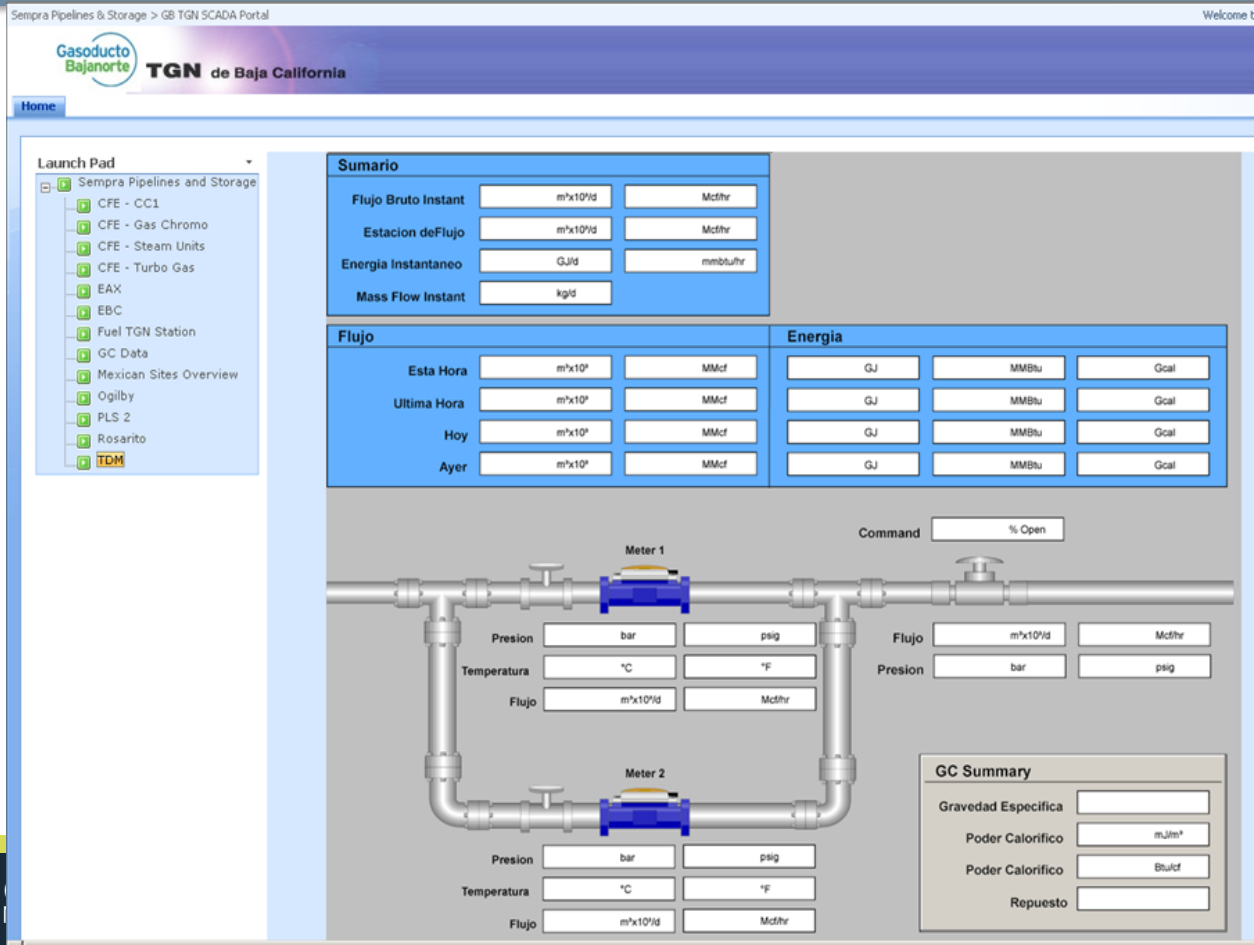
- Predicted vs. Actual Measurements



Gas Pipeline Application

Sempra Energy®

- Gasoducto Bajonorte Pipeline Monitoring
  - Pressure
  - Temperature
  - Flow



LNG Terminal Application

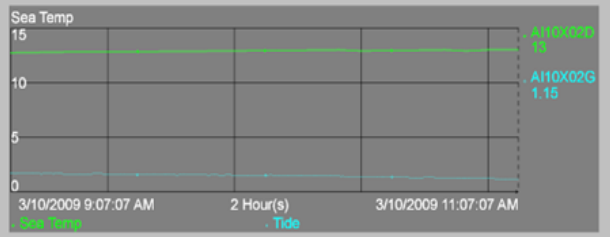
Sempra Energy®

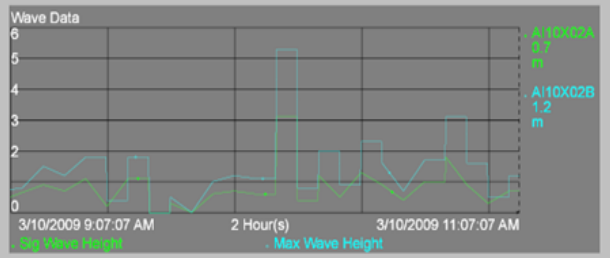
- Energía Costa Azul (ECA)

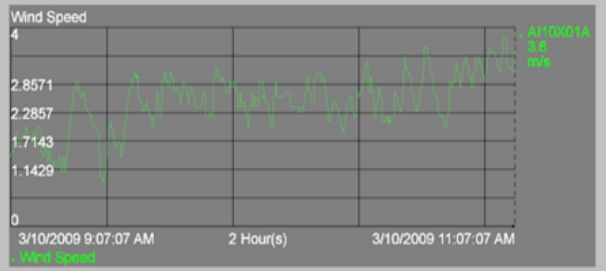
ECA Weather

ECA Meteorological and Oceanographic Data

Measure	Current	Last Month Avg.
Wind Speed	3.60 m/s	3.44 m/s
Wind Gusts	4.00 m/s	4.03 m/s
