California ISO

Shaping a Renewed Future

California ISO Preparing California for a Greener and Smarter Grid

Presented by

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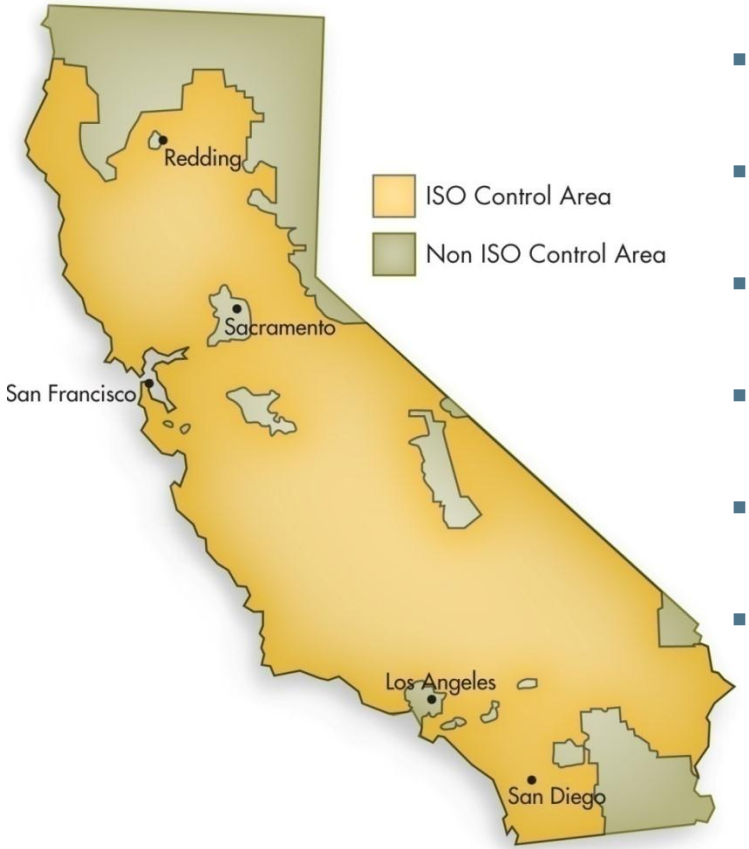
California ISO

Agenda

- CAISO Overview
- Current & Future Challenges
- Renewables Integration
- PI System Display Examples
  - Reliability Displays
  - Transmission Displays
  - Generation Displays
  - Renewables Displays
- Current & Future PI System Projects at CAISO

California ISO by the numbers

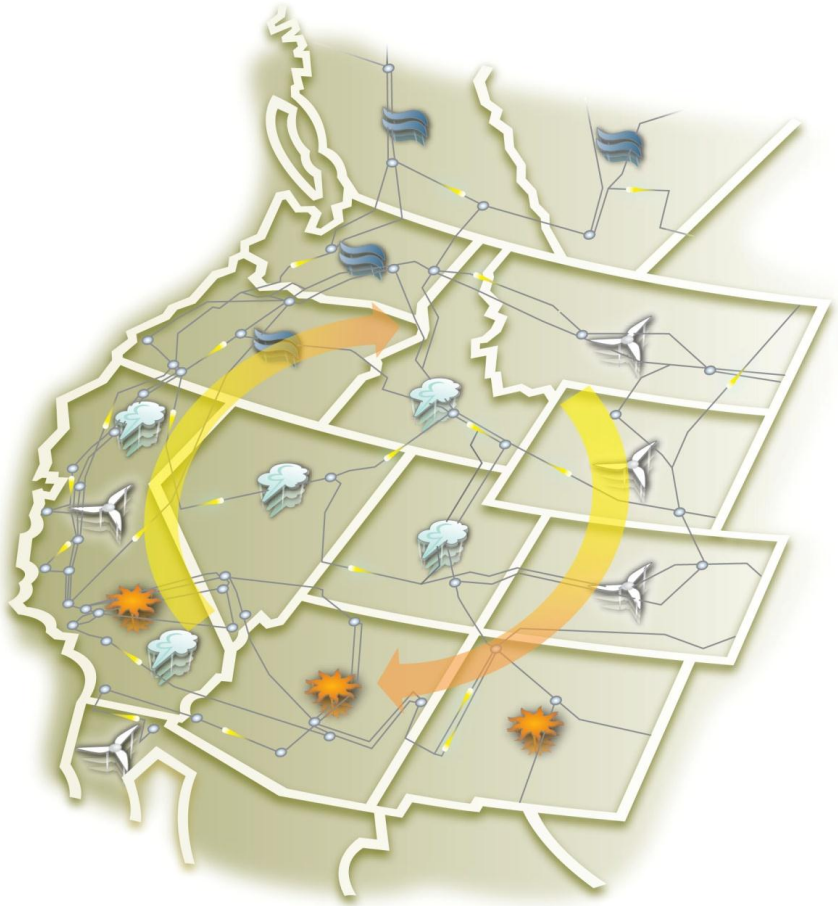


- **55,027** MW of power plant capacity
- **50,270** MW record peak demand (July 24, 2006)
- **30,000** market transactions per day
- **25,526** circuit-miles of transmission lines
- **30 million** people served
- **286 million** MW hours of electricity delivered annually

Resource reciprocity

Welcome to the Western Grid

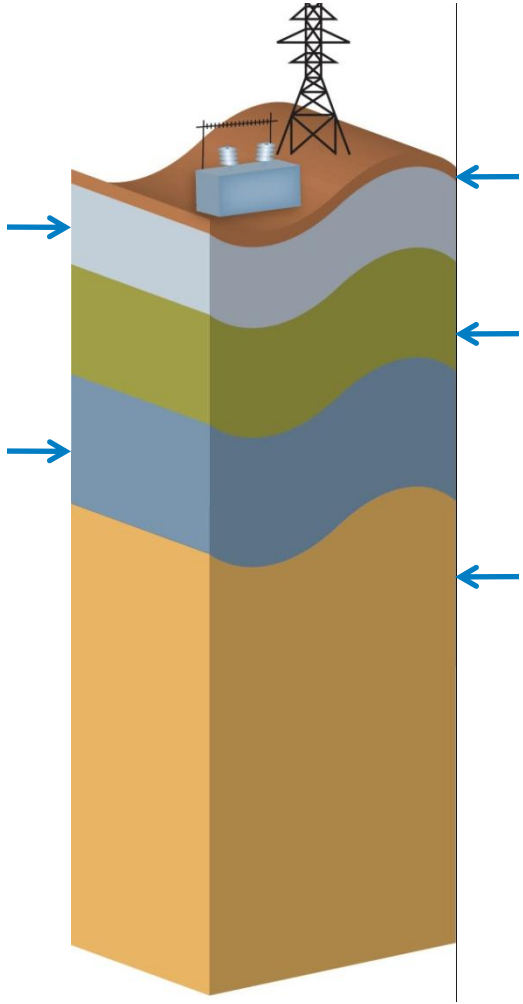
- CA is one of 14 states within **Western Electricity Coordinating Council**
- Resource sharing enhances reliability, helps achieve renewable targets and manages cost
- A quarter of all the electricity that keeps the lights on during the summer comes from other parts of the west including parts of Canada and Mexico



The power mix

12.2% - large hydro

15.3% - nuclear



1.8% - coal

13.9% - hydro, geothermal, biomass, wind, solar

56.7% - natural gas

CAISO current & future challenges

- Forecasting
- Generation fleet characteristics
- Ramping requirements
- Ambitious environmental goals
- Reliability with fewer gas powered plants
- Cost containment

We need to strike a balance between reliability, renewables and reasonable cost.

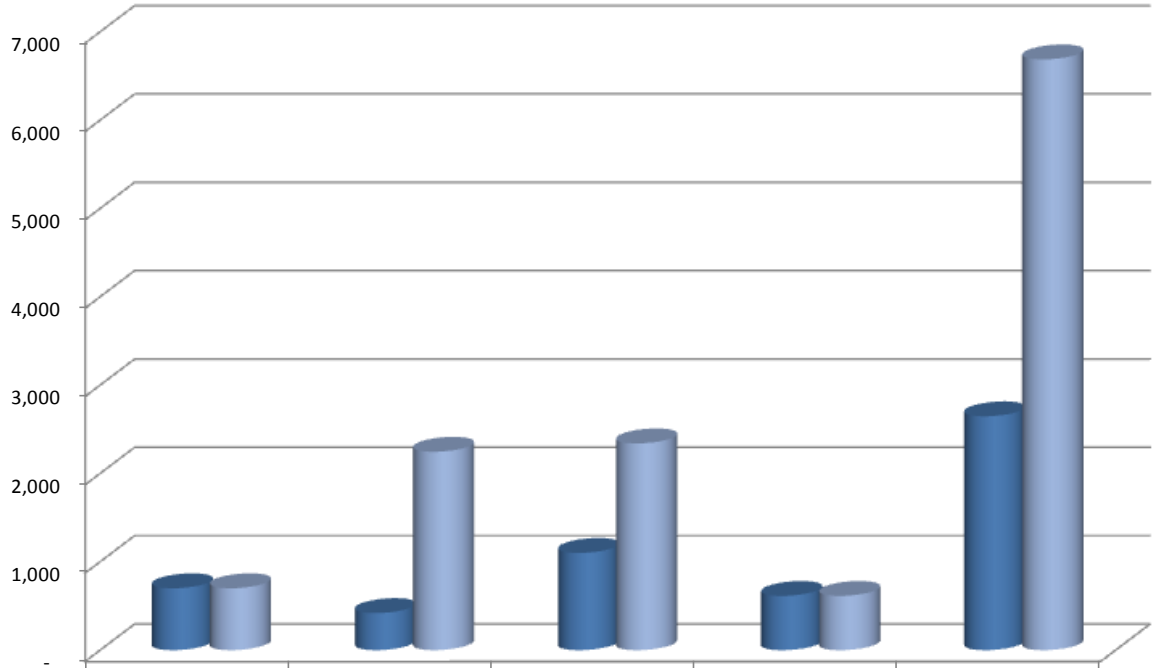
The ISO grid control room faces significant short- and long-term challenges

- Uncertainty of grid infrastructure development
- Ramping requirements significantly increased
- Continued development of control room tools
- Load and wind forecasting accuracy
- Rapid changes in grid generation fleet, especially wind and solar technologies

1. Wind and solar variability will be a significant issue by 2012-2013.

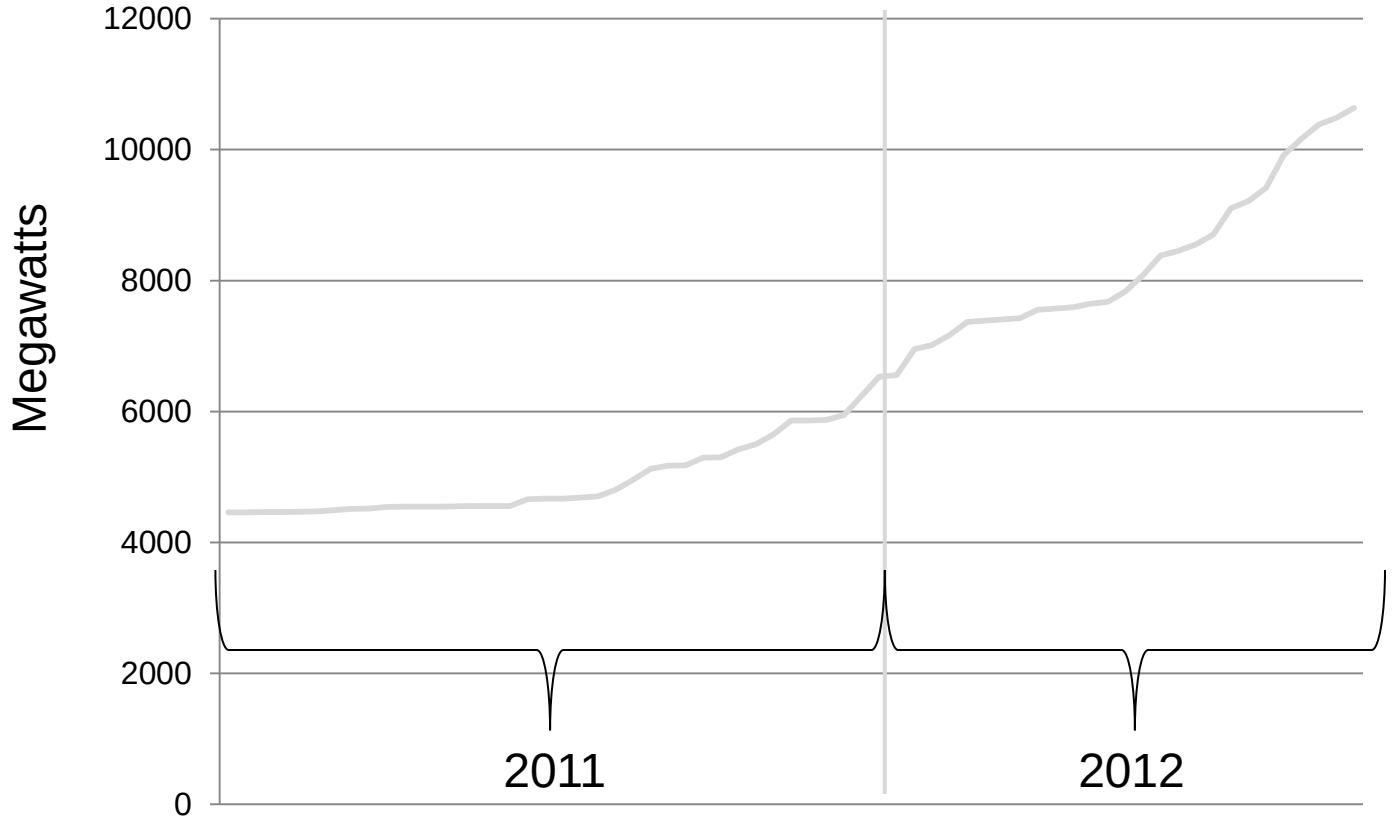
2. Synchrophasors are the most significant advancement in control center technology in the last 30 years.

