Flexibility and Storage for Integration of Renewables

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Outline

I. Background

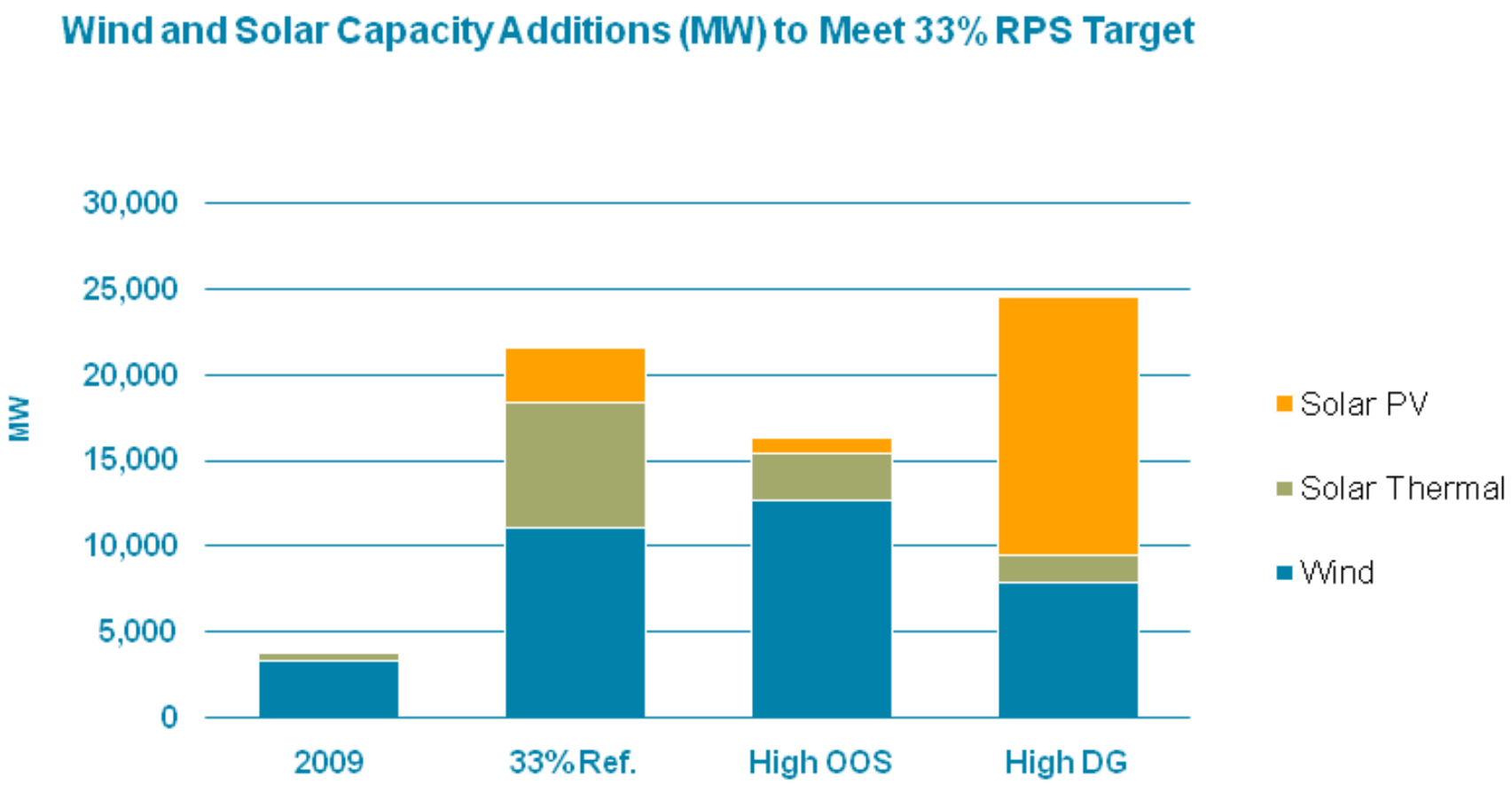
II. Renewable Integration in California

III. PG&E's Storage Projects

IV. On-going Industry Initiatives

Background

California Future Generation Mix

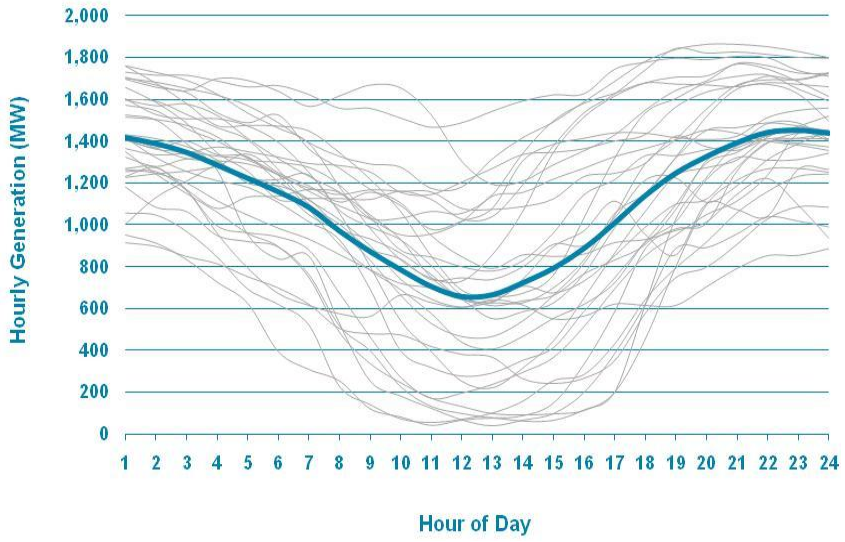


Source: CPUC, *33% RPS Implementation Analysis Preliminary Results*. June, 2009, California Public Utilities Commission

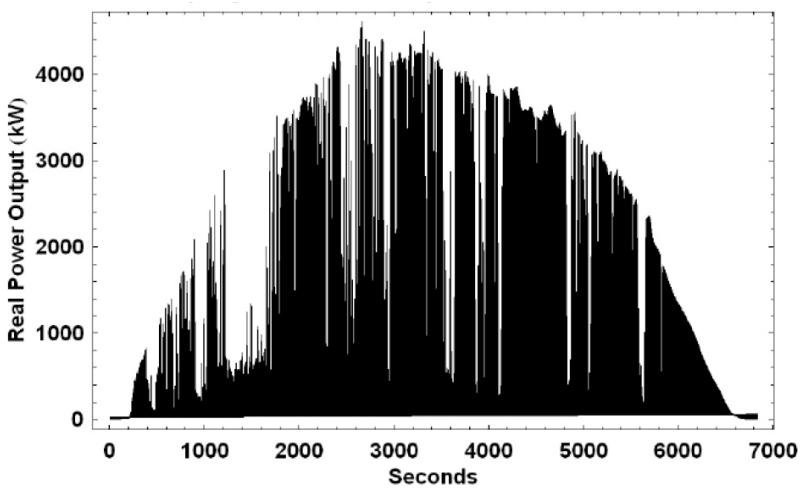
Wind and Solar are Highly Variable