Wind Direction	269.00 °	185.91 °
Air Temp C	12.30 ° C	13.85 ° C
Rain Fall	0.00 mm/hr	0.00 mm/hr
Baro Pres	1018.00 mbar	1016.75 mbar
Sig Wave Hgt	0.70 m	0.79 m
Max Wave Hgt	1.20 m	1.35 m
Mean Wave Per	9.50 sec	6.84 sec
Sea Temp	13.00 ° C	13.64 ° C
Current Speed	4.00 cm/sec	13.63 cm/sec
Current Dir	90.00 °	197.47 °
Tide	1.15 m	0.81 m







Solar Generation Projects

El Dorado 10MW Solar PV (COD:12/31/2008)

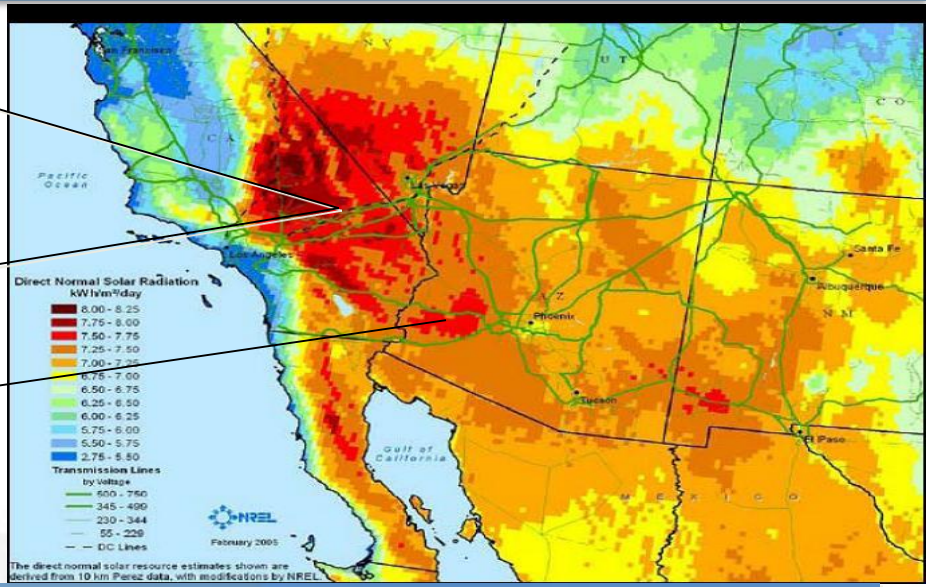
- 30 miles Southeast of Las Vega
- Technology: Thin Film Solar PV (CdTe)
- Expected Annual Yield: 23,000 MWh