The 2-3 year look-ahead: renewable resource portfolios in 2006 and 2012 (20% RPS), by capacity (MW)



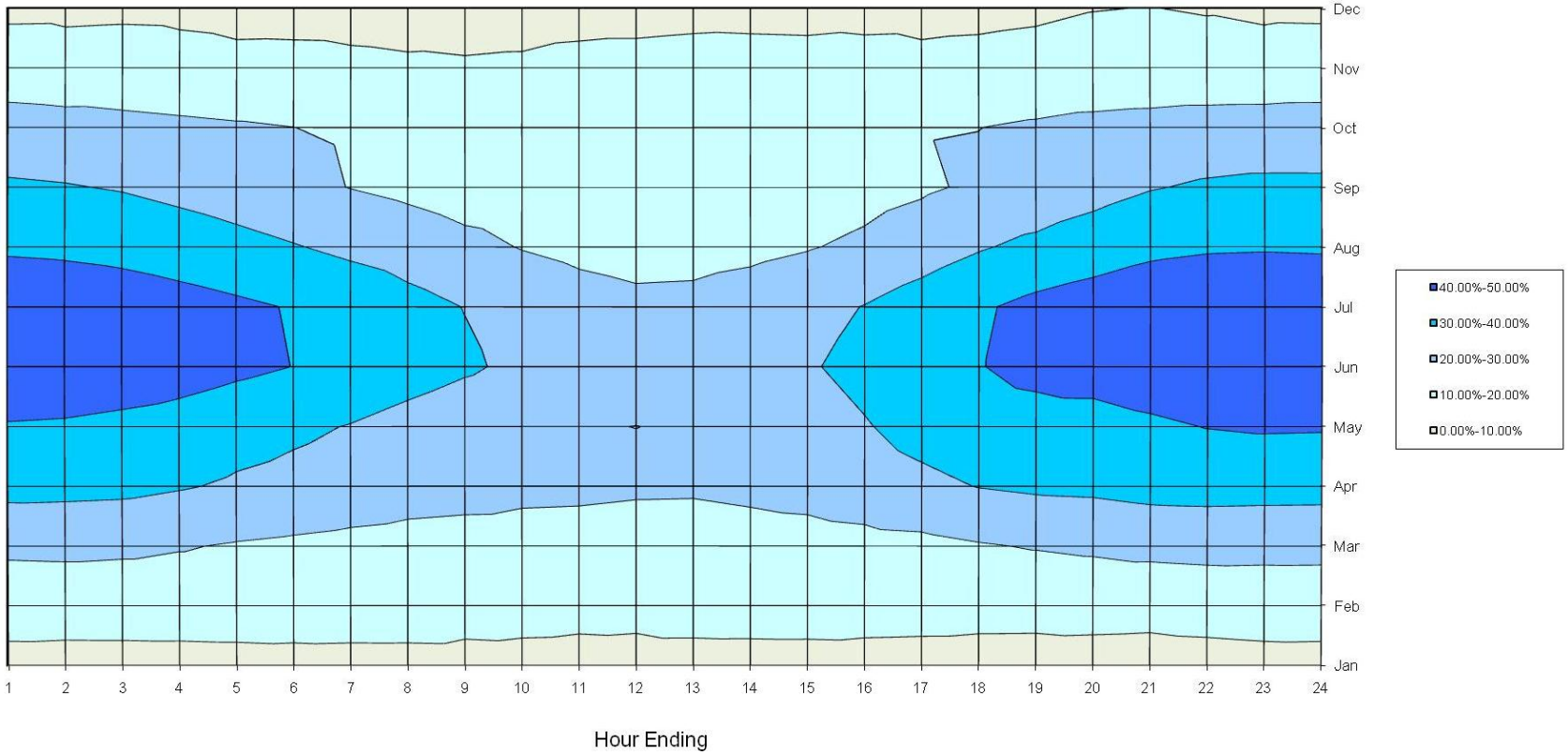
	Biomass/Biogas	Solar	Geothermal	Small Hydro	Wind
2006	701	420	1,101	614	2,648
2012 (expected)	701	2,246	2,341	614	6,688

Projected renewable growth



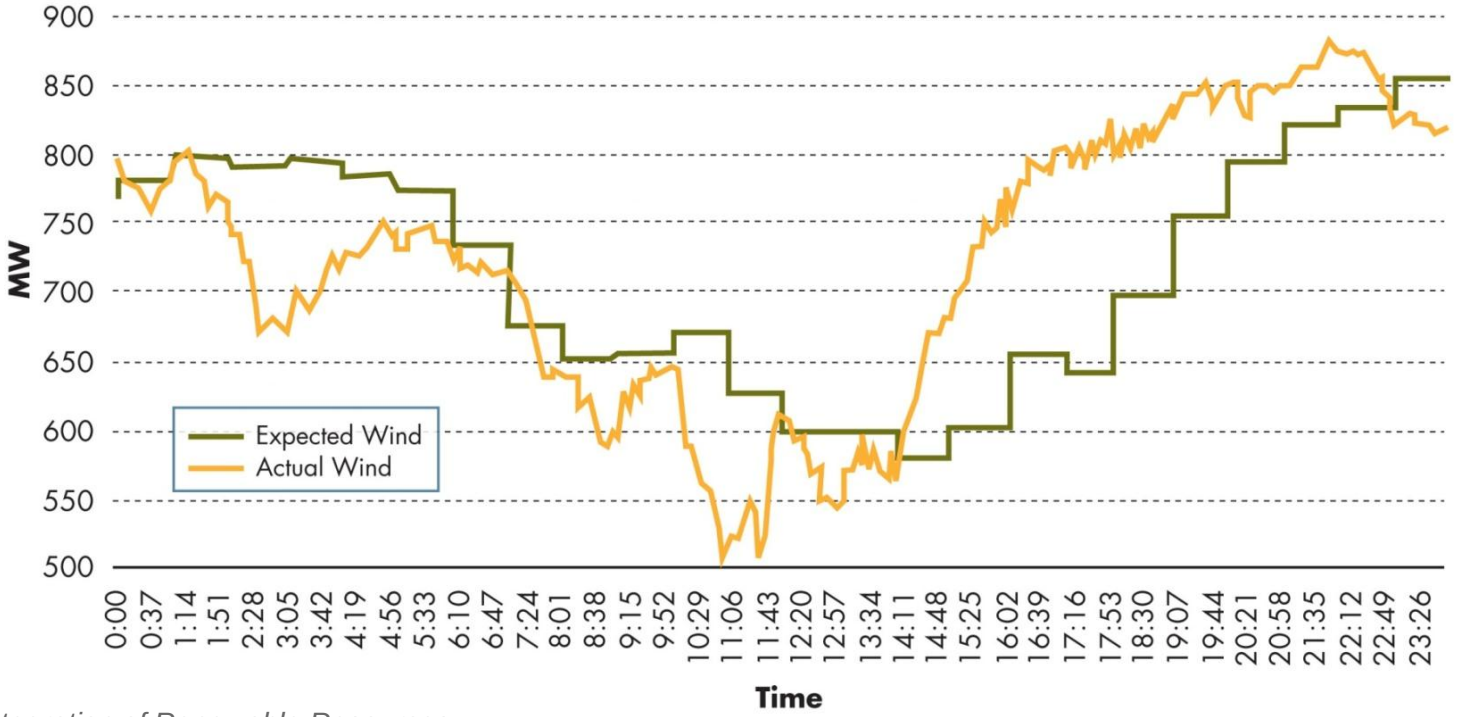
2009 CAISO wind profile –

Adjusted for monthly installed capacity average capacity factor = 22.2%



Forecasted vs. actual wind output

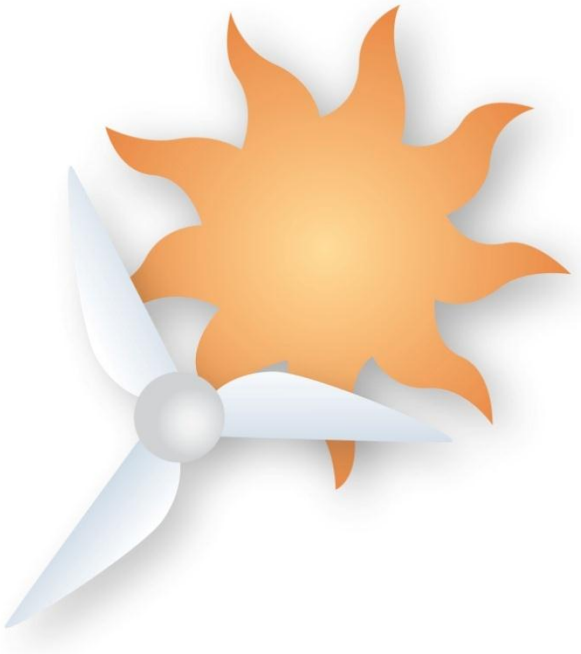
Simulated spring day in 2012



Source: 2010 Integration of Renewable Resources Operational Requirements and Generation Fleet Capability at 20% RPS

Variable power resources

Electricity fueled from the wind and the sun



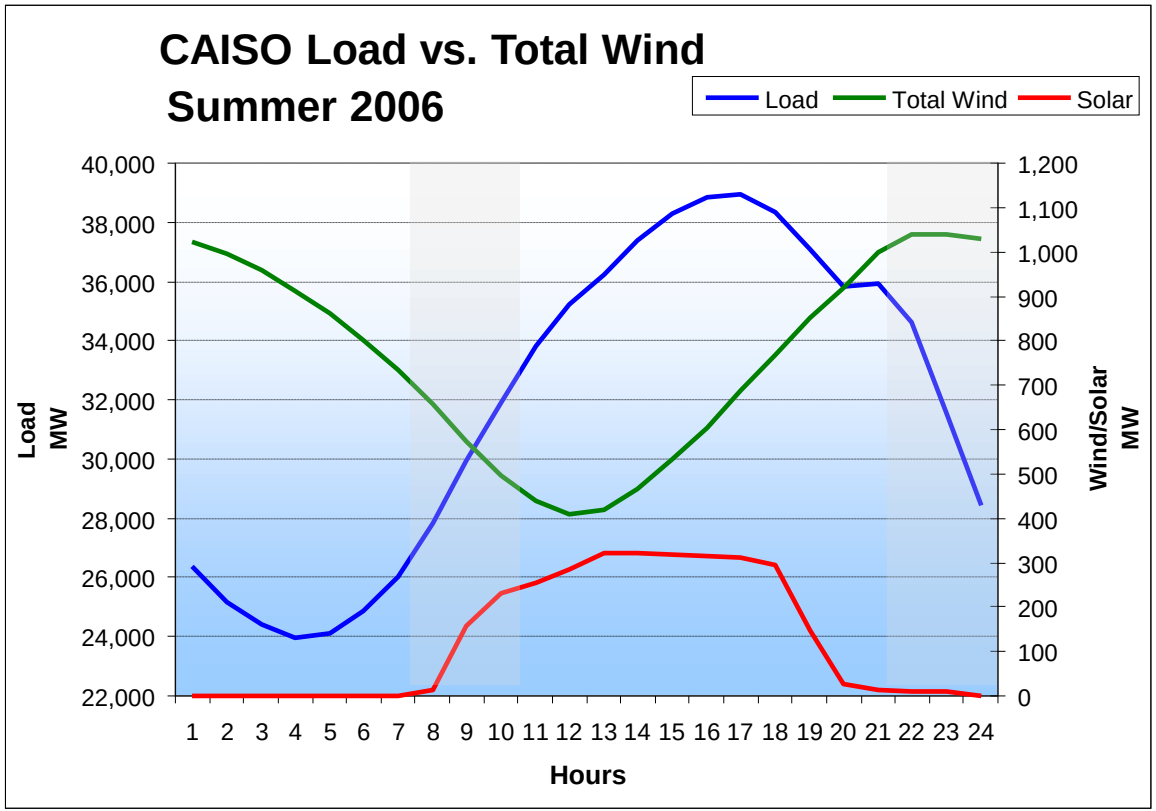
- Wind power often increases overnight, when demand is low
- Some natural gas-fired power plants **must** a continue to produce power at night to be ready for morning spike in electricity demand
- Resulting overnight oversupply of electricity from wind power and conventional plants causes utilities to sell power at low prices or even pay generators to dispose of megawatts
- Surplus power mean consumers can pay twice for electricity

The Big Question:
How do we prevent over-generation while maintaining grid reliability?

