



Resource Adequacy in the Era of RPS and Carbon Concerns: Reliability Considerations and the Specter of Scarcity Prices?

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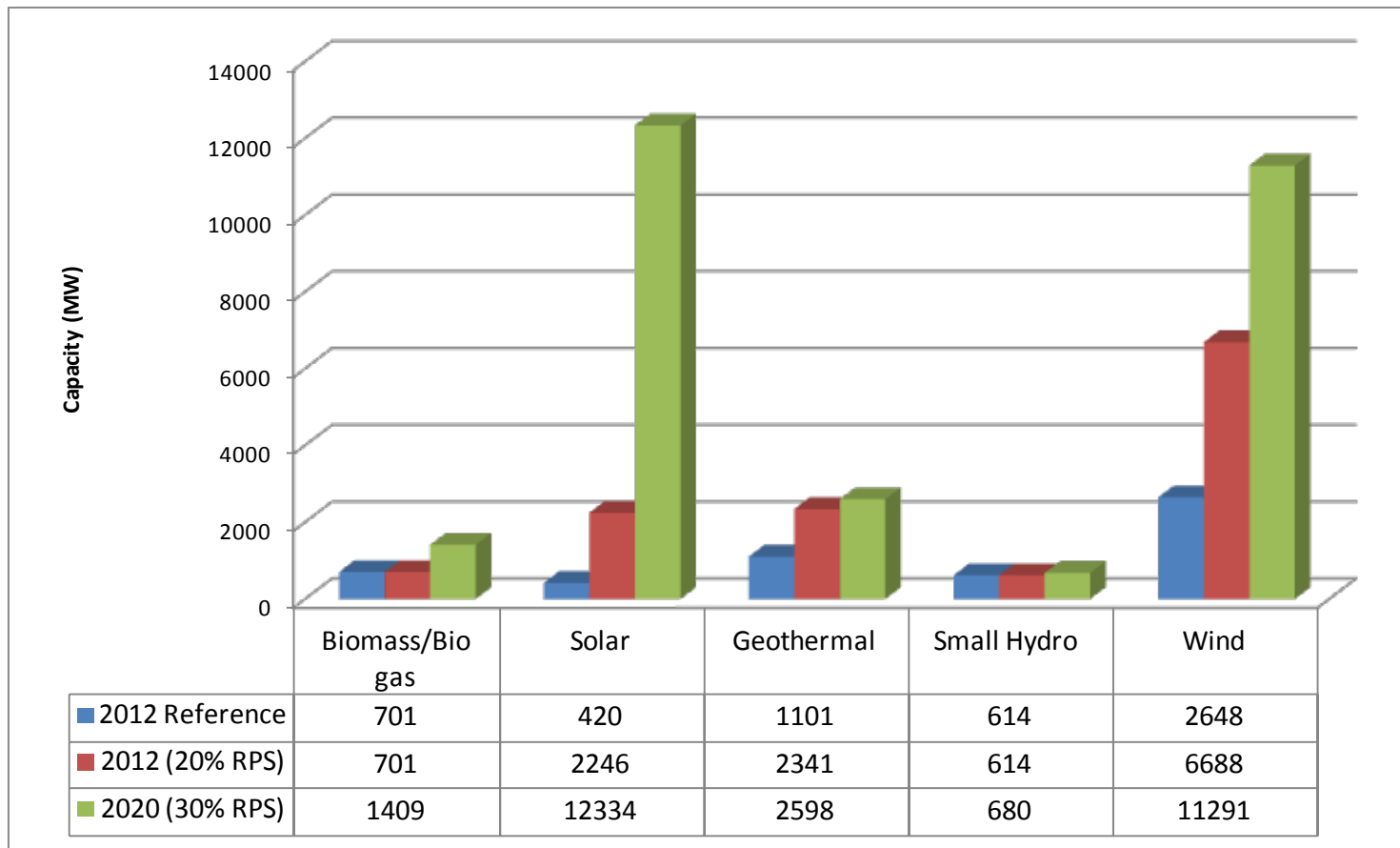
Tucson, Arizona