Copper Mountain 48MW Solar PV (6/2010)

- 30 miles Southeast of Las Vegas

Mesquite Solar (up to 500MW Solar PV or Thermal : 2010 – 2014)

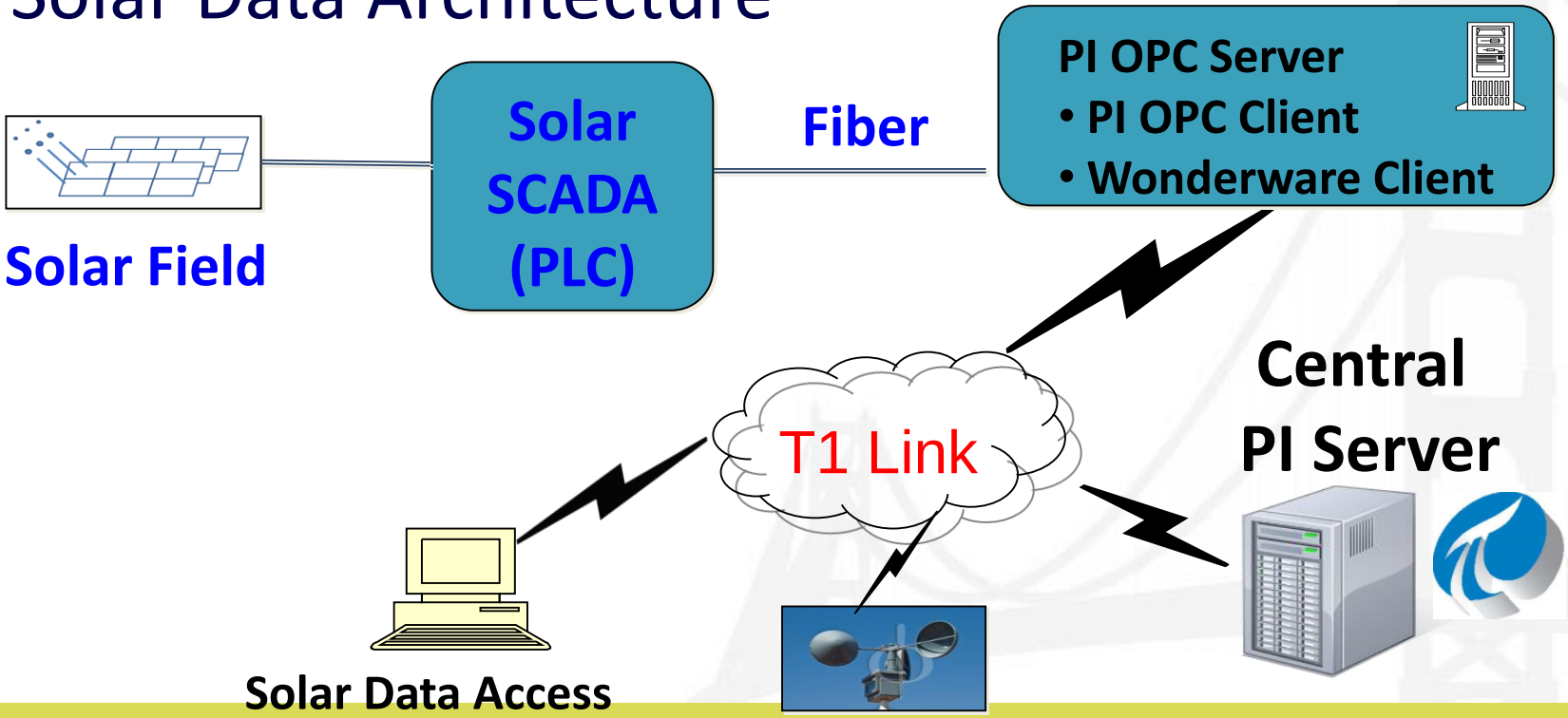
- Near Palo Verde in Arizona



Solar Generation Data Comm.

