California ISO
Shaping a Renewed Future

Jim Blatchford
Smart Grid Solutions Manager
Feb 13,14 2013

VIEW OF THE ISO

Shaping the industry

The ISO, a nonprofit public benefit corporation, maintains the constant and reliable flow of electricity for the health, safety and welfare of consumers

How?

- **Delivering 309 million megawatt-hours of electricity annually**
- **Facilitating fair and transparent wholesale electricity market**
- **Performing comprehensive transmission planning**
- **Clearing the way for clean, green resources to access the grid**

California ISO by the numbers

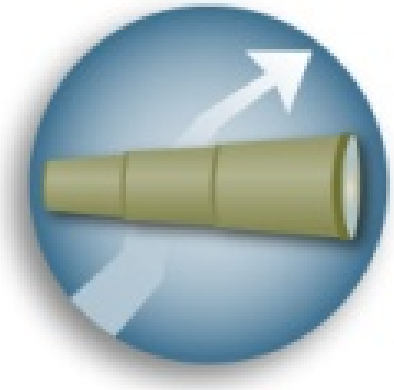
- **58,698** MW of power plant capacity
  - 5,806 MW of wind
  - 1,345 MW of solar
- **50,270** MW record peak demand (July 24, 2006)
- **26,500** market transactions/day
- **25,627** circuit-miles of transmission lines
- **30 million people** served
- **309 million** megawatt-hours of electricity delivered annually

The landscape of the electric grid is changing

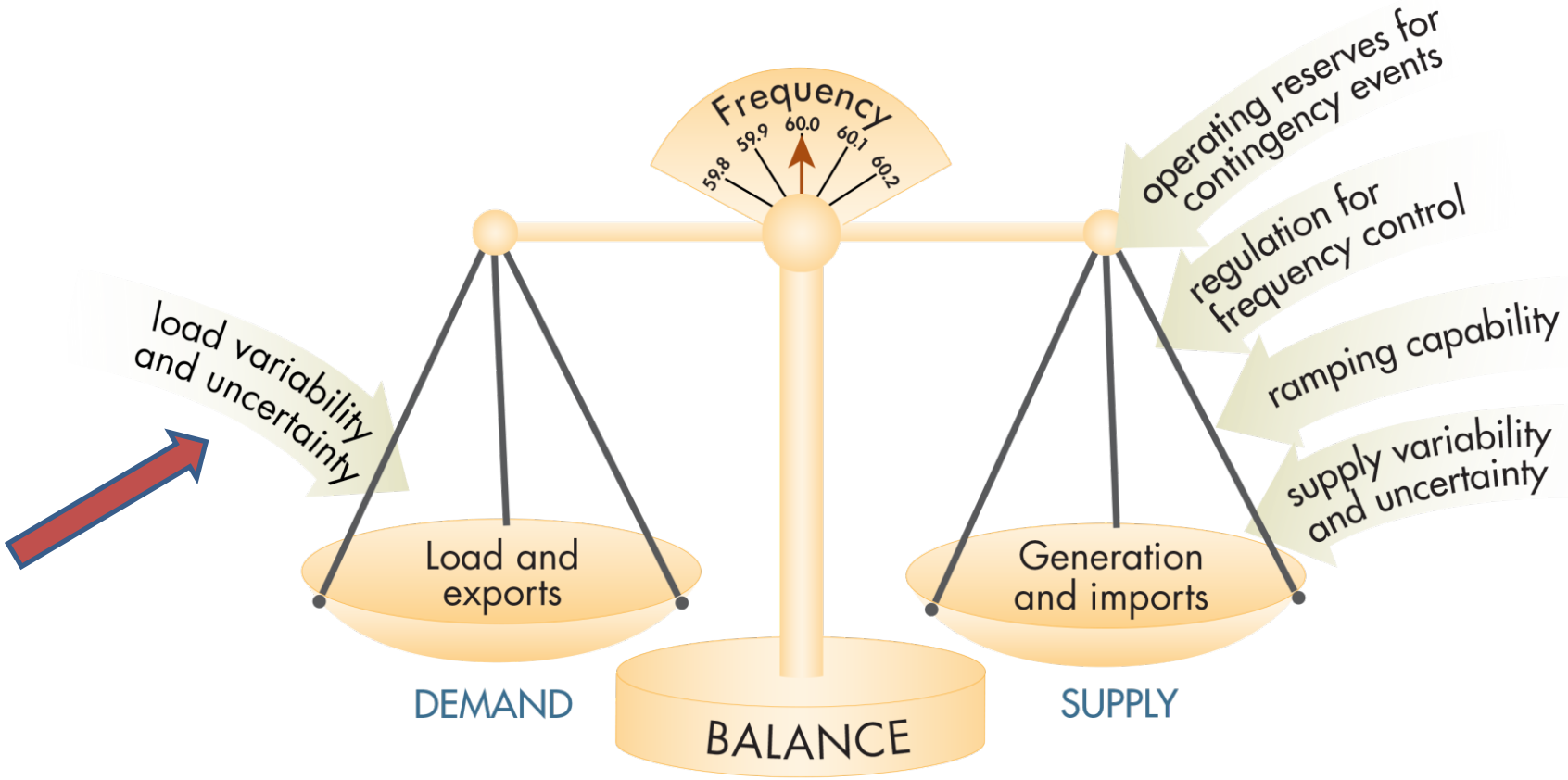
- Operational challenges
- From deterministic to stochastic planning and operations
- Changing fleet characteristics
- Role of distributed energy resources