December 9, 2010

Major state and federal policy drivers

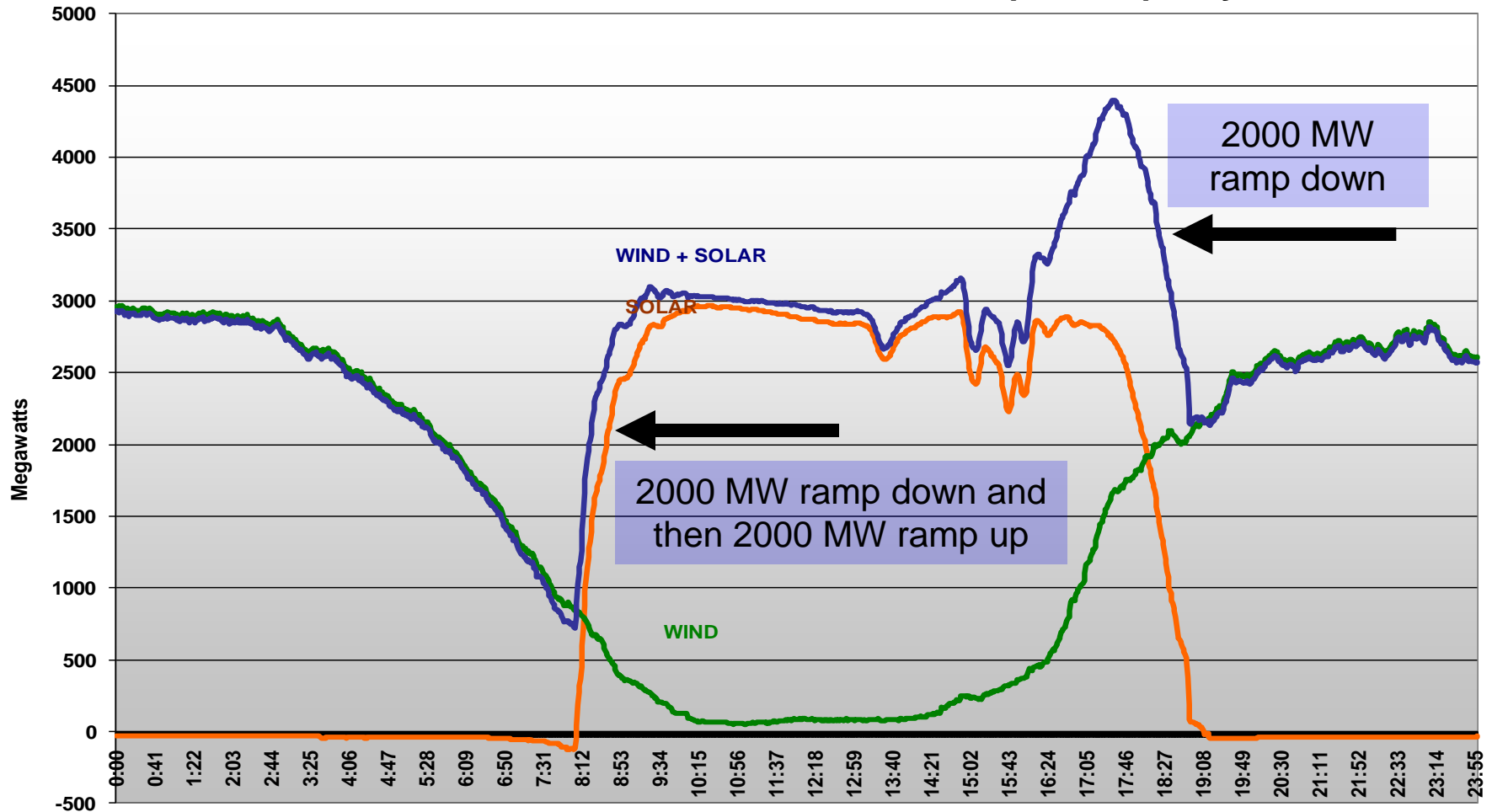
- State law AB32 –Reduction of greenhouse gas emissions to 1990 levels by 2020
- 20% Renewable Portfolio Standard (RPS) by 2012-13; 33% RPS by 2020 (Executive Order)
- Other supply side policies that could affect renewable integration
 - Repowering or replacement of once-through cooling power plants (~38% of in-state gas and nuclear capacity)
- FERC notice of proposed rulemaking on variable energy resources

Development of renewable resource portfolios in 2006, 2012 (reference) (20% RPS), 2020 (33% RPS)