Sempra Energy®

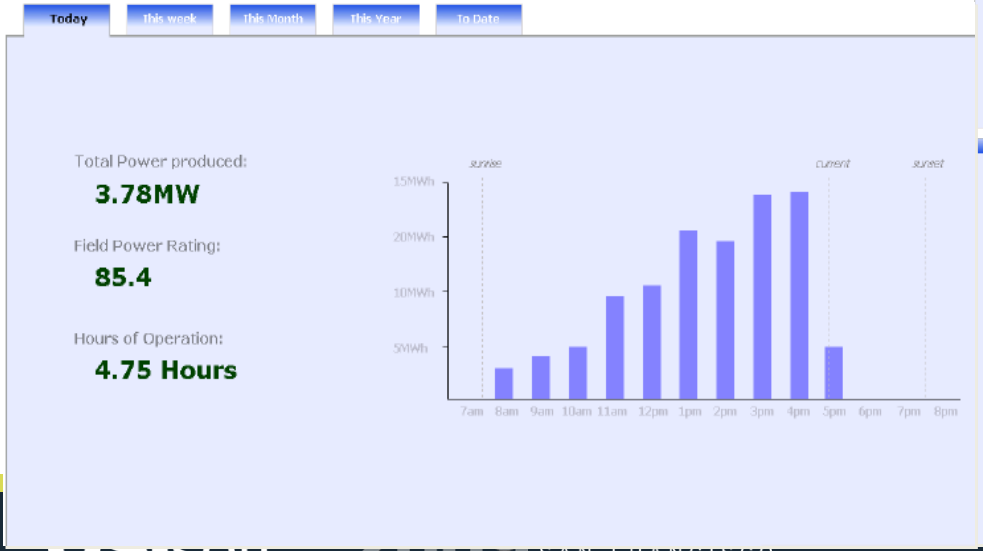
- Solar Data Architecture

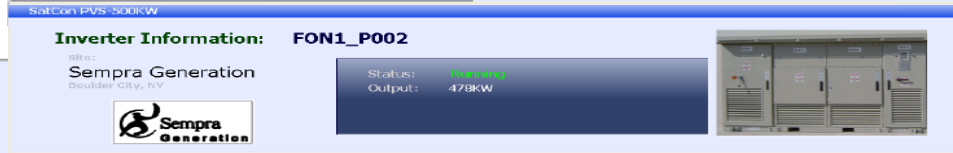


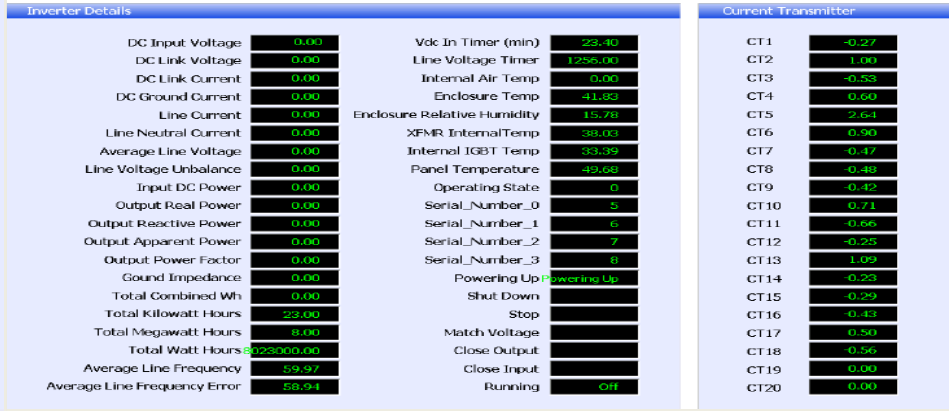
Solar Field Monitoring

Sempra Energy

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