These challenges can be addressed through improved control room tools (synchrophasors) and training

- Wind and solar modeling & production forecasting
- State estimator solution & accuracy
- Grid reliability & engineering studies
- Network and market modeling
- Awareness of regional disturbances (e.g. 1996 event)
- Dynamically assess the grid (EMS not sufficient)
  - 30 samples per second compared to once every four seconds
  - Can increase COI transfer by 1500 MW
  - Estimated reduction in congestions costs $250 million
  - Better real time visualization

Wind generation tends to be inversely correlated to daily load curve, creating ramping impacts



Resources required for renewables integration

Wind Generation

Solar Generation

"Partners in Success"

Generation Portfolio

Quick Start Units

Fast Ramping

Wider Operating Range

(lower P_{min})

Regulation capability

Storage

Shift Energy from off-peak to on-peak

Mitigate Over Generation

Voltage Support

Regulation capability

Demand Response

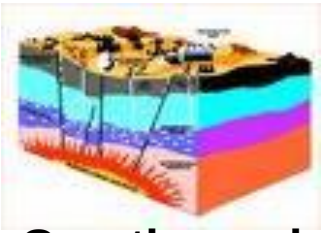
Price sensitive load

Responsive to ISO dispatches

Frequency Responsive

Responsive to Wind Generation Production

Hydro Generation



Geo-thermal Generation

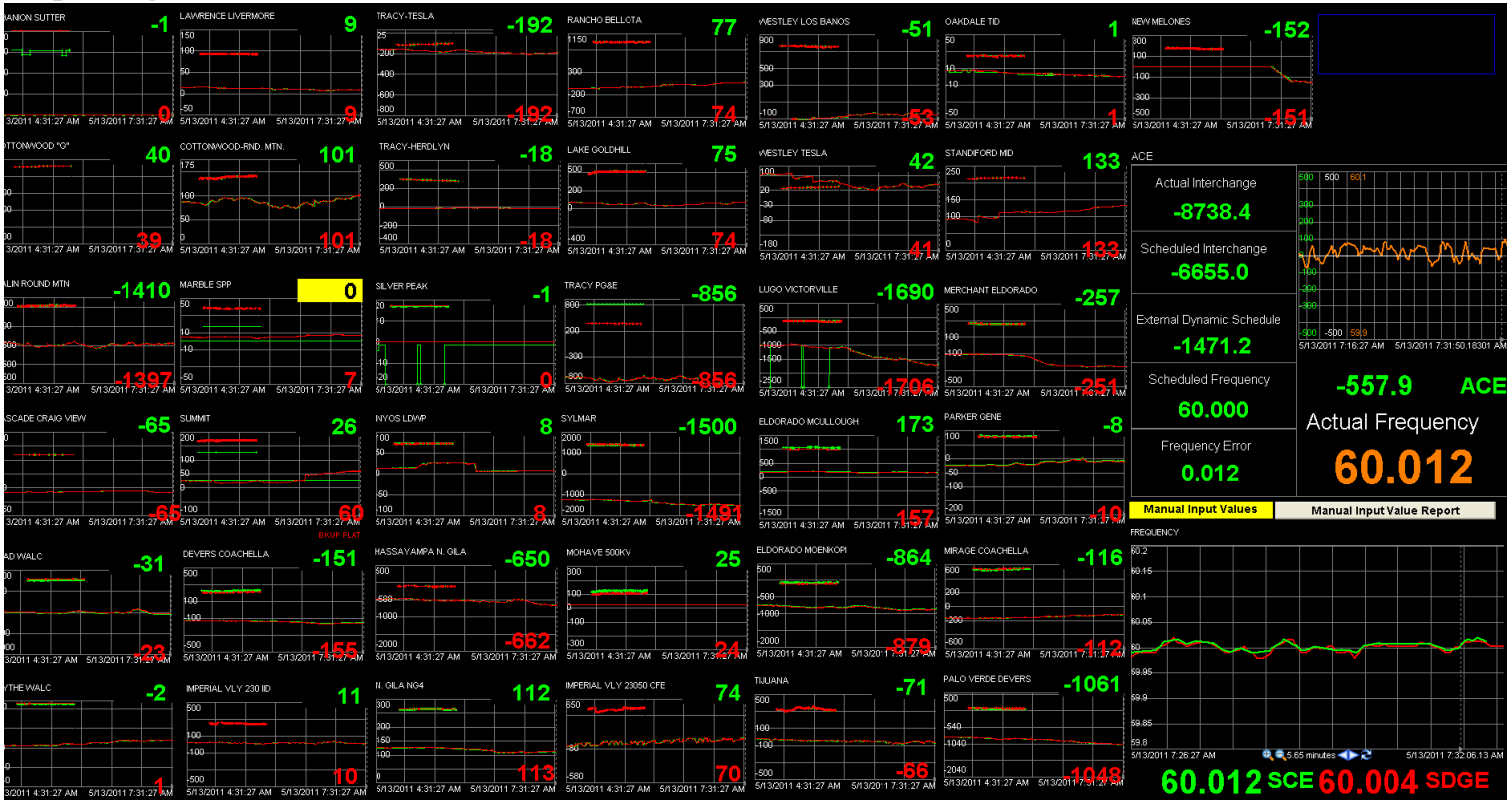
Folsom, CA – Control Room

Alhambra, CA – Control Room

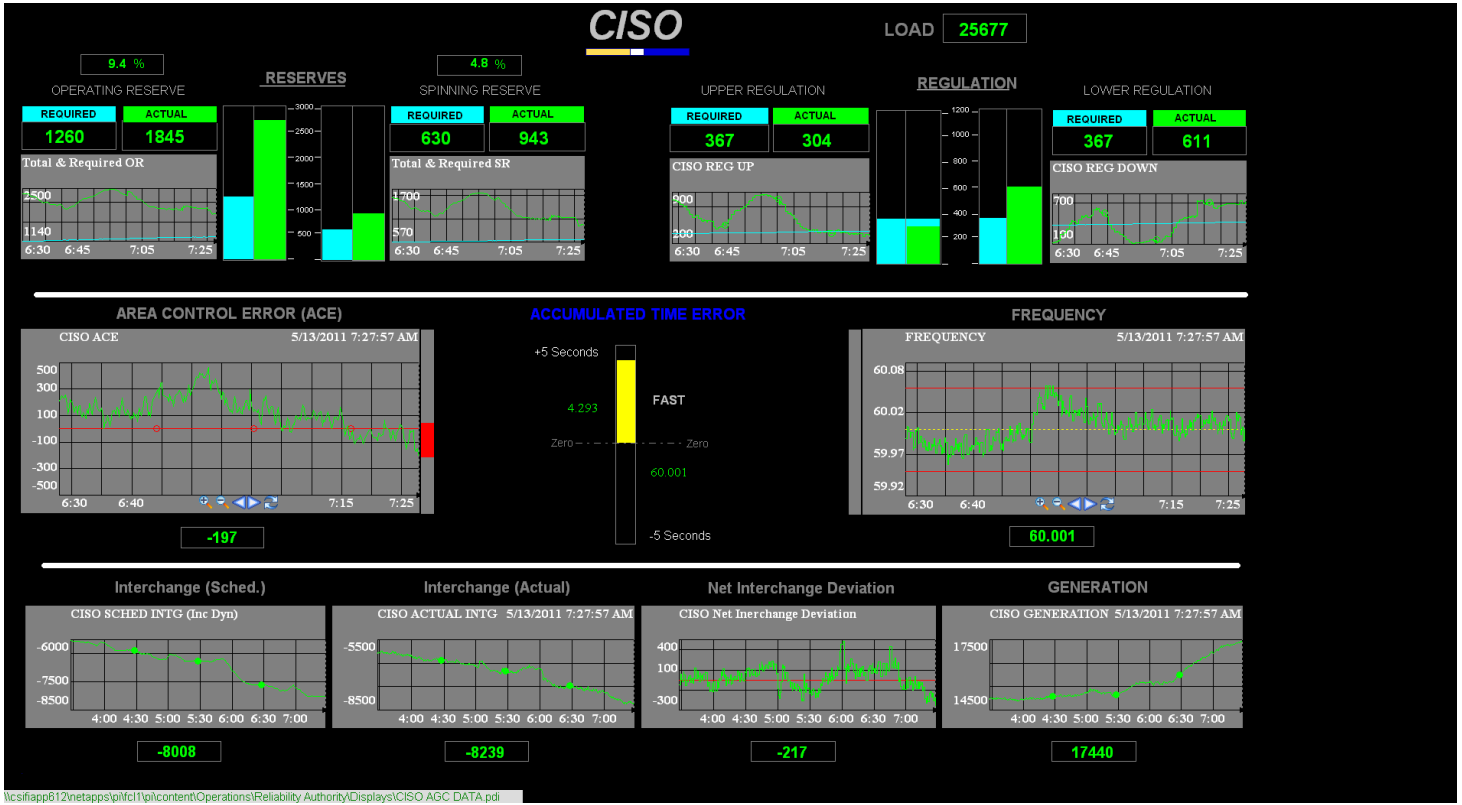
CAISO PI System Displays

Reliability

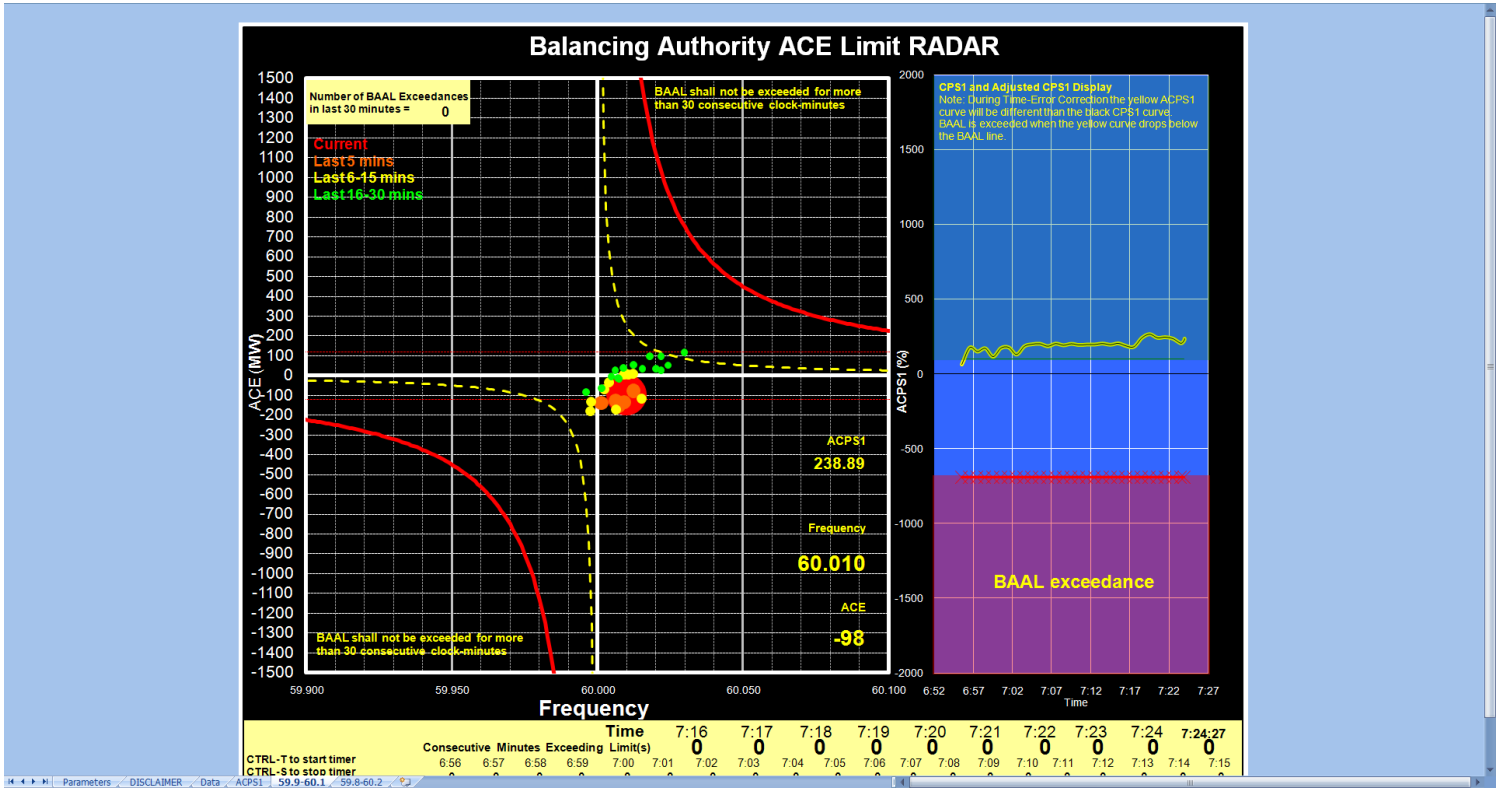
CAISO PI System Display – reliability back-up tie line display with ACE-Area Control Error/FREQ