- Wind and solar are variable resources:
  - Variability: the magnitude of power output from one moment to the next can change dramatically
  - Unpredictability: sudden changes in generation output not well-forecasted

CAISO July 2009 Wind Generation, MW



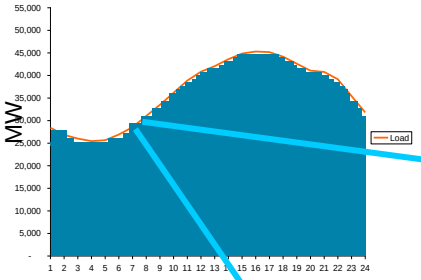
Solar Generation in Springfield, AZ



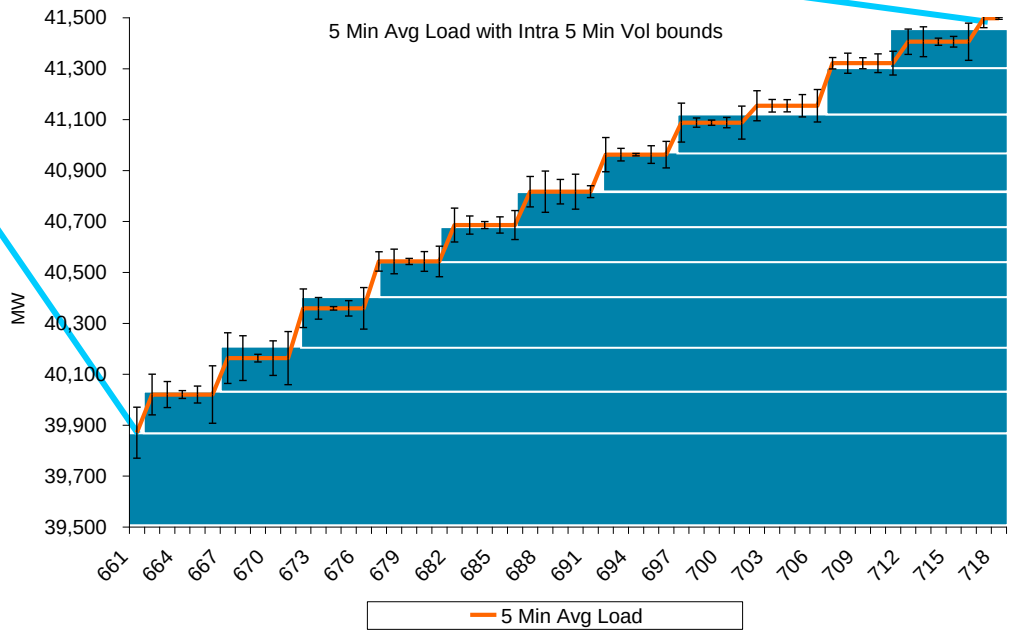
Sources: http://www.caiso.com/2747/274778eb12970.xls
Apt J. and Curtright A., "Spectrum of Power from Utility-Scale Wind Farms and Solar Photovoltaic Arrays"