Overarching challenges … over the next 10 years

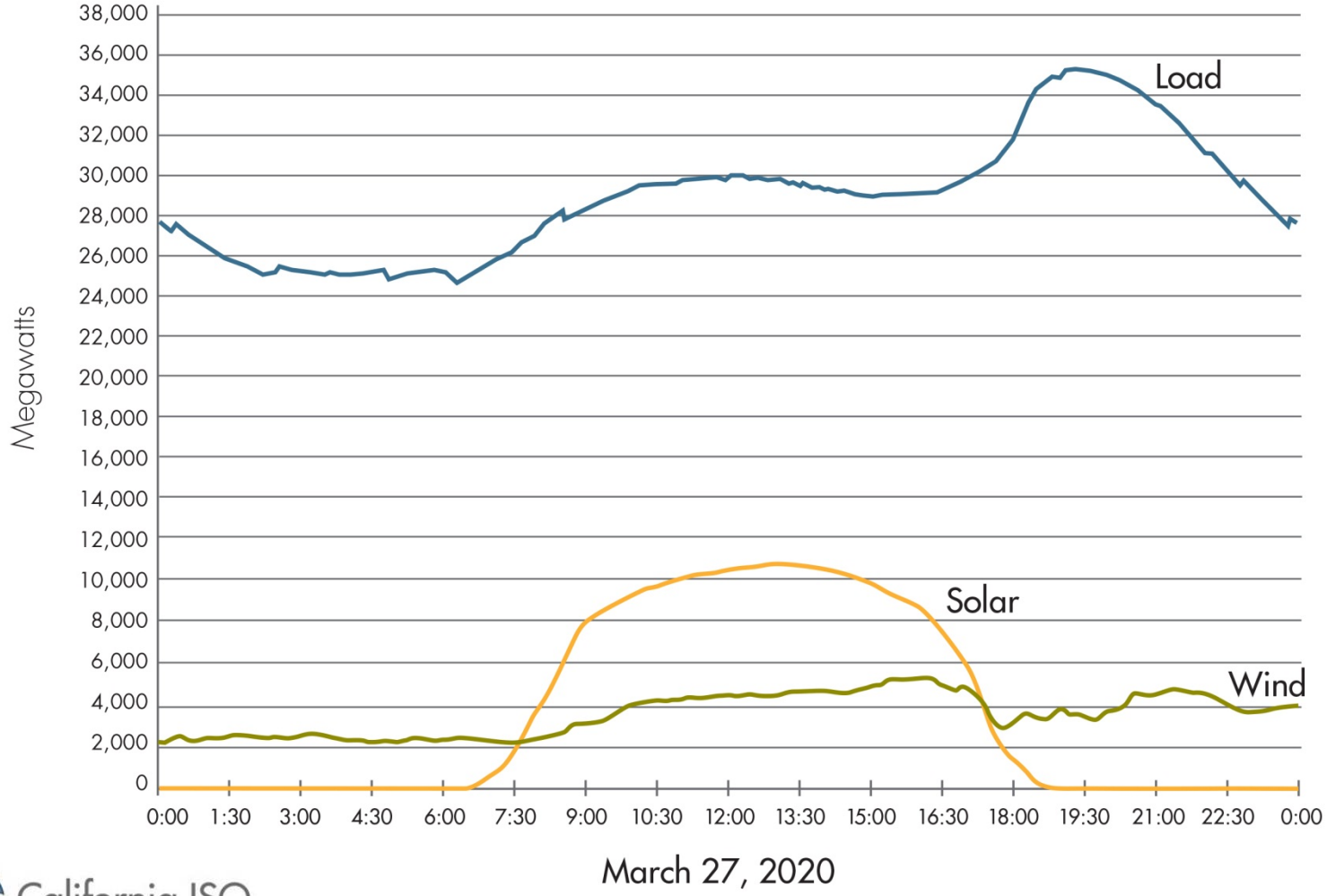
- Increased supply volatility - Over 20,000 MW of wind and solar capacity needed for CA 33% renewable energy goal
- Uncertainty surrounding thermal resources - About 12,000 MW of once through cooling resources will be repowered or retired
- Less predictable load patterns – rooftop solar, electric vehicles, and smart grid
- Changing revenue patterns - Decreasing marginal prices and changes in resource operational pattern