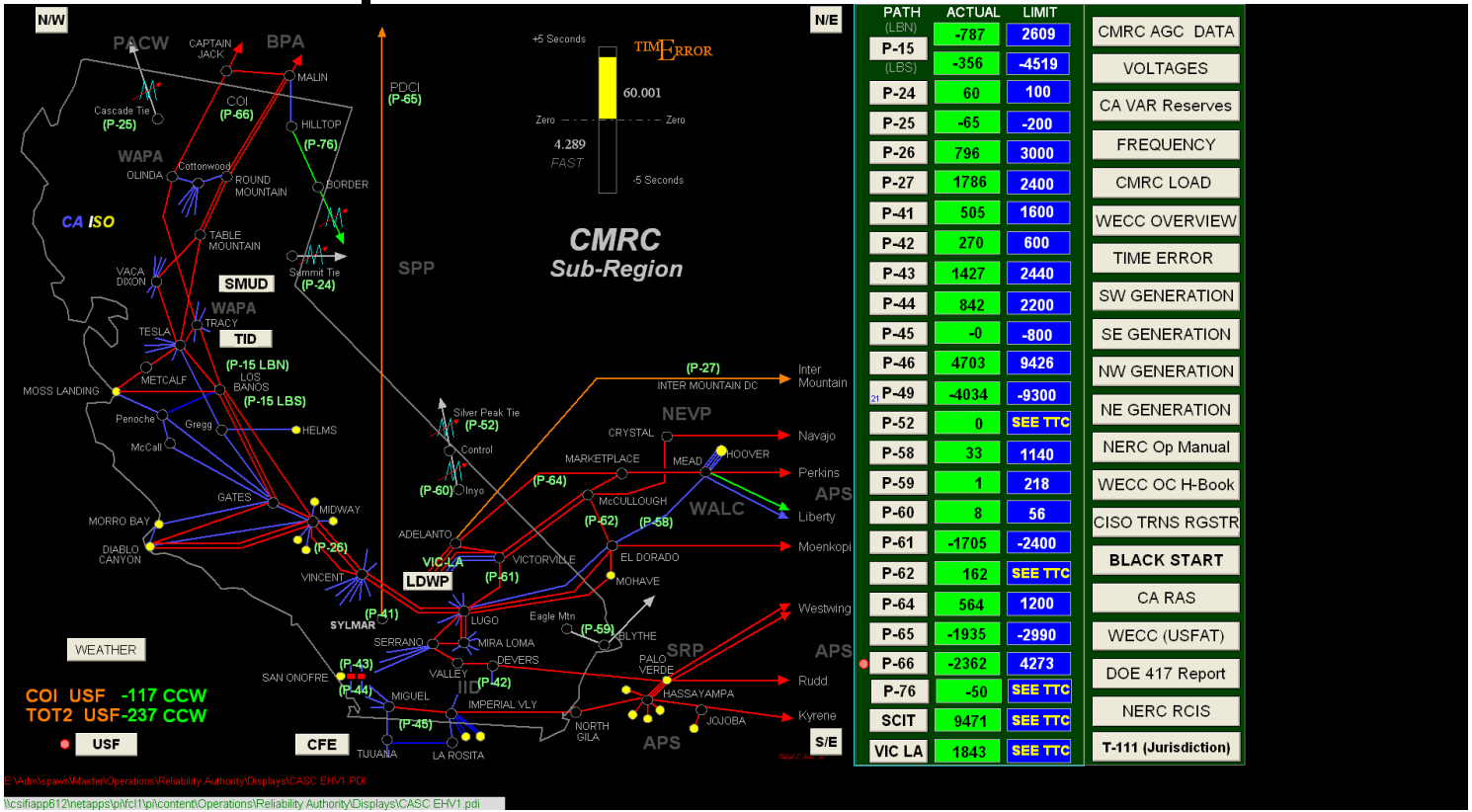
CAISO PI System Display – reliability CAISO AGC summary



CAISO PI System Display – reliability balancing authority ACE (Area Control Error) limit radar



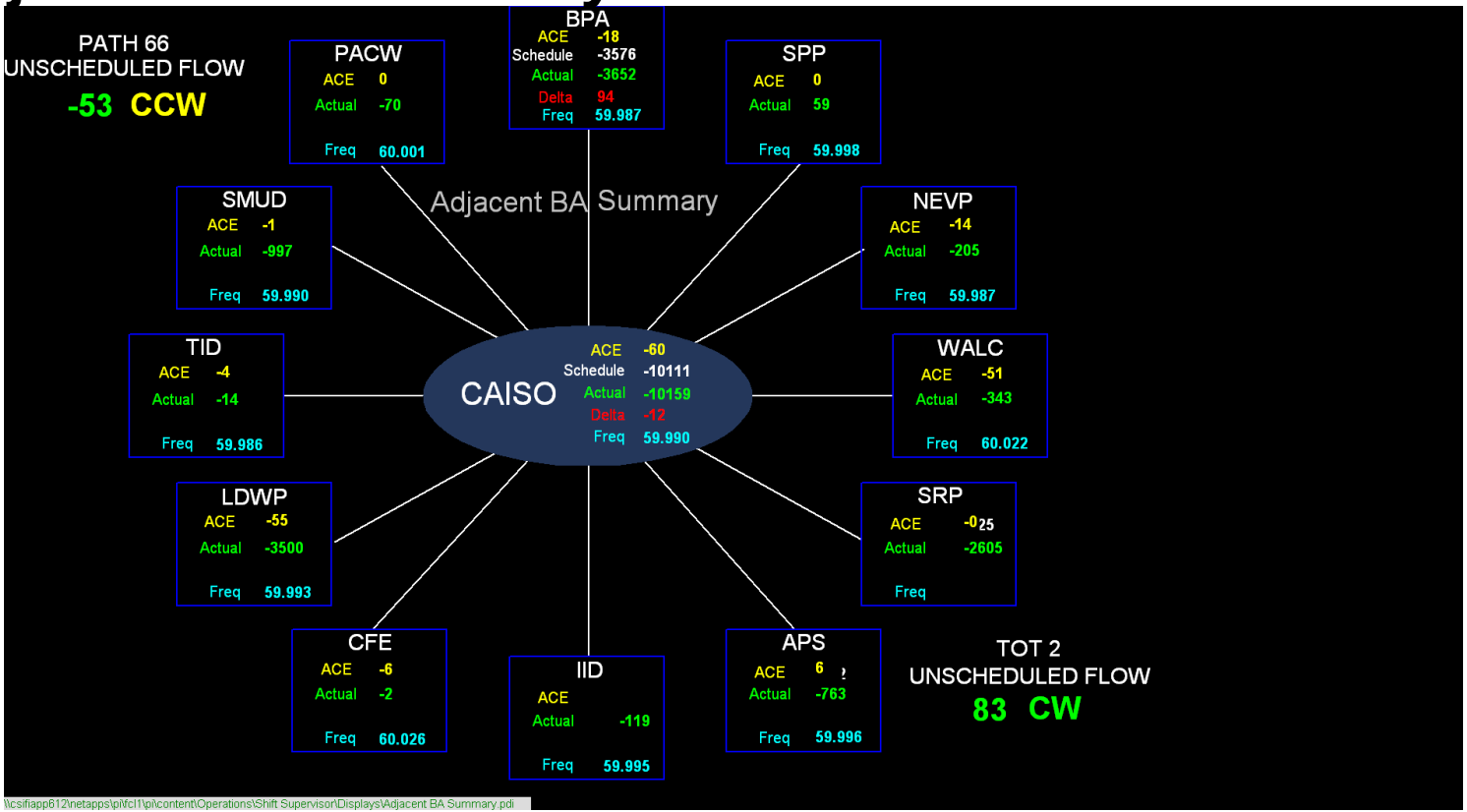
CAISO PI System Display – reliability WECC transmission path overview



PATH	ACTUAL	LIMIT
(LBN)	-787	2609
P-15	-356	-4519
(LBS)	60	100
P-24	-65	-200
P-25	796	3000
P-26	1786	2400
P-27	505	1600
P-41	270	600
P-42	1427	2440
P-43	842	2200
P-44	-0	-800
P-45	4703	9426
P-46	-4034	-9300
P-49	0	SEE TTC
P-52	33	1140
P-58	1	218
P-59	8	56
P-60	-1705	-2400
P-61	162	SEE TTC
P-62	564	1200
P-64	-1935	-2990
P-65	-2362	4273
P-66	-50	SEE TTC
P-76	9471	SEE TTC
SCIT	1843	SEE TTC
VIC LA		

CMRC AGC DATA
VOLTAGES
CA VAR Reserves
FREQUENCY
CMRC LOAD
WECC OVERVIEW
TIME ERROR
SW GENERATION
SE GENERATION
NW GENERATION
NE GENERATION
NERC Op Manual
WECC OC H-Book
CISO TRNS RGSTR
BLACK START
CA RAS
WECC (USFAT)
DOE 417 Report
NERC RCIS
T-111 (Jurisdiction)

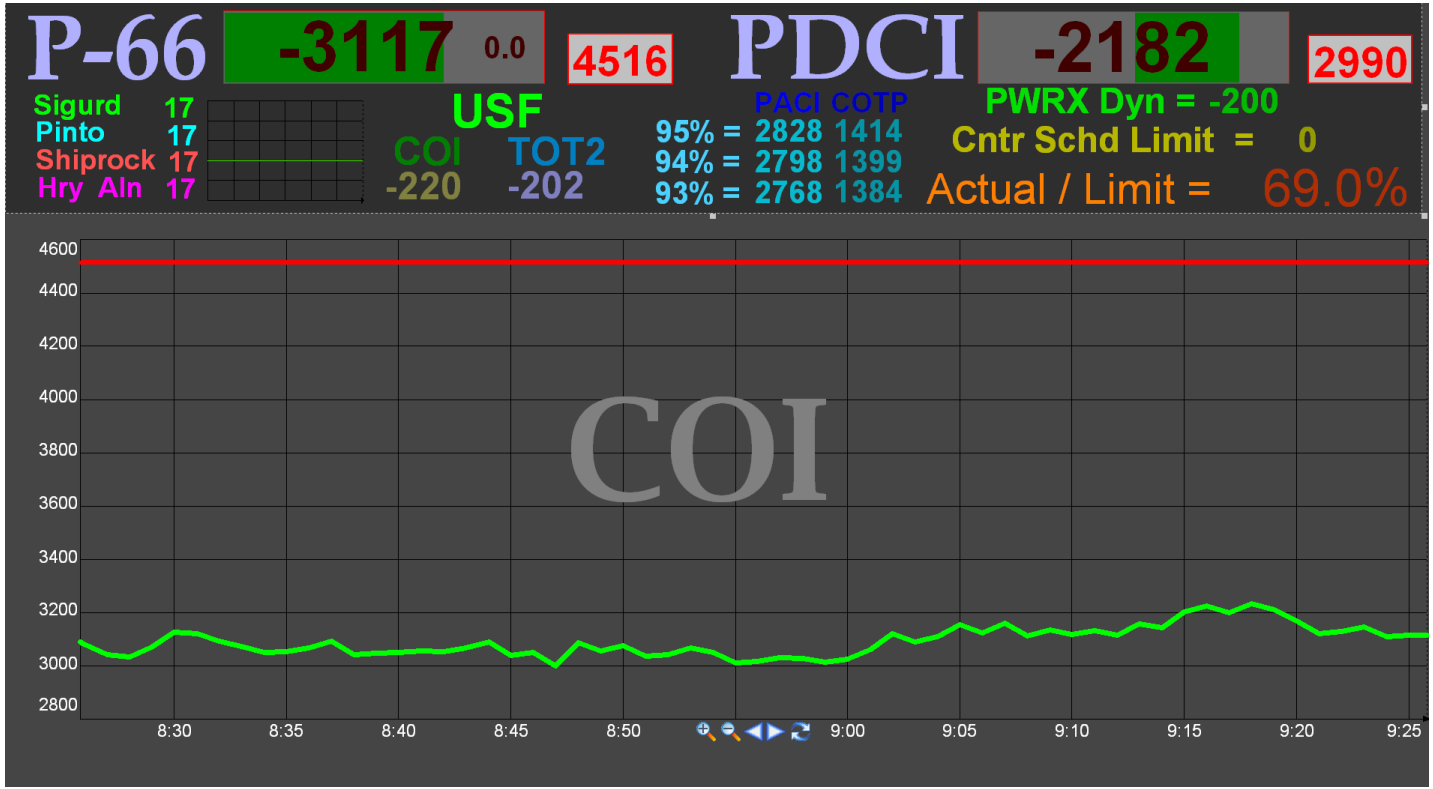
CAISO PI System Display – reliability adjacent BA summary