Flexible Resources Maintain Balance

Flexible generation manages uncertain real-time load and generation



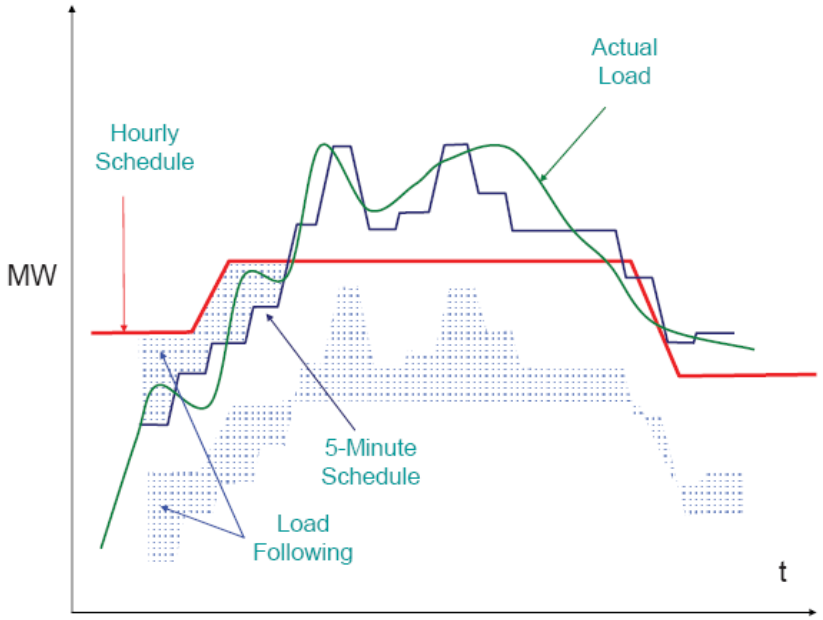
Real-Time Load Uncertainty and Forecast Generation
(CA 5 Minute Load 11am-12pm Peak Day 2005 and Hypothetical Generation)

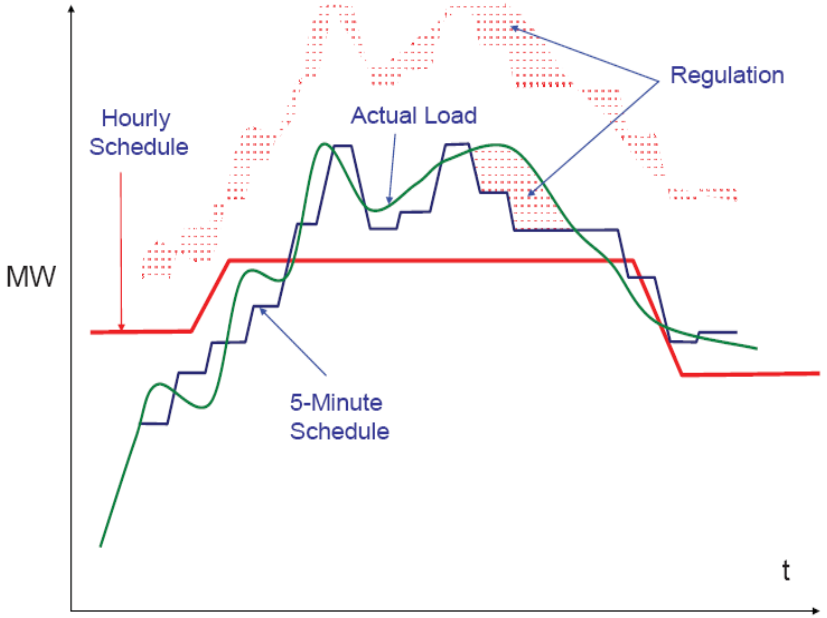


Flexible Resource Provide Ancillary Services

Load Following: Difference between the hourly schedule (red line) and the 5-minute schedule (blue line)