Visual KPI – PI Data To Go

Sempra Energy®

Plant Output Monitoring

Conditions Alert via Email

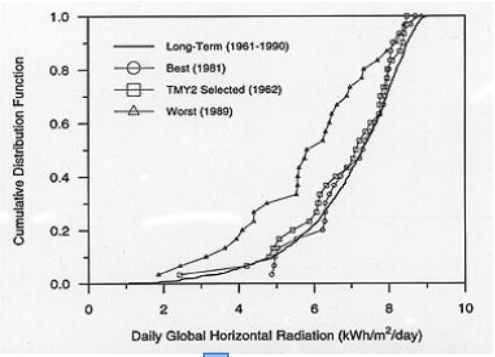
Solar Generation Applications

Sempra Energy®

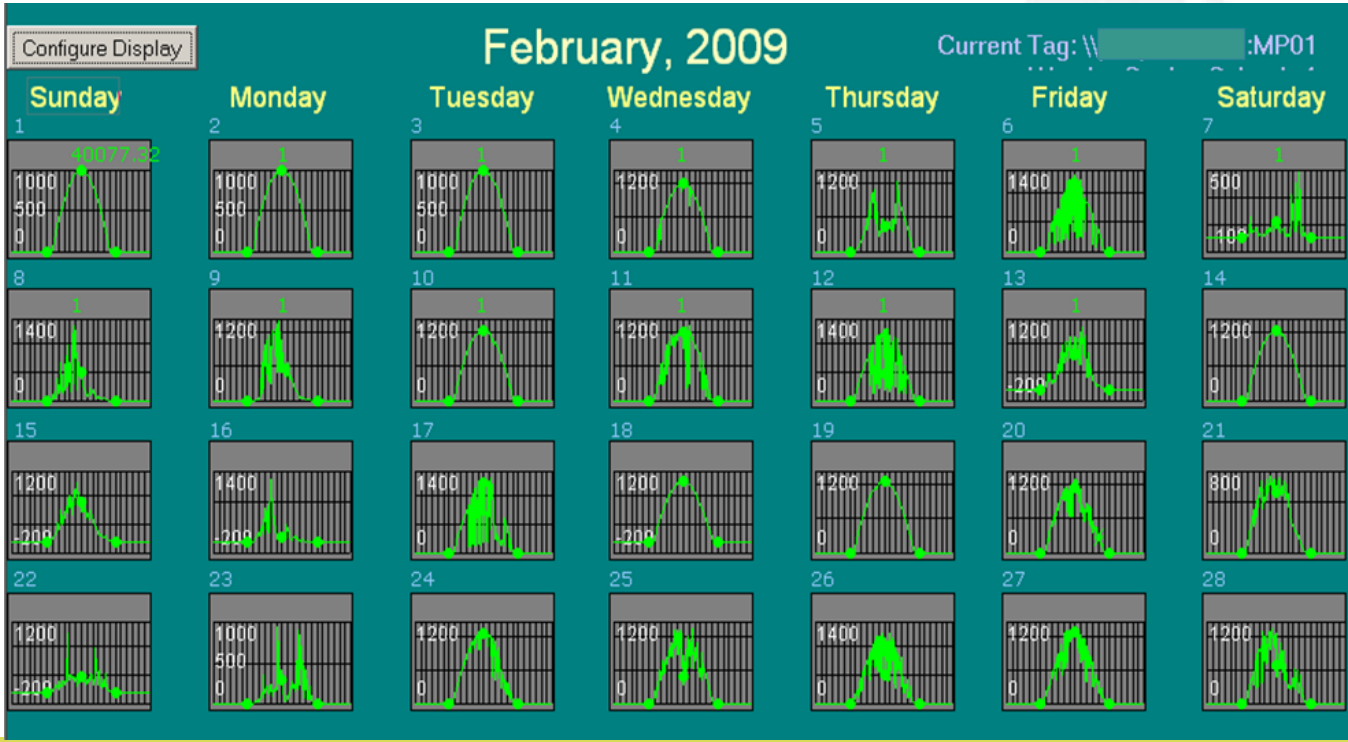
- Irradiance Analysis (Historical, Predicted, and Actual)