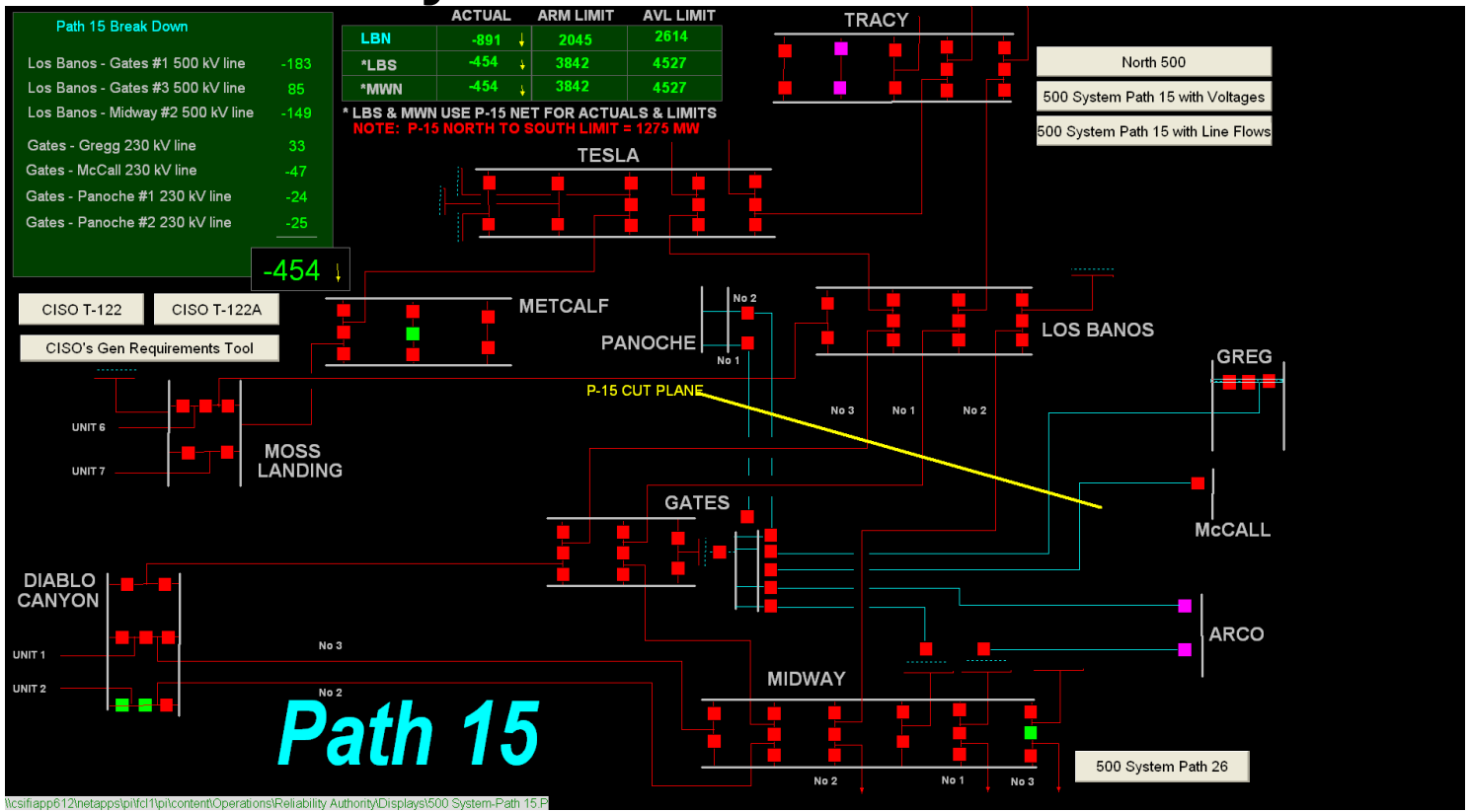
CAISO PI System Displays

Transmission

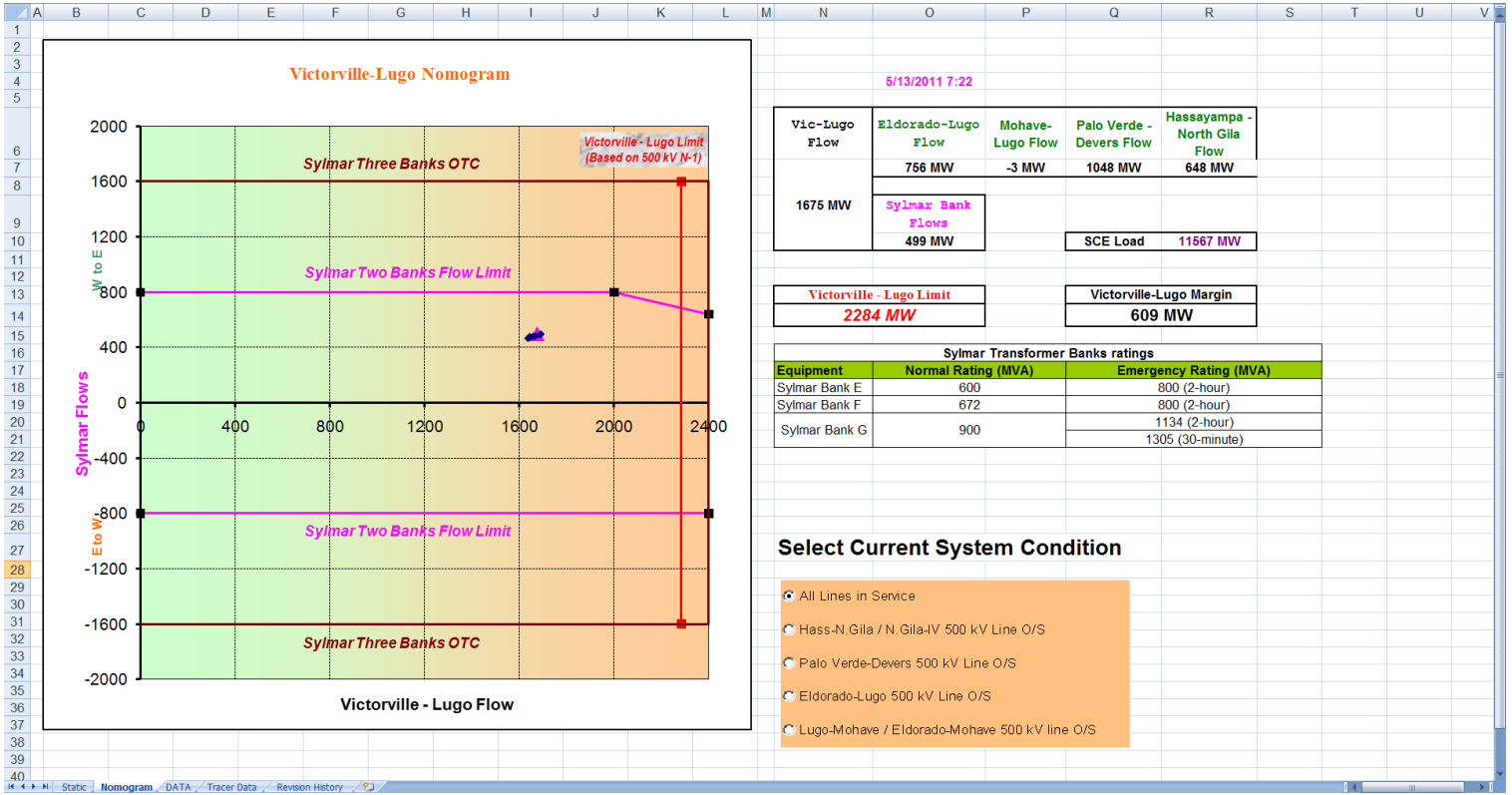
CAISO PI System Display – transmission California-Oregon Intertie (COI) summary



CAISO PI System Display – transmission path 15 summary



CAISO PI System Display – transmission nomogram



5/13/2011 7:22

Vic-Lugo Flow	Eldorado-Lugo Flow	Mohave-Lugo Flow	Palo Verde - Devers Flow	Hassayampa - North Gila Flow
	756 MW	-3 MW	1048 MW	648 MW
1675 MW	Sylmar Bank Flows			
	499 MW		SCE Load	11567 MW

Victorville - Lugo Limit	Victorville-Lugo Margin
2284 MW	609 MW

Sylmar Transformer Banks ratings

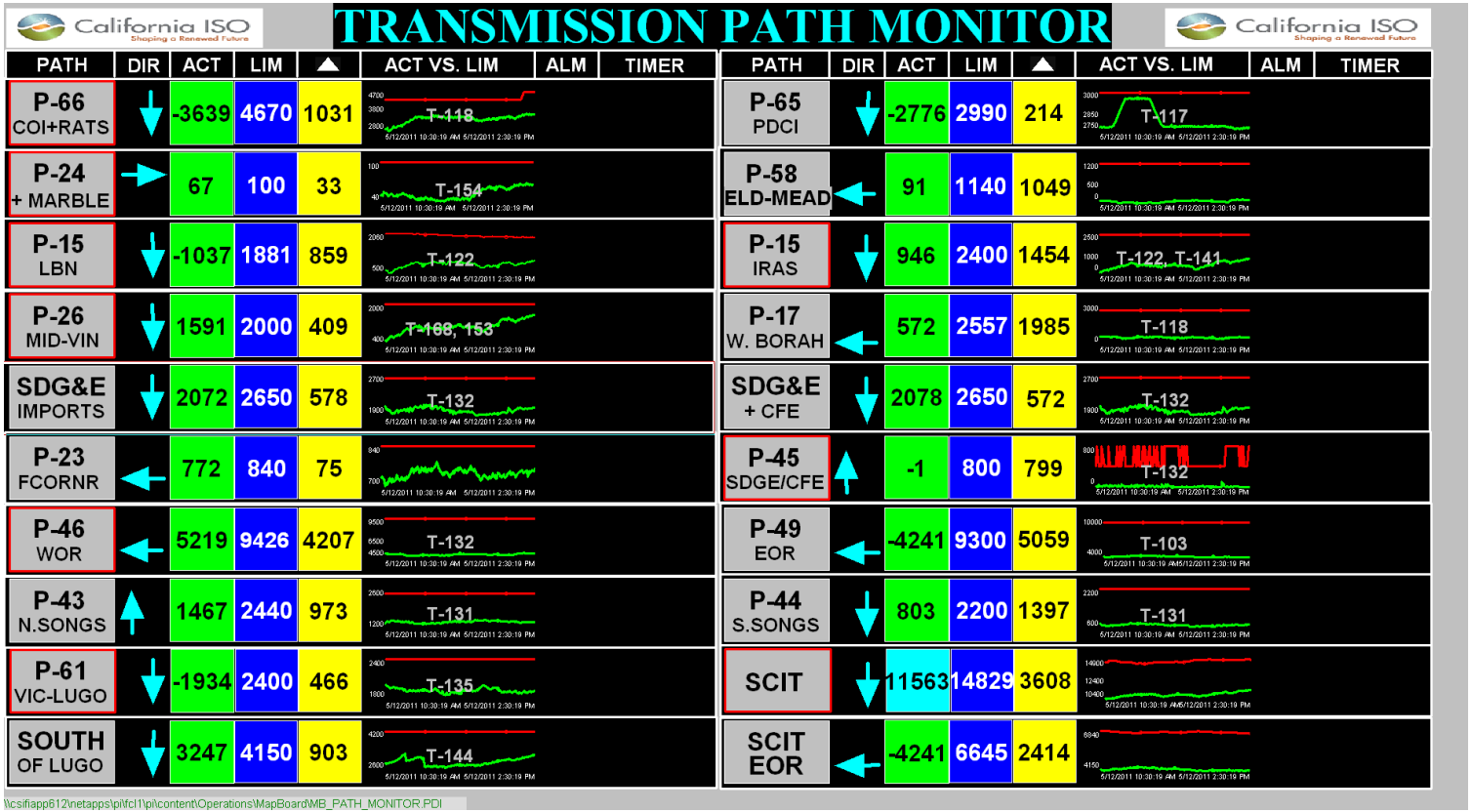
Equipment	Normal Rating (MVA)	Emergency Rating (MVA)
Sylmar Bank E	600	800 (2-hour)
Sylmar Bank F	672	800 (2-hour)
Sylmar Bank G	900	1134 (2-hour)
		1305 (30-minute)

Select Current System Condition

- (•) All Lines in Service
- ( ) Hass-N.Gila / N.Gila-IV 500 kV Line O/S
- ( ) Palo Verde-Devers 500 kV Line O/S
- ( ) Eldorado-Lugo 500 kV Line O/S
- ( ) Lugo-Mohave / Eldorado-Mohave 500 kV line O/S