Regulation: Difference between the 5-minute schedule (blue line) and the actual load/wind (green line)





Source: California ISO

Renewable Integration in California

Integration Framework to Determine Flexibility Need

Reserve Requirements

Define reserve requirements based on load and generation characteristics

Additional System Requirements

Evaluate system operation to determine additional resource needs and characteristics (MW, ramp times, etc)

Technology Mix and Costs

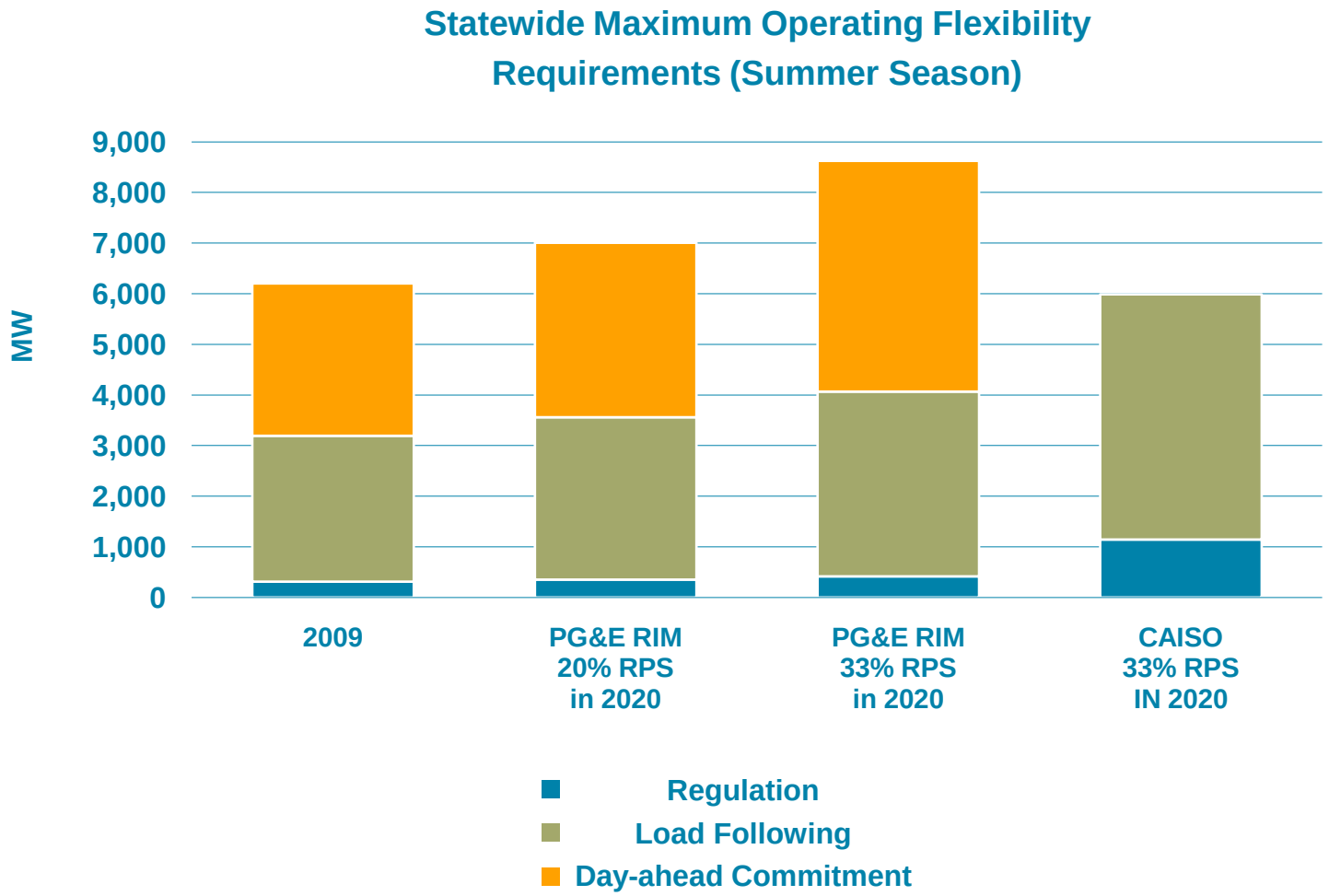
Determine mix of technologies for meeting system needs weighed against costs