The ISO's keeps the balance of supply and demand.



Resources will be dispatched to the net load demand curve.



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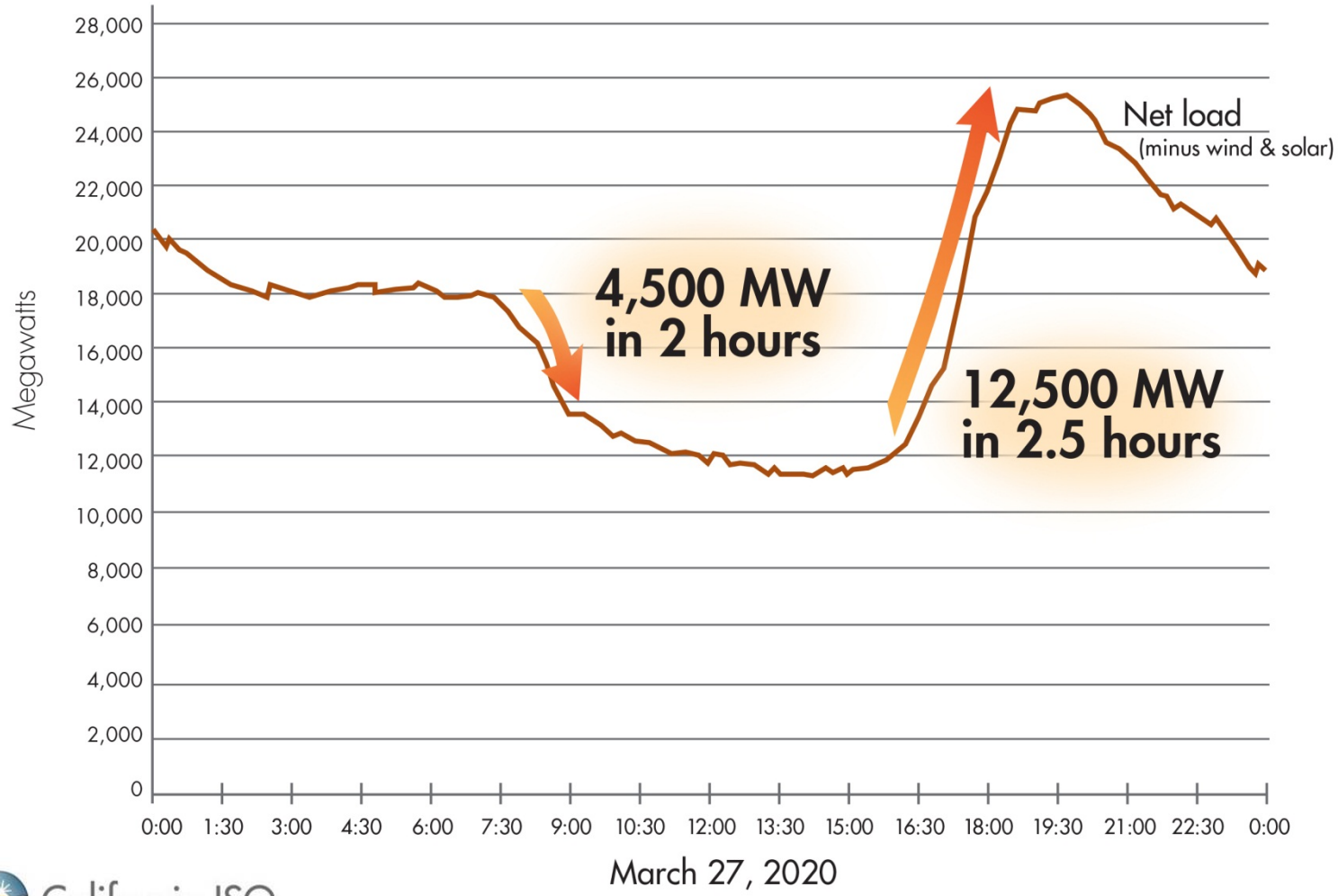
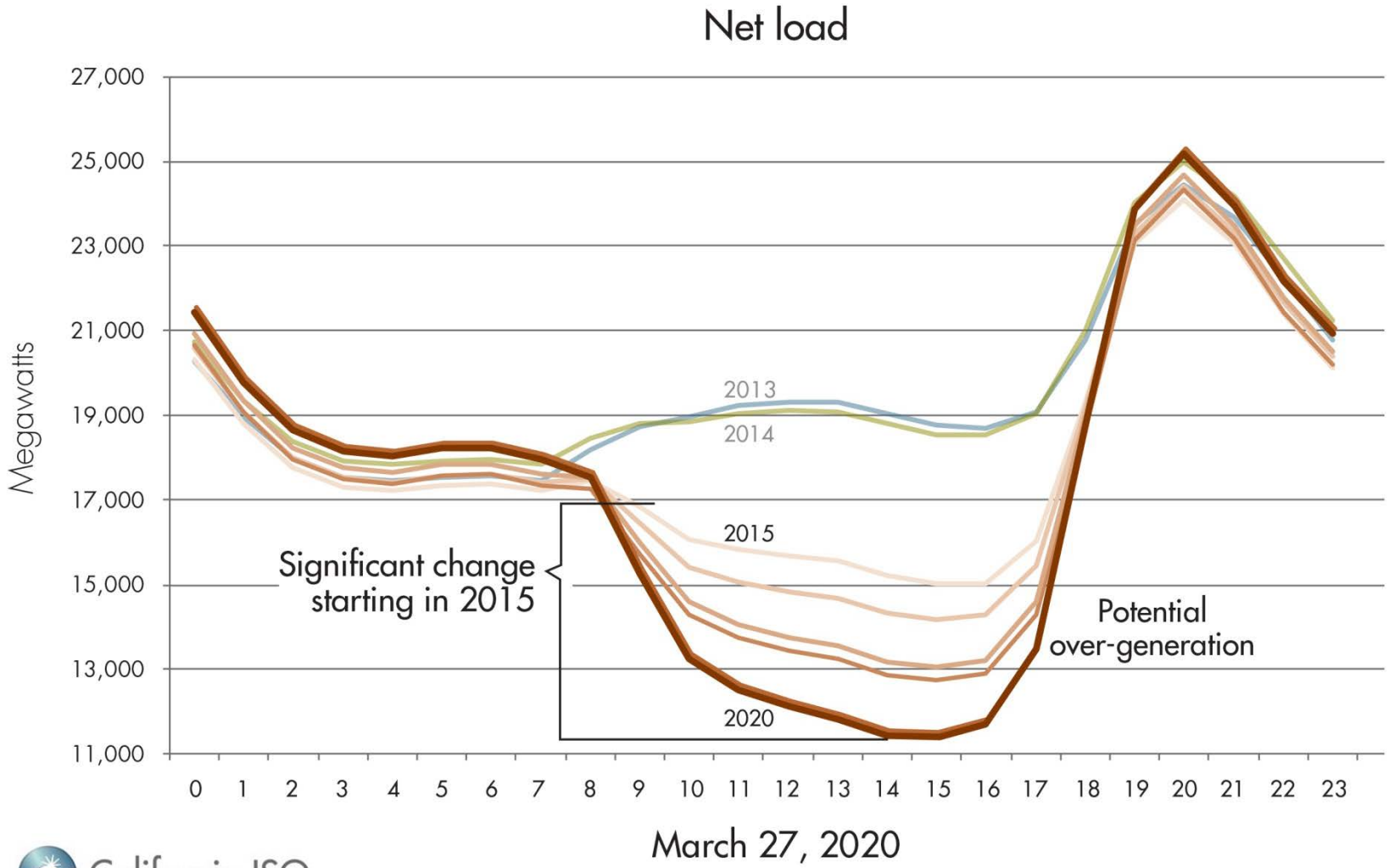