Static | Nomogram | DATA | Tracer Data | Revision History

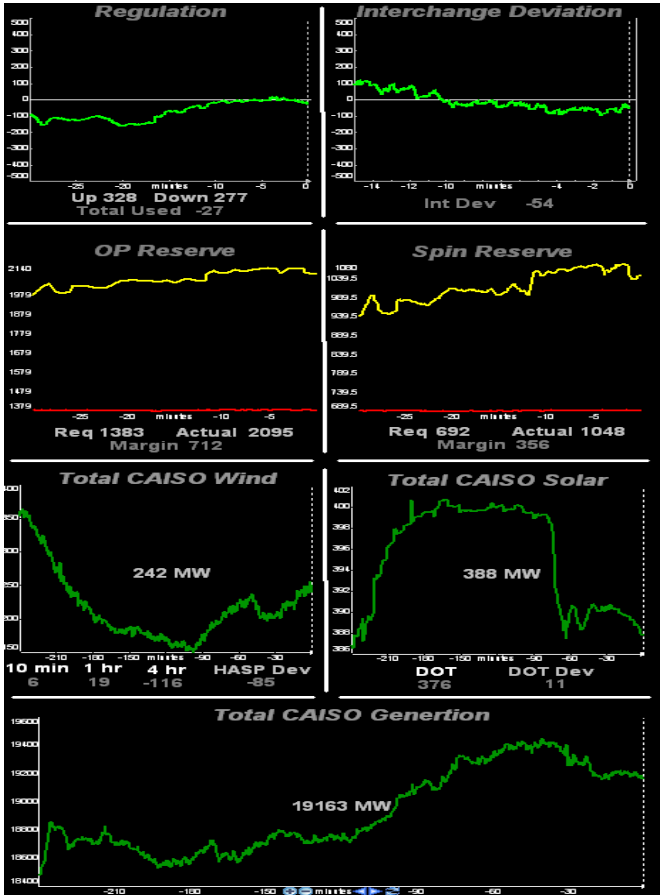
CAISO PI System Display – transmission path monitor



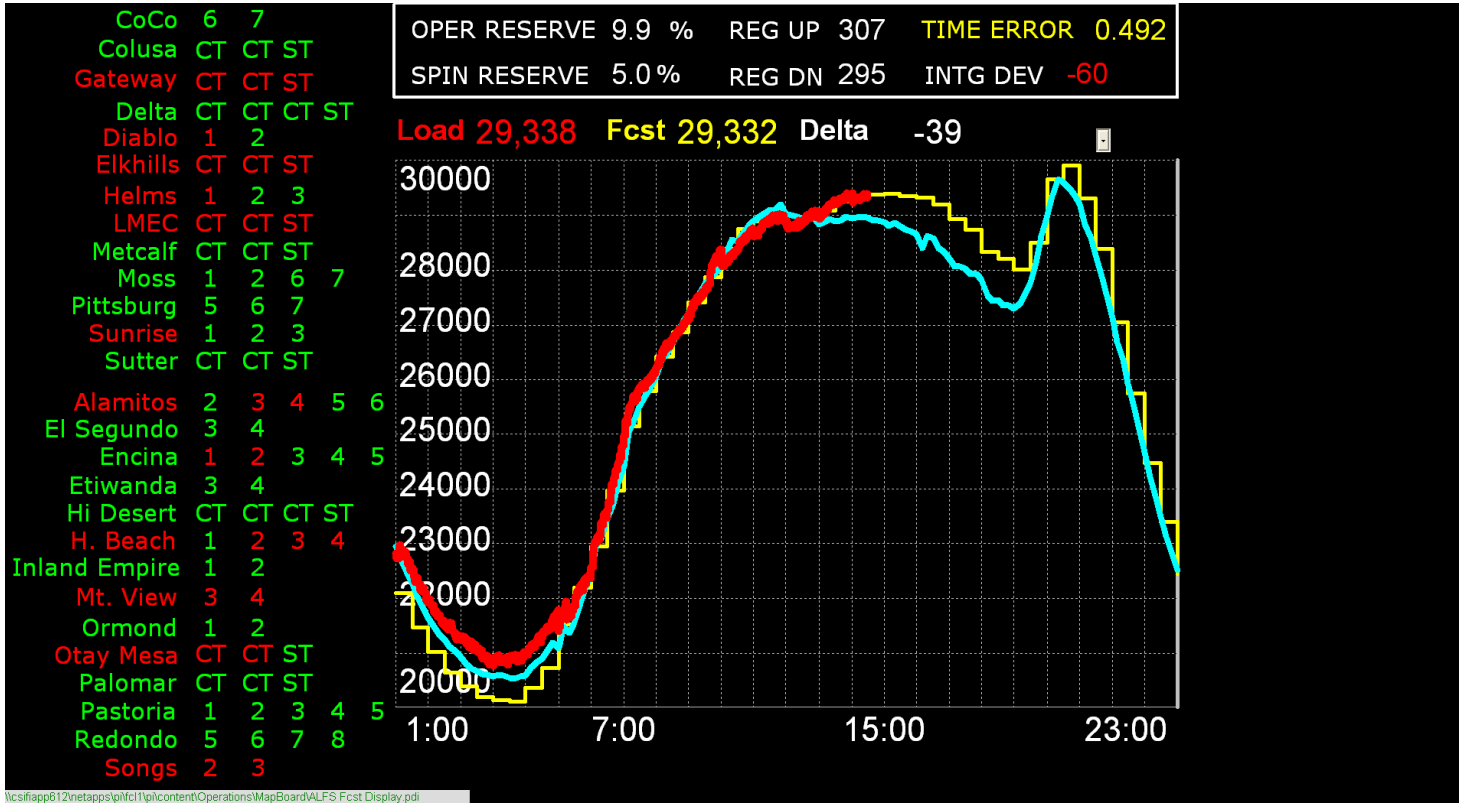
CAISO PI System Displays

Generation

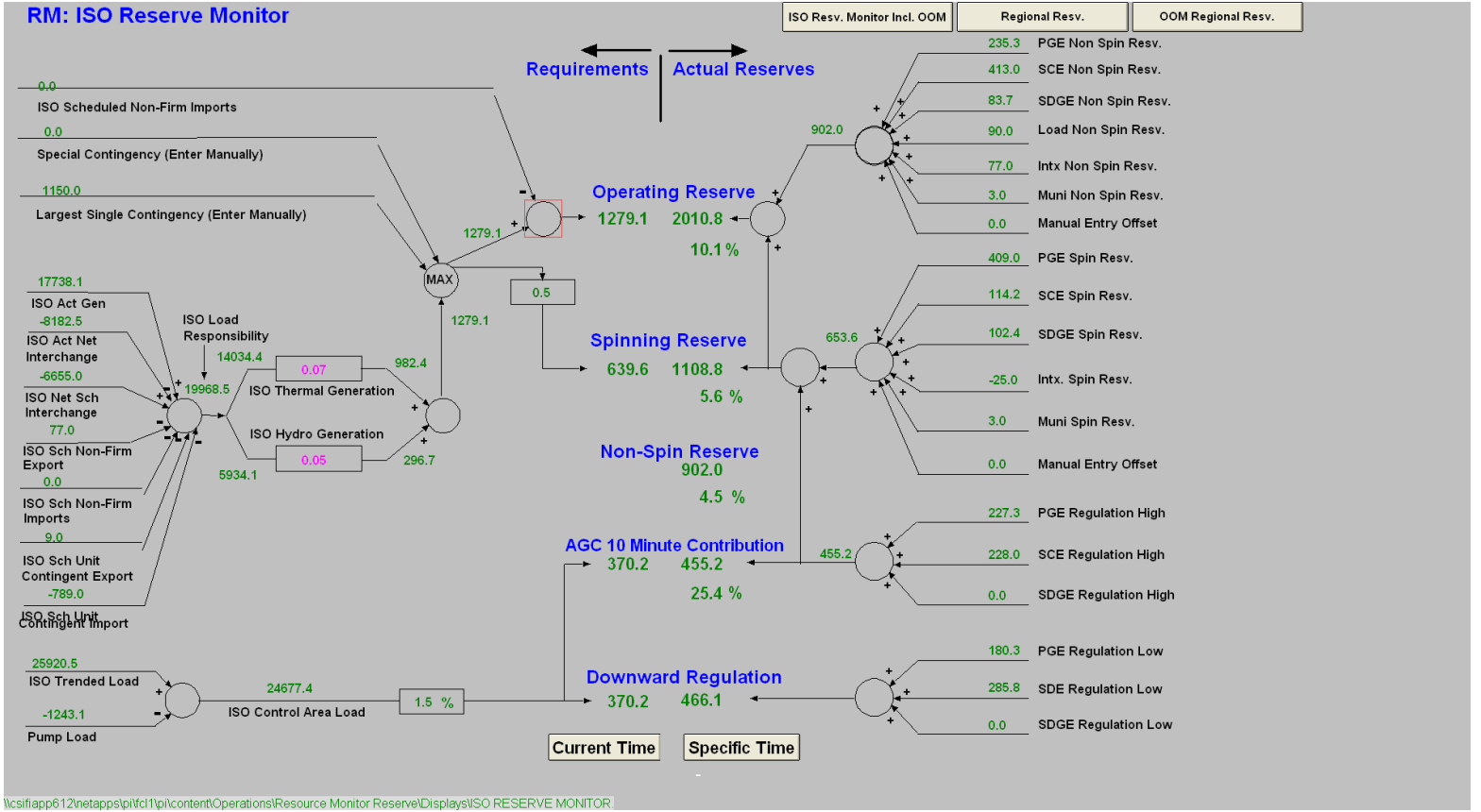
CAISO PI System Display – generation regulation summary



CAISO PI System Display – generation load forecast and DCS generator status summary

