



# Renewable Integration – California ISO Perspective

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# California Key Environmental Policies

- 20% Renewable Portfolio Standard (RPS) by 2010
- 33% RPS by 2020 (Governor Executive Order)
- State law AB32 – Reduction of greenhouse gas emissions to 1990 levels by 2020
- Repowering or replacement of once-through cooling power plants (~38% of in-state gas and nuclear capacity)

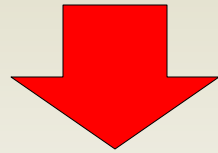
Wind and solar resources will comprise the bulk of California's renewable resource portfolio.

Year	Plant Capacity in Megawatts			
	2009 (Existing)	2012 Forecast	2020 low	2020 high
<b>PV</b>	400	830	3,234	3,234
<b>Concentrated Solar</b>	400	996	7,297	10,000
<b>Wind</b>	3,000	5,917	10,972	13,000
<b>Geothermal</b>	900	1,039	2,400	2,400
<b>Small Hydro</b>	844	844	844	844
<b>BioMass/BioGas</b>	900	950	1000	1000
<b>Total</b>	<b>6,444</b>	<b>10,576</b>	<b>25,747</b>	<b>30,478</b>

# Cost-effective transmission planning for renewable resources requires a comprehensive approach

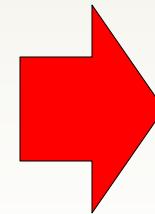
- Regional Coordination

- WECC Transmission Expansion Policy Planning Committee
- California Transmission Planning Group (CTPG)



- Comprehensive planning for the CAISO Balancing Area

- Interconnection projects
- “Right-sized” generation ties
- Reliability upgrades
- Economic upgrades
- Policy driven projects (e.g., 33% RPS goal)
- Unconditional & conditional needs determination



Single  
Unified Plan

# Renewable integration will have significant operational impacts.

- Increased ramps in morning and evening
- Increased load following requirements
- Increased requirements for Regulation Up and Regulation Down and Regulation Costs
- Potential increase in operating reserves and need for supplemental reserves
- Increased frequency of over-generation
- Increased stresses on generation fleet from ramping, cycling

# ISO actively pursuing operational and market enhancements to support renewable integration.

## ■ Operational Enhancements

- Wind & solar forecasting tools (output, ramping requirements)
- More sophisticated grid monitoring systems
- Over-generation mitigation procedures
- Coordination with neighboring balancing areas
- Generation interconnection standards
- Pilot projects (storage, synchrophasors, demand response)

## ■ Market Enhancements

- New market products & changes to market rules
- Increased regulation and reserve requirements
- More sophisticated day-ahead unit commitment algorithms

# Requirements for Integration of Renewables

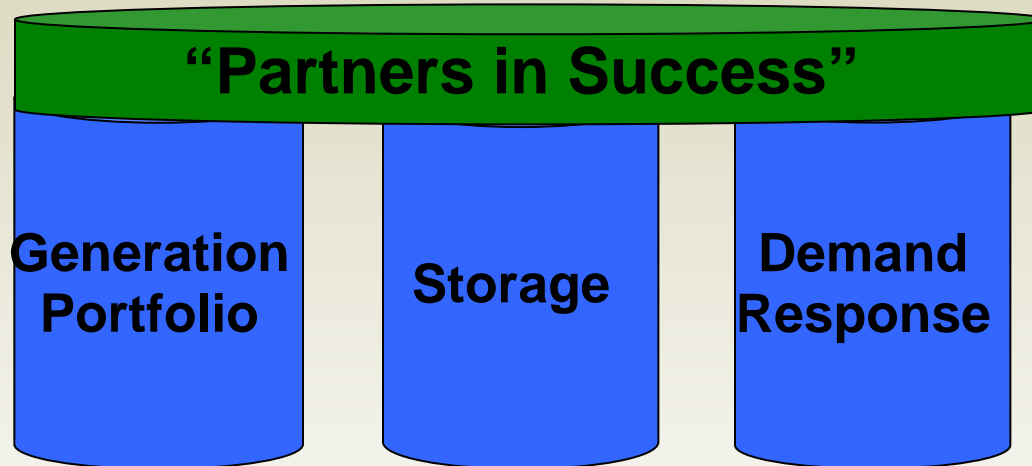
## Resources Required for Renewables Integration



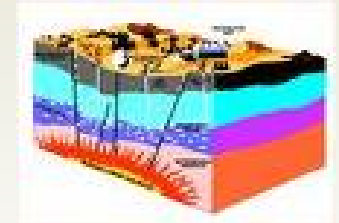
Wind Generation



Solar Generation



Hydro Generation



Geo-thermal  
Generation

Quick Start Units  
Fast Ramping  
Wider Operating  
Range (lower  $P_{min}$ )  
Regulation capability

Shift Energy from  
off-peak to on-peak  
Mitigate Over  
Generation  
Voltage Support  
Regulation capability

Price sensitive load  
Responsive to ISO  
dispatches  
Frequency Responsive  
Responsive to Wind  
Generation Production