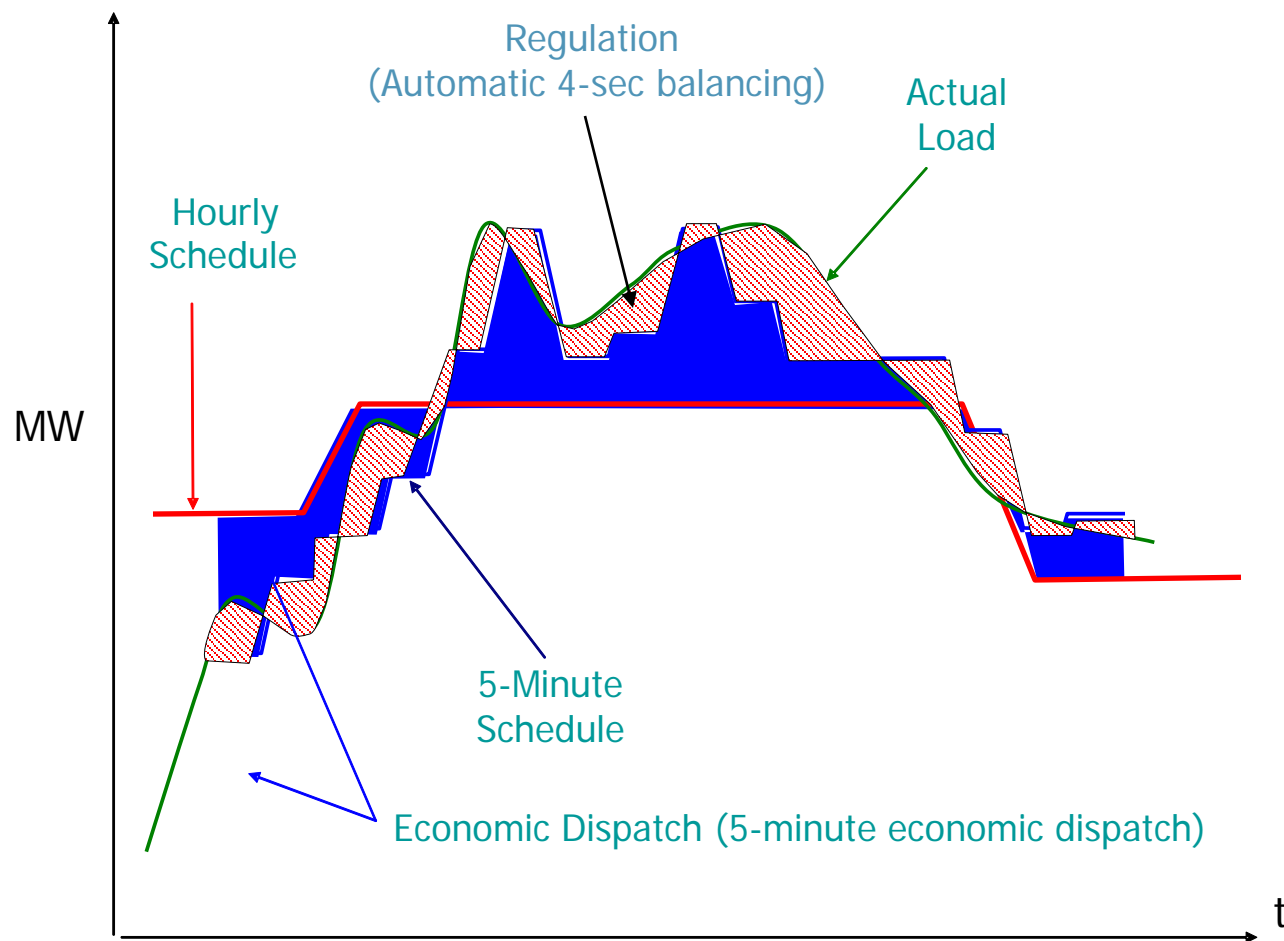


Interaction of wind and solar on ramping requirements

4000 MW SOLAR and 6000 MW WIND Nameplate Capacity



The different components to balancing supply and demand



ISO study of renewable integration at 20% RPS provides in-depth analysis of operational requirements

-  Diversity of wind and solar resources changes flexibility needs
-  More Regulation Up and Down will be needed
-  The ISO has sufficient regulation capability to meet 20% RPS
-  Load-following requirements will also increase in some hours
-  Enhanced management of flexible capability is needed
-  Over-generation conditions may be exacerbated
-  Some resources will need to start and/or ramp more frequently
-  Revenue from energy market could decline
-  Self-scheduling will be barrier for managing operational flexibility