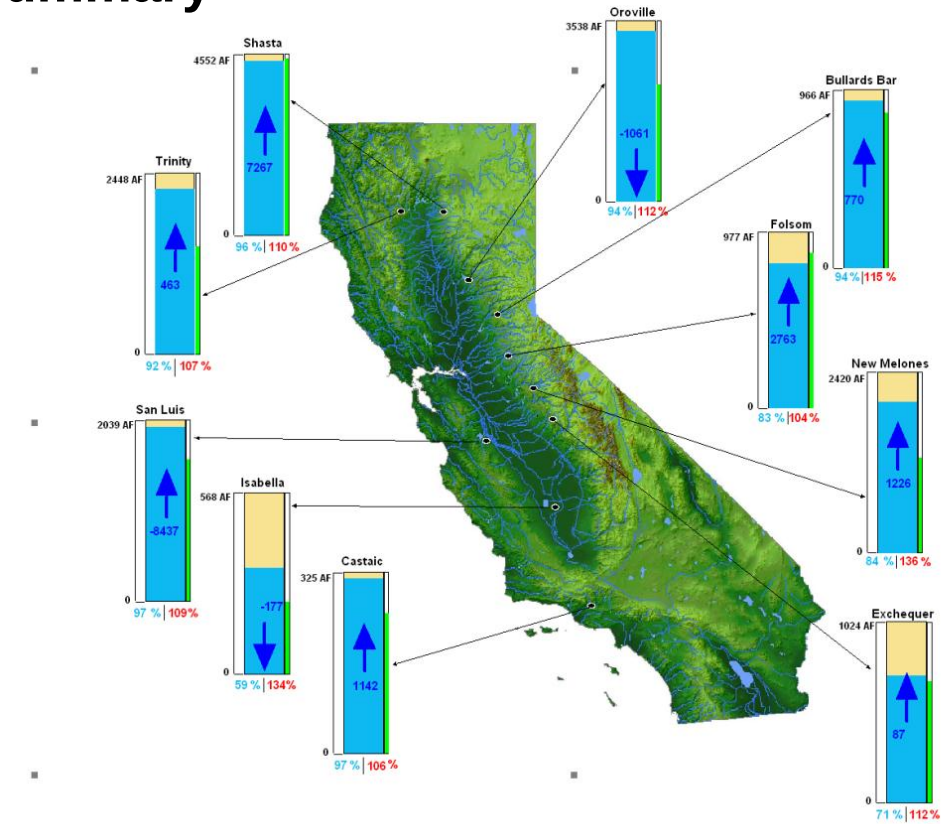


CAISO PI System Display – generation CAISO reserve monitor

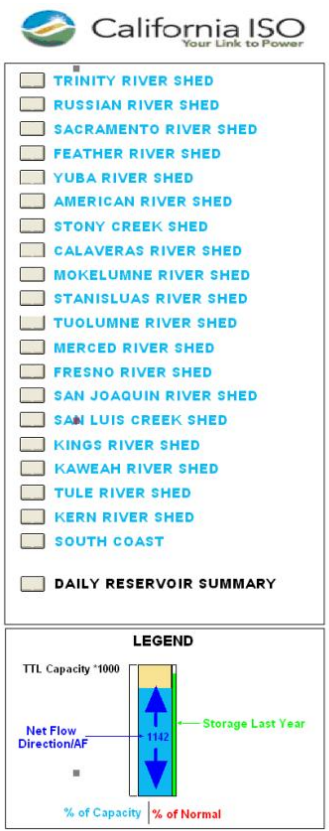


CAISO STI/PI System Display – generation – AGC Summary using PI System data

CAISO PI System Display – generation hydro conditions summary



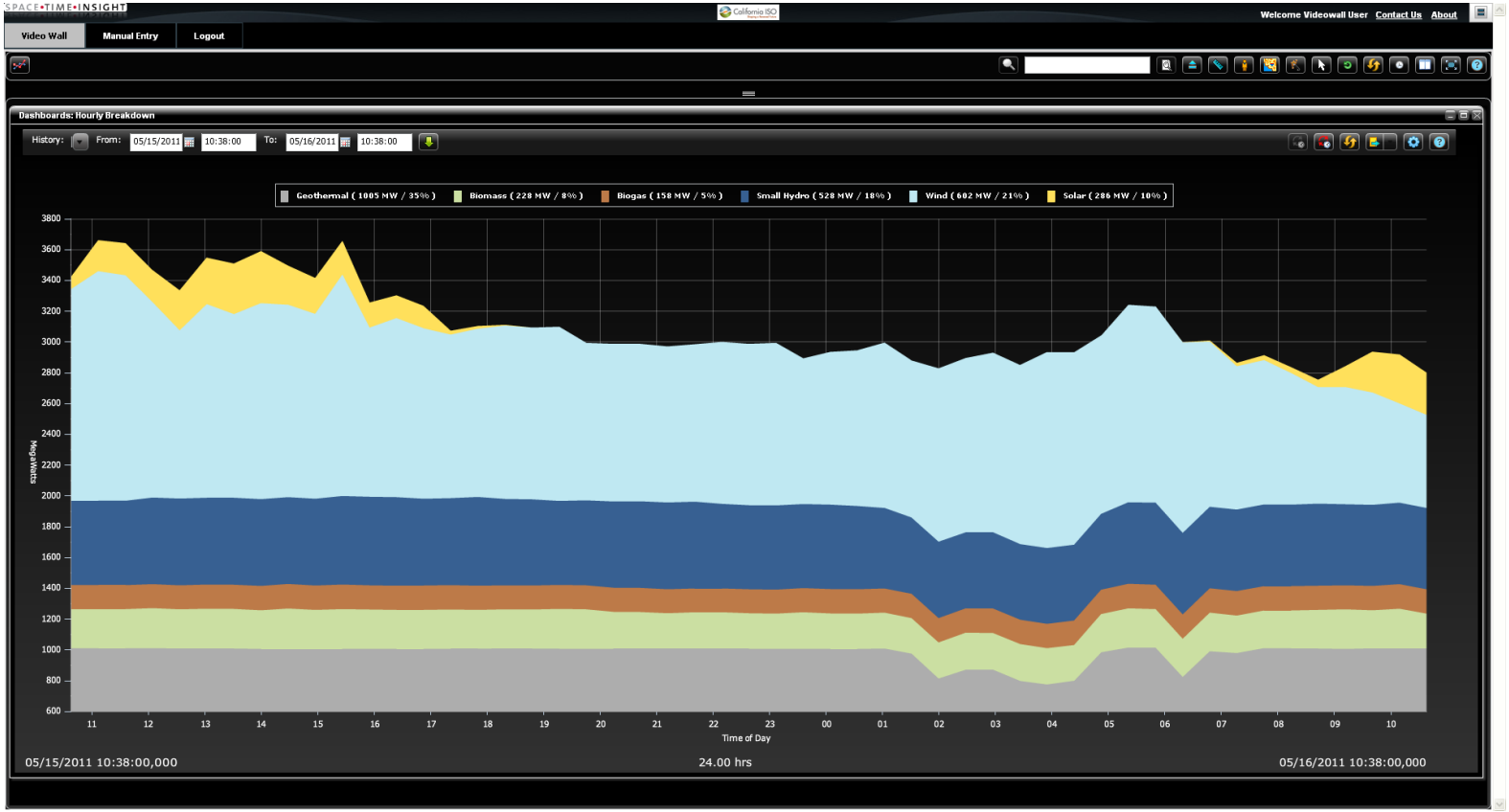
\\csifiapp612\netapps\pi\fcl1\pi\content\Operations\Hydro\CURRENT_HYDRO_CONDITIONS_cal_map.PDI



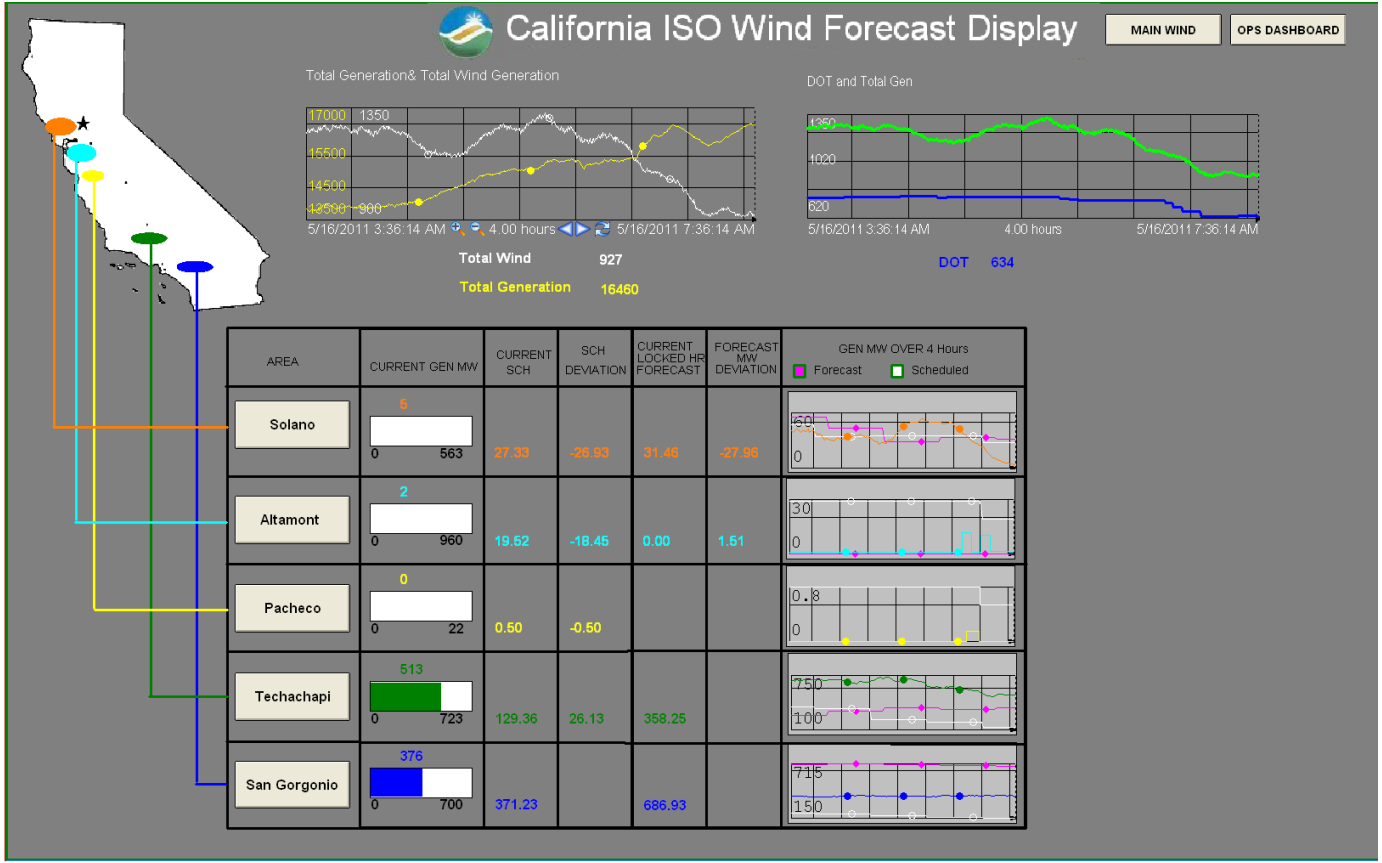
CAISO PI System Displays

Renewables

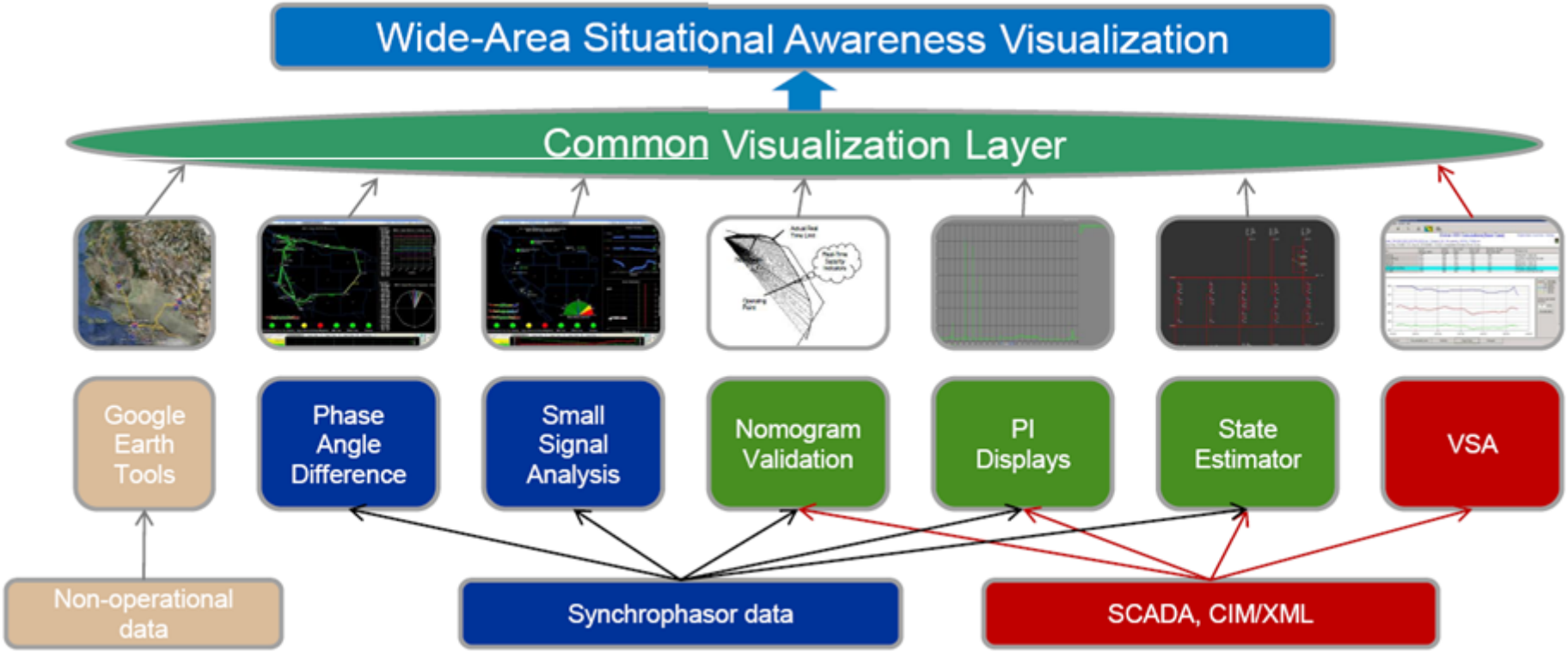
CAISO STI/PI System Display – 24 hr renewables portfolio using PI System data