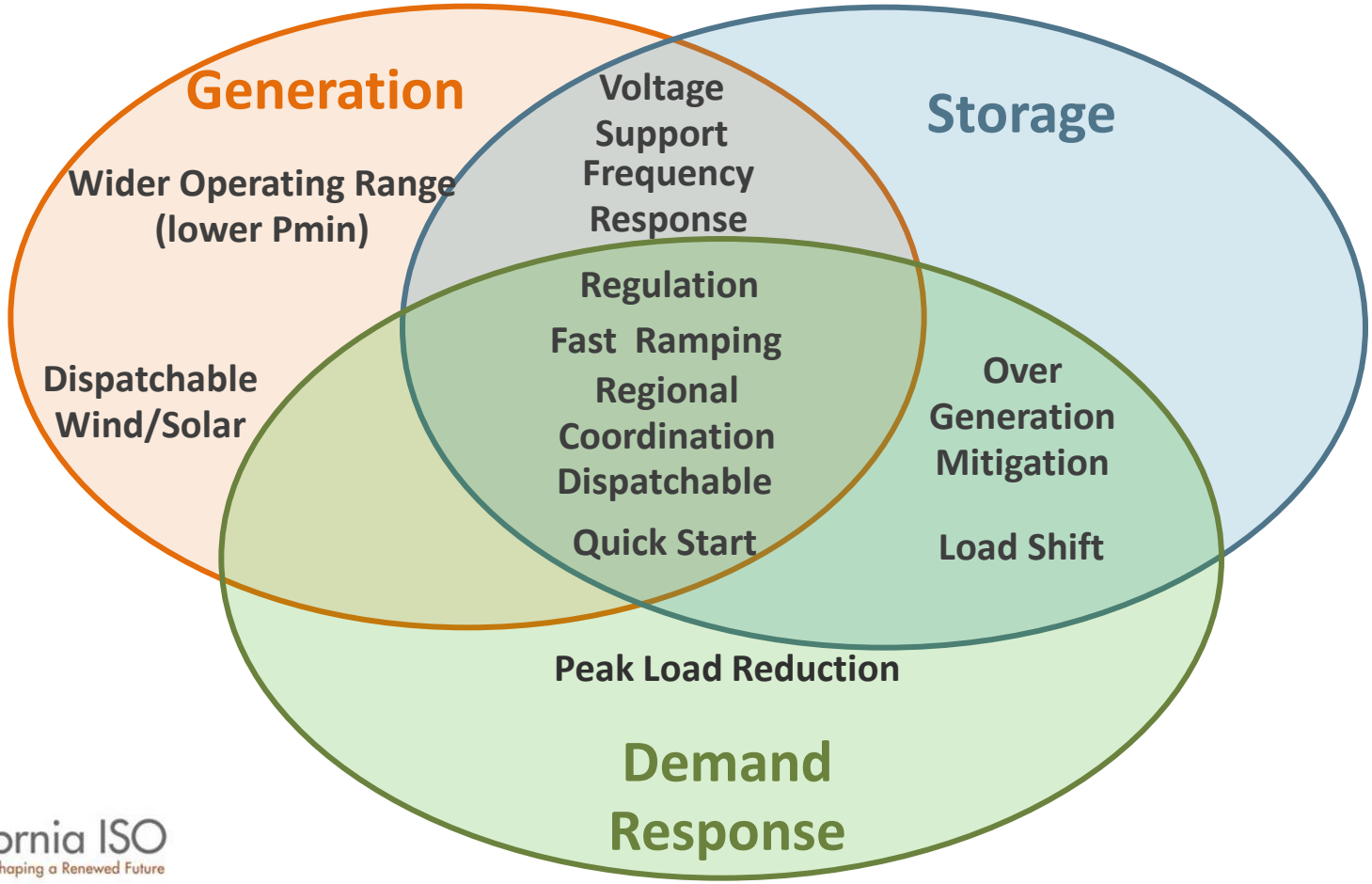
Net load pattern changes significantly starting in 2015



Operating to net load curve presents challenges and additional fleet requirements.

- Operations challenges
  - > Forecasting errors have larger impact on unit commitment
  - > Over-generation conditions in non-minimum load hours
  - > Power quality issues due to more frequent switching
  - > Voltage control
- Fleet needs to include additional flexibility
  - > Meet significant ramp requirements
  - > Frequent cycling (on/off)
  - > Response speed and duration
  - > Ability to recover after contingency (inertia, governor response)
  - > Low minimum load

Several resource types including distributed energy resources contribute to balancing the system.