<http://www.caiso.com/2804/2804d036401f0.pdf>

20% RPS

INTEGRATION OF RENEWABLE RESOURCES

Operational Requirements
and Generation Fleet
Capability at **20% RPS**

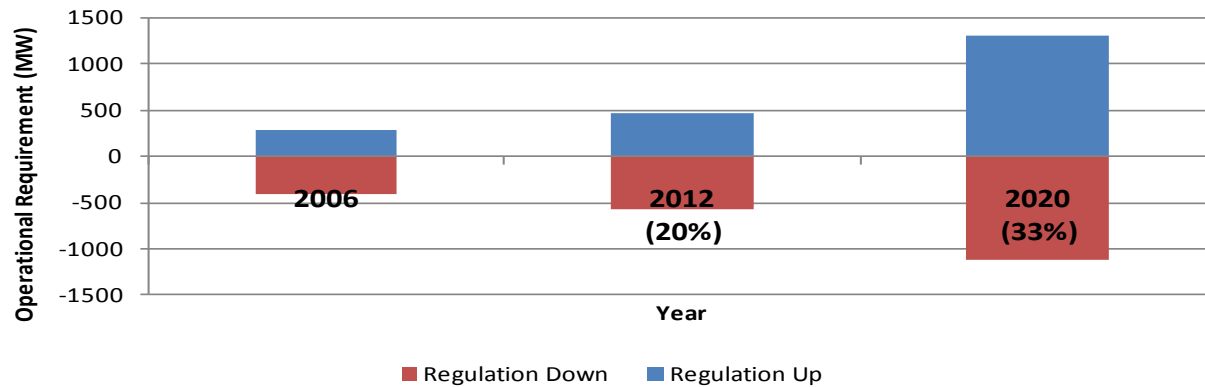
August 31, 2010



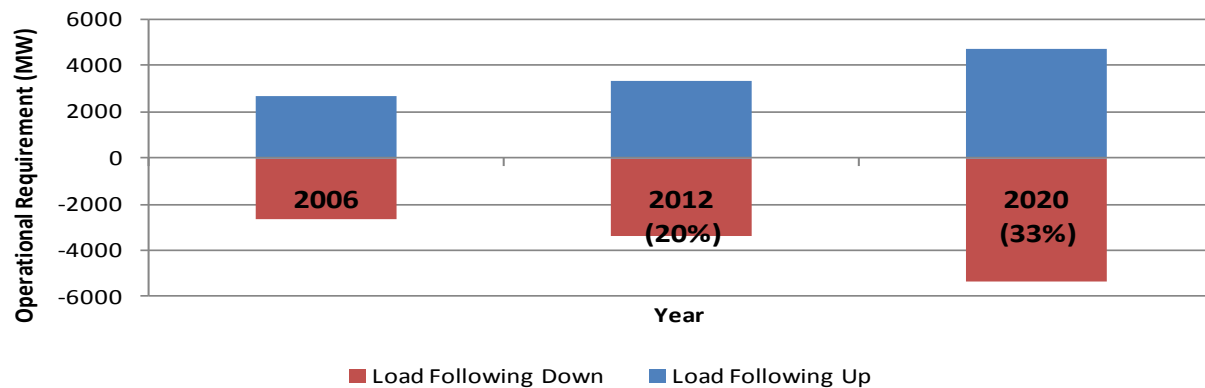
 California ISO
Your Link to Power

Expected average regulation and load-following capacity requirements

Regulation Requirements



Load Following Requirements



Aggregate Operational, Emissions and Revenue Changes for Combined Cycle Units in 2012 (under simulation assumptions)

	20% RPS case	2012 Reference case	Percent change
Number of starts	3,362	2,492	35 %
On-peak Energy (GWh)	32,421	36,259	-11 %
Off-peak Energy (GWh)	26,146	31,056	-16 %
CO2 Emissions (MMtons)	24.27	27.97	-13 %
Revenue (\$ billion)	3.46	4.1	-16 %

Aggregate Operational, Emissions and Revenue Changes for Simple Cycle Gas Turbines in 2012 (under simulation assumptions)

	20% RPS case	2012 Reference case	Percent change
Number of starts	9,618	12,123	-21 %
On-peak Energy (GWh)	6,223	10,244	-39 %
Off-peak Energy (GWh)	3,359	5,034	-33 %
CO2 Emissions (MMtons)	5.5	8.6	-35 %
Revenue (\$ billion)	0.6	1.0	-39 %

ISO actively pursuing operational and market enhancements to support renewable integration

- Resource adequacy and planning
 - Resource adequacy rules reflecting operational characteristics
 - Long-Term Procurement Plan supporting renewable integration
- Operational Readiness
 - Wind & solar forecasting tools (output, ramping requirements)
 - More sophisticated grid monitoring systems
 - Over-generation mitigation procedures
 - Coordination with neighboring balancing areas
 - Generation interconnection standards
 - Intra-hour scheduling and dynamic transfers
- Market/Policy Enhancements
 - New market products & changes to market rules
 - Increased regulation and reserve requirements
 - More sophisticated day-ahead unit commitment algorithms