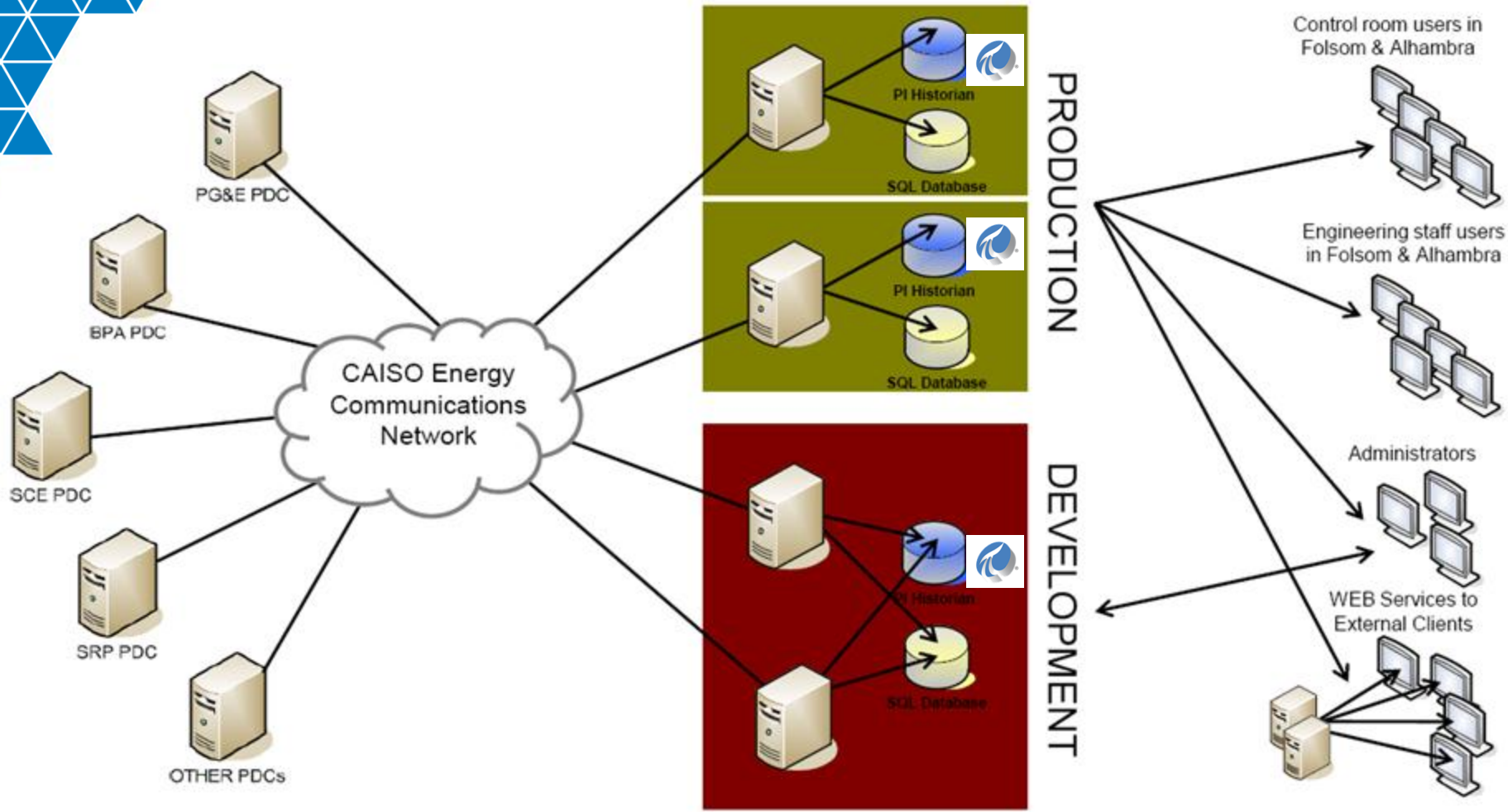


CAISO PI System Display – wind forecast and generation summary

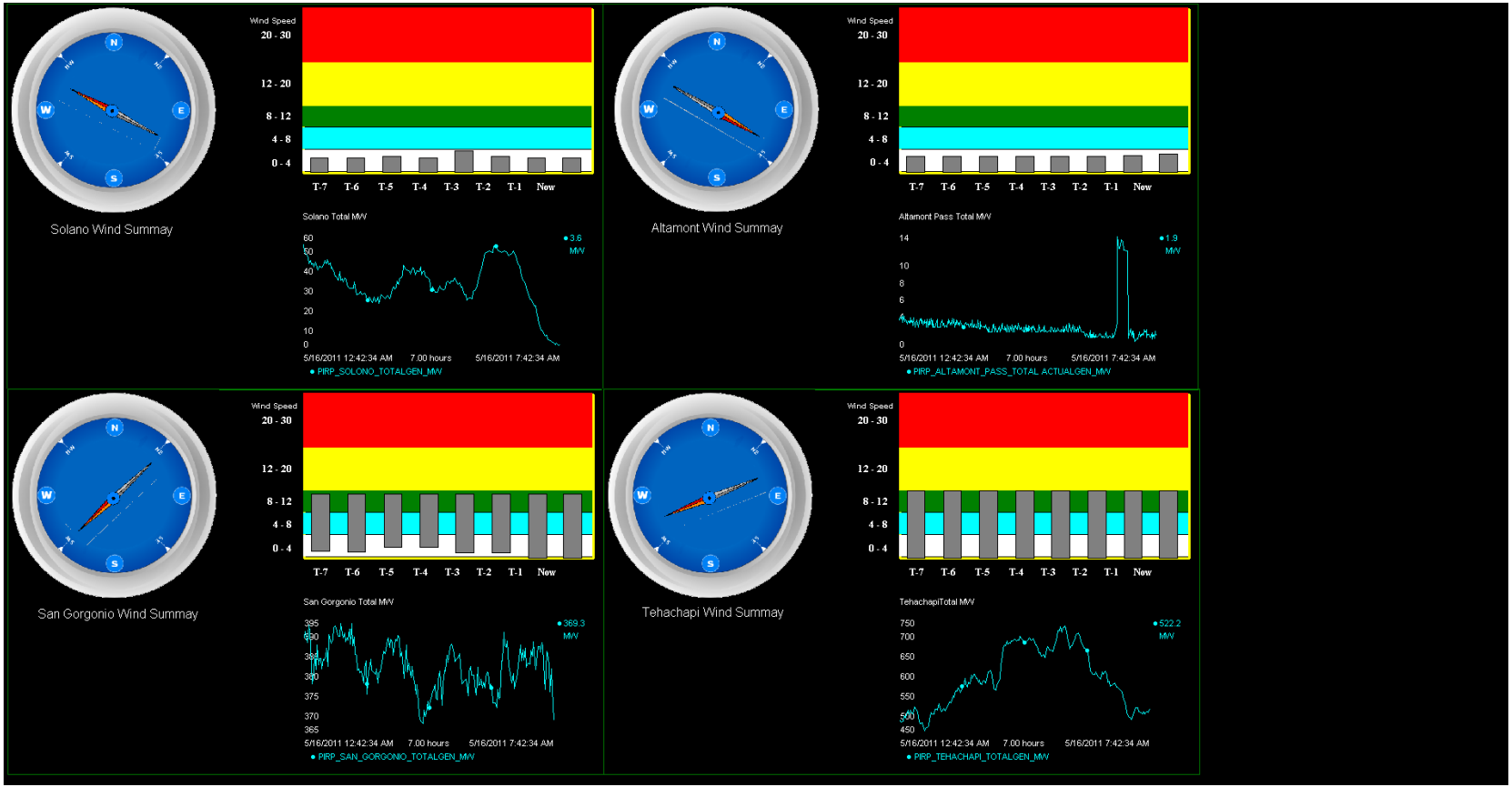


California ISO's goal is to have wide-area situational awareness through a common visualization layer that integrates the results of multiple applications

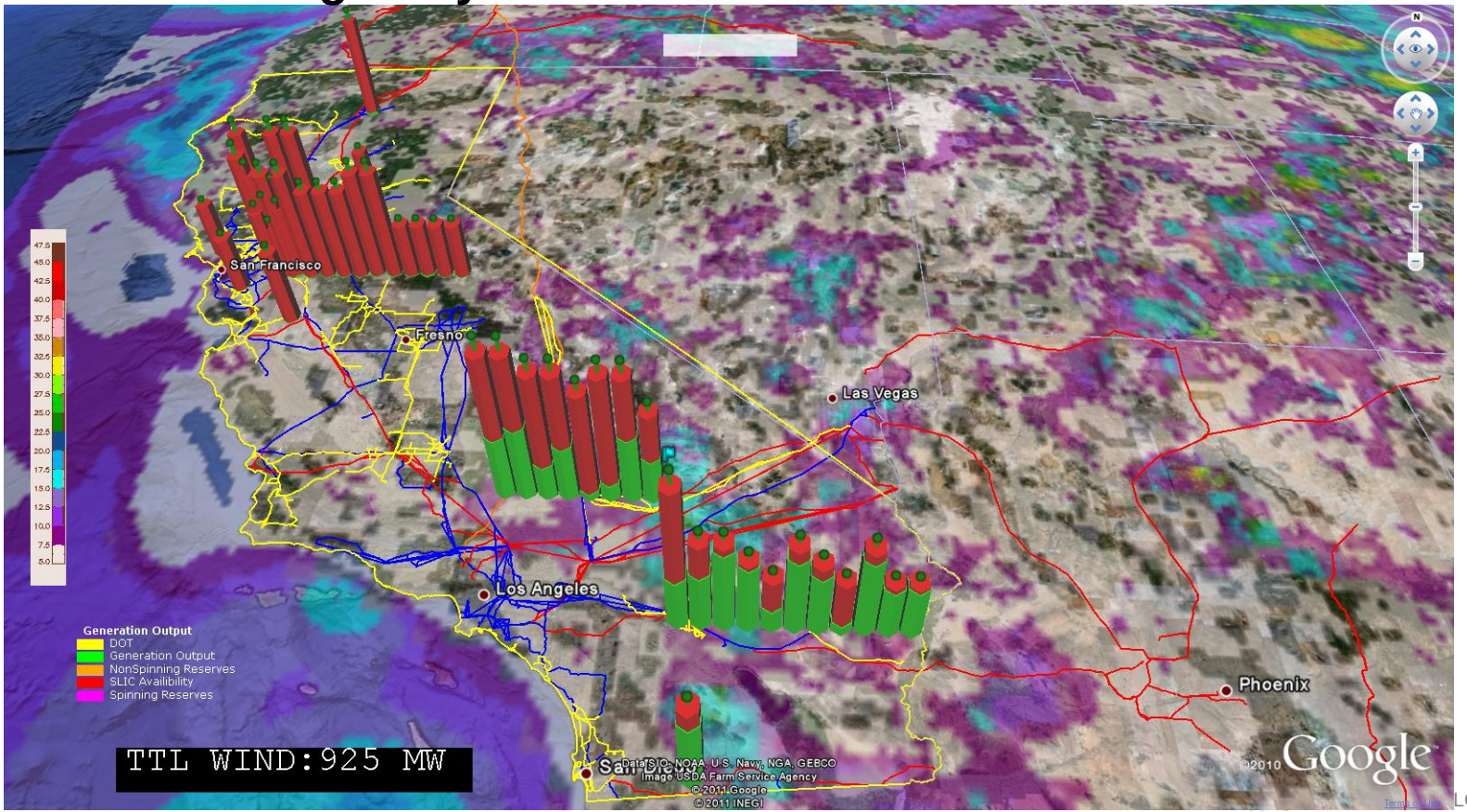




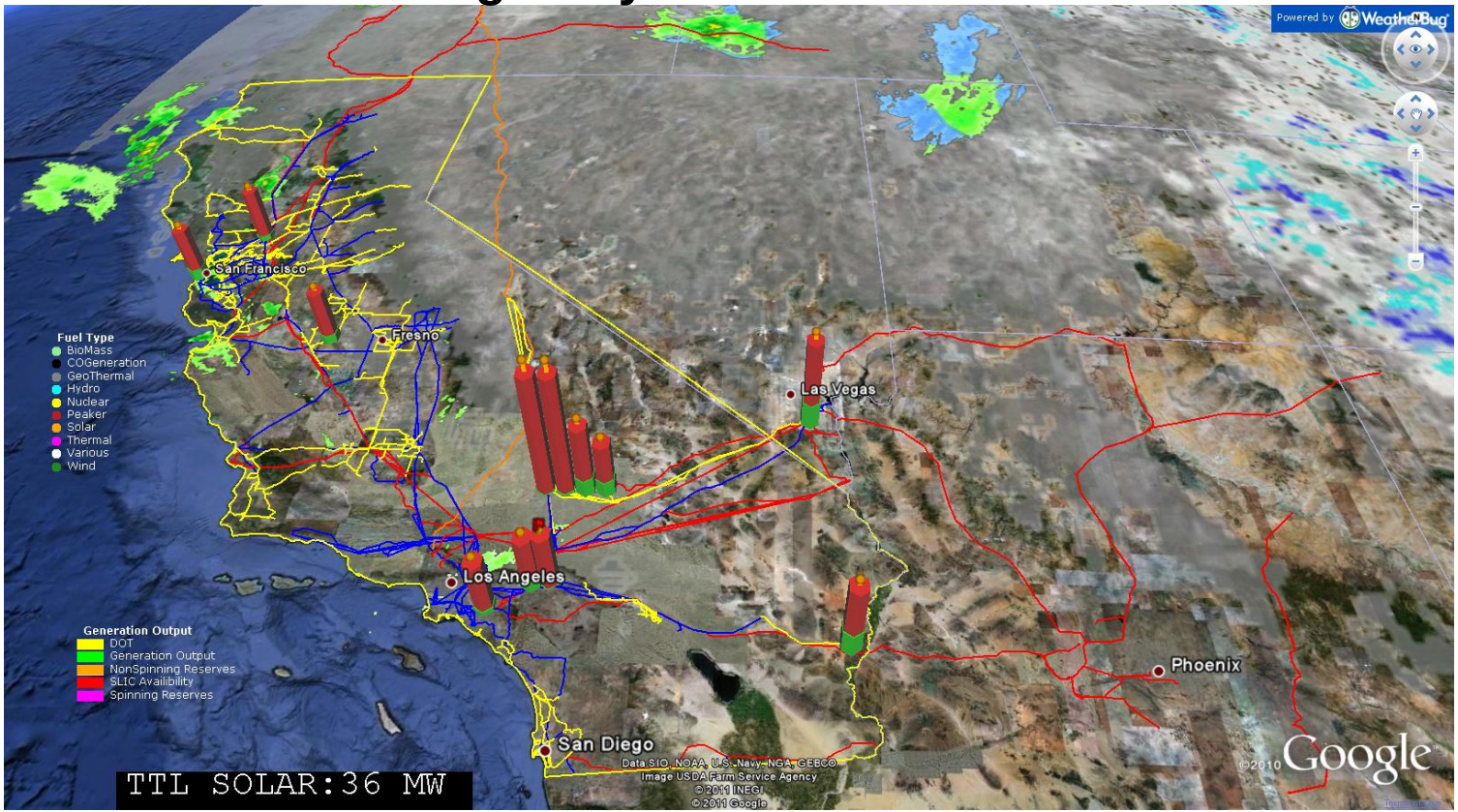
CAISO PI System Display – wind speed, directions and output summary



CAISO STI/PI System Display –wind speed contour and wind generation using PI System data



CAISO STI/PI System Display – solar generation summary with cloud cover using PI System Data



CAISO Current & Future PI System Projects

- Synchro-Phasor Integration
- Western Interconnection Synchrophasor Project
- 56 PMUs already sending data
- 100 PMUs estimated by December 2011
- 180 PMUs estimated by December 2012
- 250 – 300 PMUs estimated by December 2013

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Questions or Comments?

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Thank you