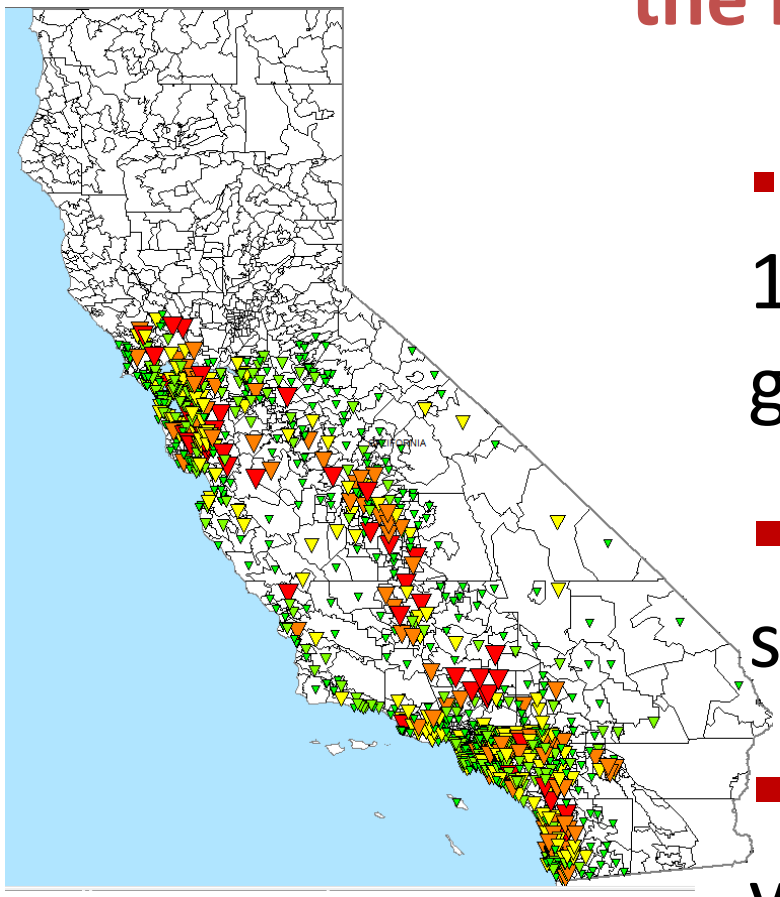
Challenges remain to understand impact of distributed energy resources and become reliable grid resource.

- Operational impacts
  - System load forecast
  - Coordination of Transmission / Distribution voltage control devices
  - Coordination during system restoration
- Grid resource characteristics
  - Visible and controllable
  - Available as a long-term resource
  - Automated response to disturbances

Draft- Operational and Planning Characteristics Needed from Distributed Energy Resources