National Renewable Energy Lab (NREL)

- Typical Meteorological Year (TMY)
- TMY2 and TMY3 Data Sets



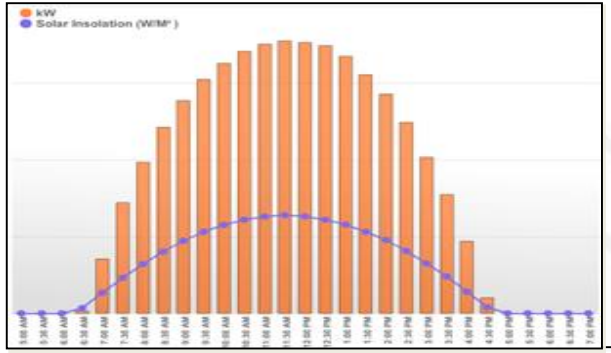
Statistical Modeling

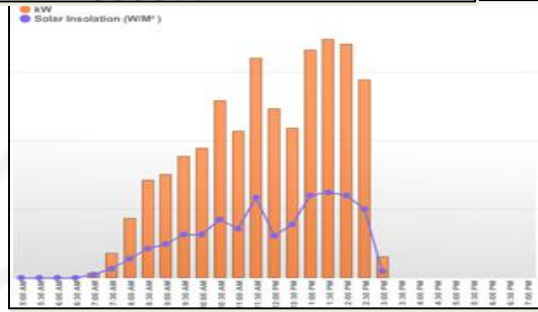


Solar Generation Applications

Sempra Energy®

- Output forecasting
  - Modeling
    - Historical output analysis
    - Equipment conditions
    - Weather forecast
    - Predictable trends
  - Day-Ahead (DA) scheduled
    - DA Scheduled versus actual metered quantity
  - Intra-hour forecast
    - Requires additional pyranometers & weather stations
    - To mitigate schedule imbalance and intermittencies
- Operations & Maintenance
  - System and panels performance monitoring (Equipment degradation)
  - Soil condition & washing frequency

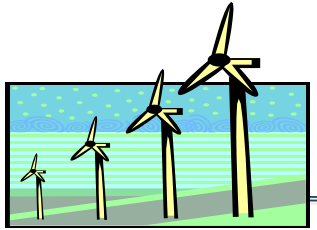




Wind Generation Data Planning

Sempra Energy®

- Wind Data Architecture



Fiber

Wind SCADA (PLCs)

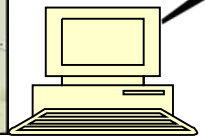
Fiber

LOCAL CONTROL CENTER
SCADA Master
PI OPC Server

Wind Farm

T1 Link

BACK-UP CONTROL CENTER
SCADA Access
PI OPC Server



Wind Data Access

Central PI Server

Looking Forward…

Sempra Energy®

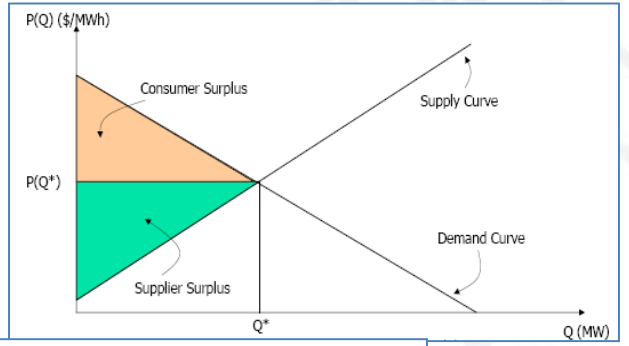
Continue to expand analysis & modeling capabilities in PI

