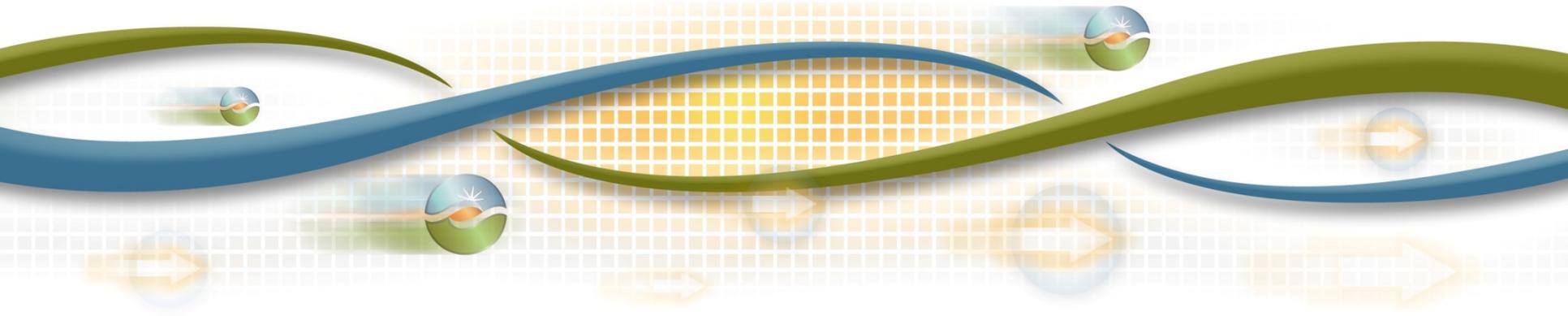


# Meeting the Challenge of Integrating High Levels of Renewable Energy

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Shucheng Liu, Ph.D.  
Principal, Market Development

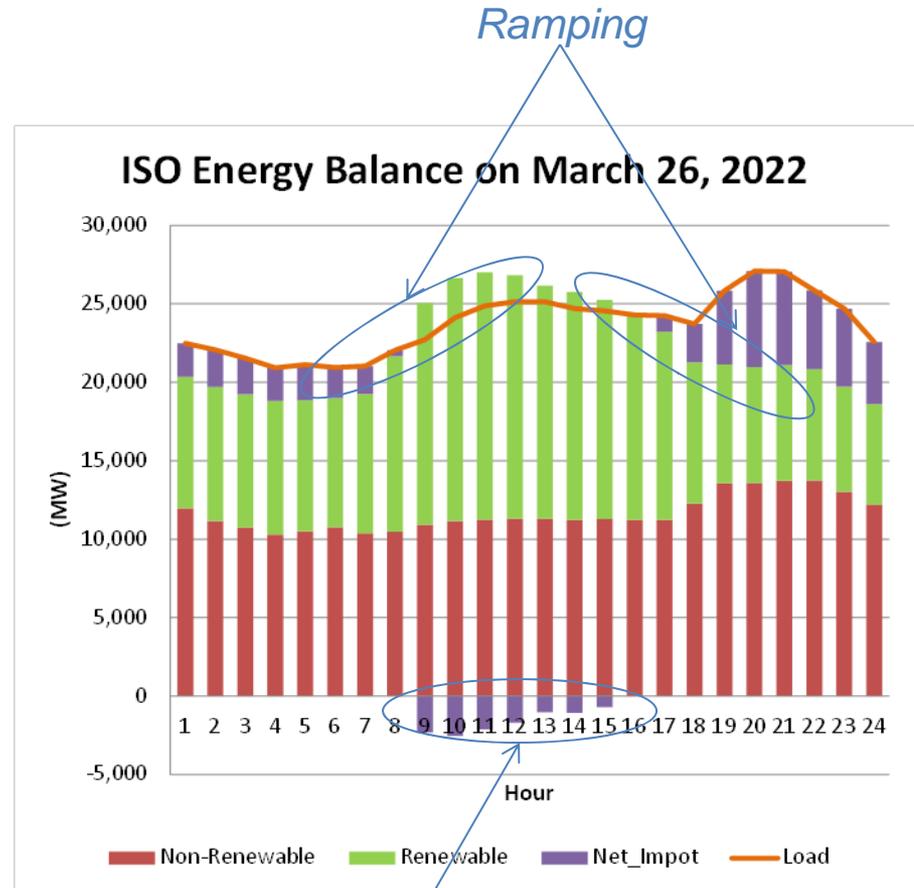


# California is on track to meet 33% Renewable Portfolio Standard by 2020.

- The ISO and CPUC are developing the tools needed to maintain reliability
  - Flexible Resource Adequacy (RA) requirement
  - Multi-year forward procurement of RA resources
  - Long Term Procurement Plan (LTPP) proceeding
  - Flexibility upward/downward constraint products

# Sufficient flexible capability is the key for renewable integration.

- Flexible capability provides
  - Energy ramp
  - Intra-hour load following
  - Operating reserves
  - Frequency and voltage support
  - Ability to absorb or store over-generation



*Over-generation, export or curtailment*

# Diversification of renewable resource technologies and locations helps smooth integration.

ISO Renewable Energy Mix at 33% RPS (GWh)

	Biomass	Geothermal	Small Hydro	Large Solar PV	Small Solar PV	Solar Thermal	Wind	Sum
PG&E_BAY	117	418	0	0	256	0	1,065	1,857
PG&E_VLY	4,561	11,053	3,699	3,432	2,088	0	3,959	28,793
SCE	2,321	2,966	1,576	5,960	1,656	4,812	7,580	26,871
SDGE	127	0	0	1,763	314	0	912	3,116
OUT-STATE	1,603	3,087	40	2,649	0	0	10,925	18,303
Sum	8,729	17,524	5,315	13,804	4,313	4,812	24,442	78,940

- Wind vs. solar
- Solar PV vs. solar thermal with storage
- In-state vs. out-state resources

\* The table shows the renewable portfolio of 2012 LTPP Track 2 study Base scenario.

The right mix of resources will be effective in renewable integration.

- Flexible resources with fast start-up and ramp capabilities
- Demand response
- Storage
- Dispatchable renewable generation

# Increased regional coordination provides benefits in renewable integration.

- Expanding capabilities of:
  - Reserve sharing
  - Dynamic scheduling
  - Energy Imbalance Market
- Providing benefits of:
  - Additional flexibility to support operation
  - Efficient use of reserves
  - Over-generation mitigation
  - Lower energy costs



California ISO  
Shaping a Renewed Future

# Thank you!

Shucheng Liu, Ph.D.

California ISO

[sliu@caiso.com](mailto:sliu@caiso.com)