		Programs	Activation Time	Activation Method	Duration (D_i)	Availability Trigger	Times/Month	Maximum Participation (MW)	Availability	Telemetry Requirement	Characteristic	Comments
1	Ancillary Services	**Frequency Response**	< 10 seconds	Auto (UFR)	Up to 15 minute	Post-Contingency	At least 5 times/year	150	Annual	4-seconds	Trips at 59.8 Hz? Trip frequency level to be determined bt Planning studies. Must respond within 10 seconds	ERCOT currently trips up to 1,400 MW of load at 59.7 Hz
2	Ancillary Services	**Spinning Reserve**	The resource must reach 10 percent of its awarded spinning capacity within 8 seconds, if frequency is less than or equal to 59.92 Hz Full deployment within 10 min	Auto	Day-ahead: Up to ≤ 60 minutes. Real-time: Up to ≤ 30 minutes	Post-Contingency -- for loss of a resource greater than 500 MW?	At least 10 times/year	250	As Bid	1-minute	Within the first 10 seconds, power output changes in one second for any frequency deviation less than or equal to 59.92 Hz	ISO Tariff Appendix K. Need to check how frequent contingency reserves are dispatched in the most recent calendar year. (Need is 25% of obligation)
3	Ancillary Services	**Non-Spinning Reserve**	Full deployment within 10 min	Manual or Auto	Day-ahead: Up to ≤ 60 minutes. Real-time: Up to ≤ 30 minutes	Post-Contingency -- for loss of a resource greater than 500 MW?	Less than 10 times/year	250	As Bid	1-minute	Load needs to be on-line and consuming energy	Dispatch following a Contingency. (Need is 25% of obligation)
4	Ancillary Services	**Regulation Up/Down**	Real-time	AGC	Day-ahead: Up to ≤ 60 minutes. Real-time: Up to ≤ 30 minutes	When needed	Continuous	200	As bid	4-seconds; WECC Requirement	The resource must respond immediately, without manual operator intervention	Participation through smart-grid technology. ((Need is 25% of obligation)
5	Flexibility	**Flexible Ramping Capacity**	Day-Ahead	Auto	Up to 3 hour; Must be off during the scheduled hours	Consistent with Flexi-ramp dispatch		750	Annual	1-minute	Similar characteristics to resources participating in flexi-ramp	25% of hourly load-following requirement
6	Local Requirement	**LCR (pre-contingency)**	Day-ahead	Manual or Auto	Up to 8 hour; Must be off during the scheduled hours	Pre-Contingency; e.g. when flows are within 90% of a limit	At least 20 times/year	Eligible curtailment amount determined by Planning studies	Annual	1-minute	Load needs to be located and uniquely dispatchble within an LCR area; Load must be available all year	Will be called pre-contingency. e.g.: based on day ahead market
7	Local Requirement	**LCR (post-contingency)**	< 10-minutes	Auto	Up to 8 hour	Post-Contingency	Approximately 5 times/year	Eligible curtailment amount determined by Planning studies	Annual	1-minute	Load needs to be located and uniquely dispatchble within an LCR area; Load must be available all year	Will be called post-contingency. e.g.: (1) G-1 (2) N-1
8	System Needs	**Peak Demand Reduction**	Day-ahead	Manual or Auto	Up to 6 hour; Must be off during the scheduled hours	Available for dispatch when DA forecast > 45,000 MW ??	At least 10 times/year	10% of Peak Load	Summer	5-minutes	This is different to load shifting. The intent here is to reduce the peak load demand	Need to check # of times load exceeded the threshold in the previous year. Maybe more useful during the summer; Could also help during non-summer months when resources are on maintenance
9	System Needs	**Load Shifting**	Day-Ahead	Manual or Auto	Up to 4 hour; Must be off during the scheduled hours	Minimum net-load < 12,000 MW	As needed	10% of Peak Load	Non-summer months	5-minutes	The intent is to shift net-load peak demand to non-peak hours	Incent pump loads etc. to operate during hours the ISO anticipated net-load to be less than non-diospatchable generation
10	System Needs	**Emergency DR-Short Notification**	< 10-minutes	Auto	Up to 4 hour	Post-Contingency; Must be in Restricted Maintenance/Warning Notice/Transmission Emergency	At least 5 times/year	2% of Peak Load	Annual	1-minute	Mitigate Path/SOL violations	Will be called post-contingency for Path/SOL violations
11	System Needs	**Emergency DR-Long Notification**	Day-ahead	Manual or Auto	Up to 4 hour; Must be off during the scheduled hours	Restricted Maintenance or Alert Notice Issued/Transmission Emergency	At least 5 times/year	2% of Peak Load	Annual	5-minutes	Potential challenges identified in DA	Will be called post-contingency for Path/SOL violations
12	System Needs	**Over-generation**	< 30-minutes	Manual or Auto	Up to 2 hour	Alternative to curtailing renewable generation	As needed	2,000	Annual	5 minutes	Go from off-line to on-line when prices go negative; bid for consumption or charge device	Respond to negative prices; Incentive to use distribution load aggregation (Smart-Grid)

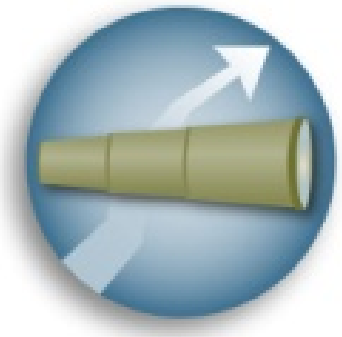
Distributed generation adds to the changes in the load profiles.



- Gov. Brown initiative to install 12,000 MWs distributed generation
- Over 1400 MWs of roof top solar installed to date.
- Limited ISO production visibility

In 2010 and 2011, the ISO collected solar PV penetration data to gain greater visibility.