- Real-time & Historical Data Analysis & Modeling
- Timely Decision Making Capability
- Energy Market Assessment & Transaction
- Improve Abilities for New Business Development
- Create Synergy Across the Integrated Business
  - Data Integration of linked Businesses
  - Data and Information Access Management

Sempra Energy®

Organized Market - CAISO LMP Prices Analysis

- CAISO Real-time & Historical Data
  - Hourly Day-ahead LMP Prices (over 3000 nodes)
  - 5 Minute Real-time LMP Prices (over 3000 nodes)
- Decision Drivers from Analysis
  - Planned Outage Scheduling
  - Adaptive Plant Operations
  - Bidding Strategies
  - Hedging for Congestions



$$\lambda_i = \lambda_{Ref} - L_i \times \lambda_{Ref} - \Sigma_j (\mu_j \times SF_{ji})$$

Marginal Cost at the reference bus	Marginal Cost of losses from the reference bus to bus *i*	Marginal Cost of transmission congestion from the reference bus to bus *i*

$$\lambda_i = \lambda_{Ref} + \lambda_{Lossi} + \lambda_{Congestioni}$$

Future Applications in PI

Sempra Energy®

Bi-lateral Energy Market - Pricing Analysis

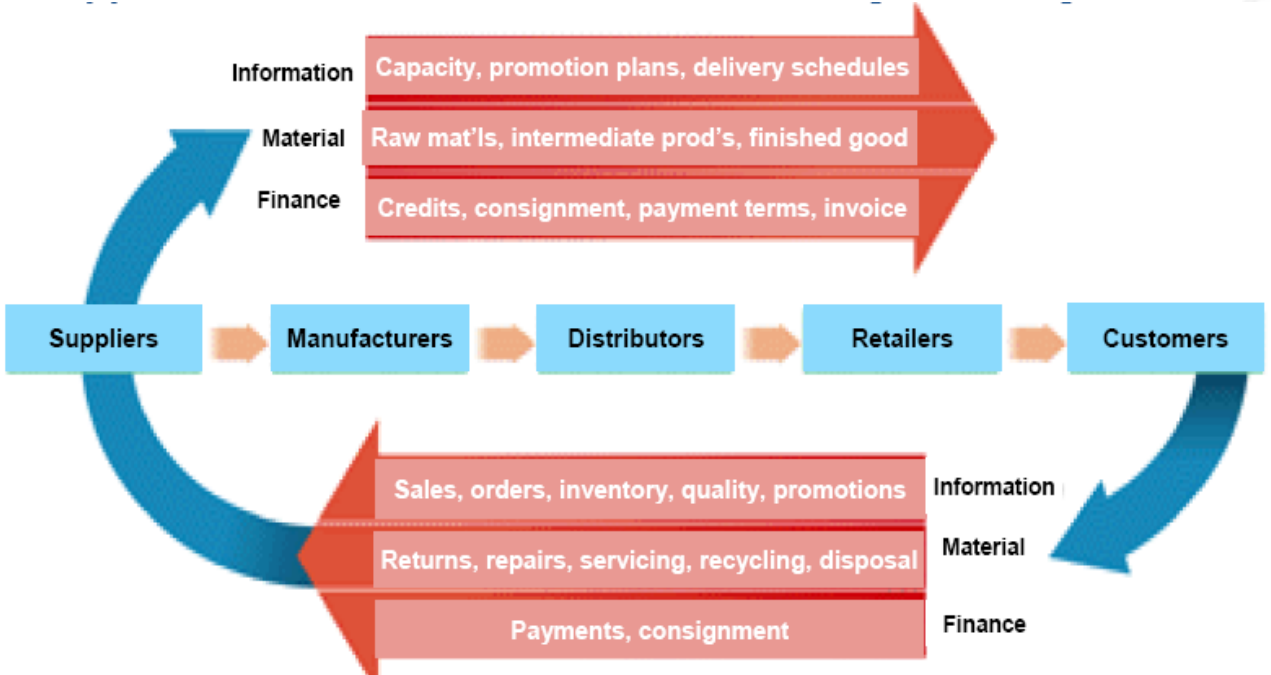
- Historical, Actual, and Forward Prices
  - Daily On-peak and Off-peak Prices by Trading Hub
- Temperature Data (Historical, Actual, & Forecast)
- Supply & Demand Data
- Other Cost Drivers: Commodities Prices
  - Crude Oil / Heating Oil
  - Natural Gas

Future Applications in PI

Sempra Energy®

Smart Grid – An Energy Supply Chain

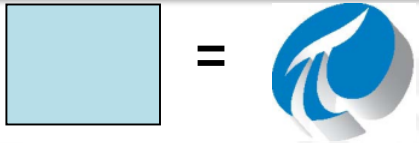
- Learning from the Best in Retail Business
- Supply Chain of Walmart (from Store Shelves to Suppliers)



Future Applications in PI

Sempra Energy®

Smart Grid's Supply Chain



PI System Infrastructure

Electron Flow

Coal, Nuclear

Base Load Plants

LNG Import

Gas Trans./ Storage

Natural Gas

Combined Cycle Plants

Gas, Solar, Wind

Peakers

Renewable

Transmission Network

Investor Owned Utility Co.

Publicly Owned Agencies

Customers *Smart Meters*

Customers

Information Flow

Data Integration

Data in Silos Today! Smart Grid Will Drive End-to-End Data Integration!

In Summary

Sempra Energy®

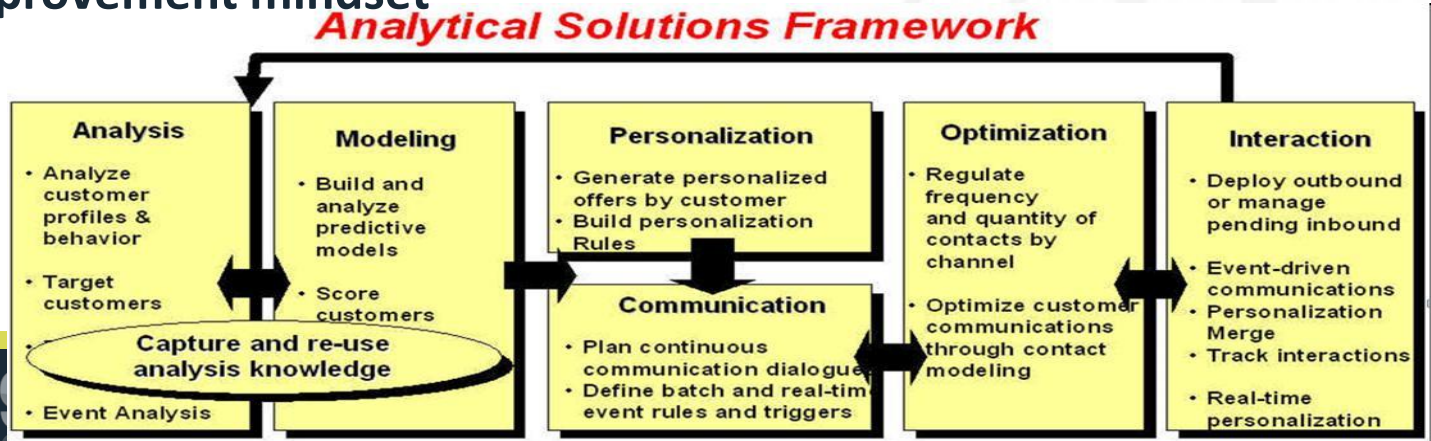
DNA of a Successful Company

- People & Company Culture
  - Make good judgment
  - Make decisions timely
  - Work hard
  - Succeed as a team
  - Continuous improvement mindset

OSIsoft PI Infrastructure

Leveraging Technology

- Data Integration & Analysis for JIT Decision Support & Communication
- Relevant Information Drives Efficiency & Productivity



"It is not the strongest of the species that survive,
nor the most intelligent,
but the one most responsive to change."

Charles Darwin

Be Prepared for Changes!