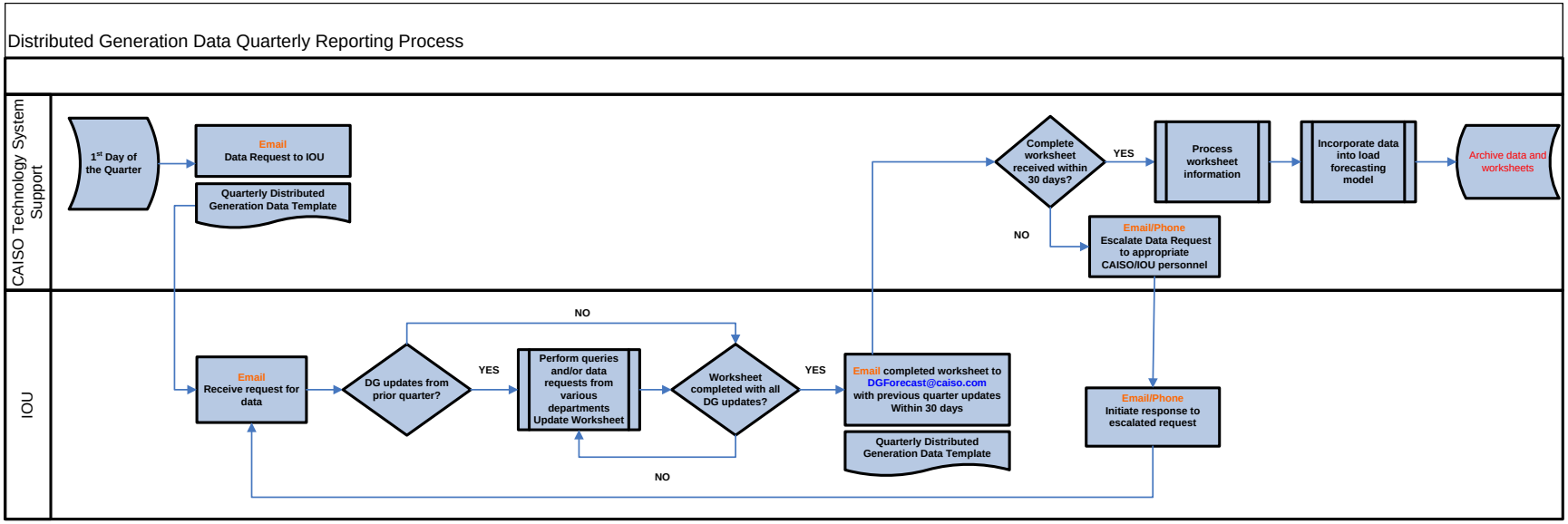
- Goal: Ability to account for distributed energy resources in forecasting to support market and system operations
- We **<u>thought</u>**t we needed to know actual installations and actual energy production
- Data was collected from publically available sources including utility interconnection queues, the California Solar Initiative (CSI) database, and verification with IOUs



ISO data needs to support inclusion of distributed energy resources in forecasting.

- Solar installation data
  - > Total generating capacity (CEC-AC for solar systems - nameplate values for all other technologies)
  - > Tracking style (single or multi-directional) or fixed units
  - > Aggregated by zip code / distribution substation / ISO sublap
  - > Quarterly updates
- Aggregated hourly actual production data available within a month after actual production to train forecasting model
  - > When available for DERs

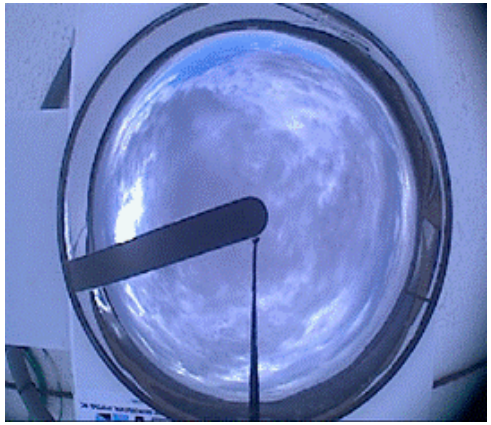
The ISO established a process with the IOUs to receive the solar installation data



Hourly production data was not available

Going forward solar forecasting efforts.

- Internal ISO Efforts
  - Including IOU information
  - Tuning Model
- Clean Power Research efforts
  - Tom Hoff
- UCSD Research
  - Prof. Carlos Coimbra
  - Prof. Jan Kleissl



Project Sponsors and Partners

CPUC

CSI Solar RD&D Program
www.calsolarresearch.ca.gov

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Itron CSI RD&D Program Manager

SunShot U.S. Department of Energy

THANK YOU

JIM BLATCHFORD
SMART GRID SOLUTIONS MANAGER
JBLATCHFORD@CASIO.COM
(916)351-2411

Q &A AND DISCUSSION