Integration Studies in California

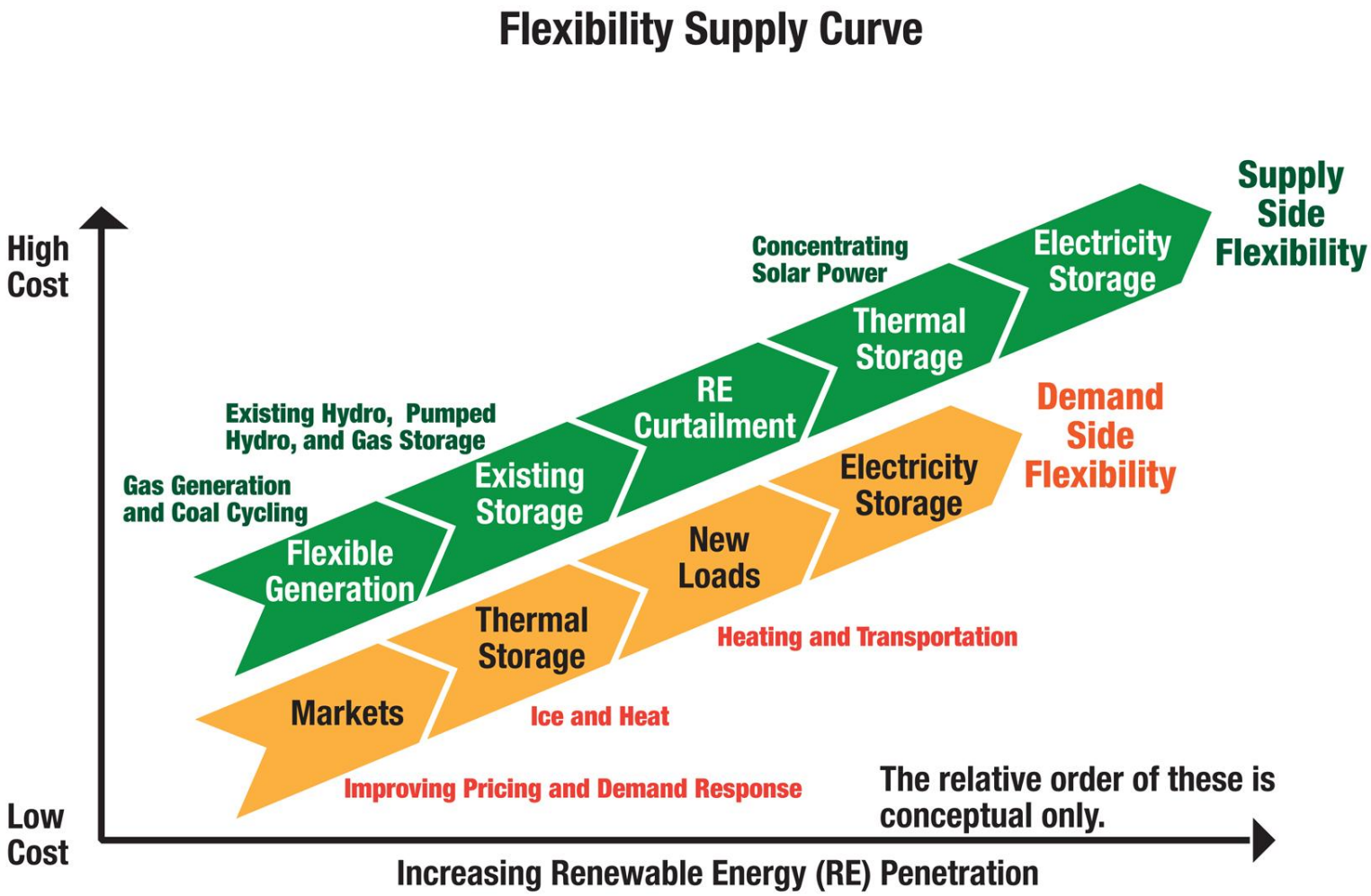
There is no standard approach to estimate flexibility needs

Approaches	CAISO Study	Renewable Integration Model (PG&E)
Explanation	• Production simulation model using Plexos • Simulate operation of grid hourly • Identify and solve operating violation by adding flexible capacity	• Estimate flexibility need analytically • Simplified representation of key drivers of flexibility need
Advantages	• Detailed representation of grid • Existing and new resource limitations represented	• Produces results in minutes • Can vary/test sensitivity of results • Accessible (uses simple tools)
Disadvantages	• Requires thousands of assumptions • Slow (takes days) to estimate need • Becomes outdated fast	• Simplified representation of grid • Need to calibrate results

Integration Needs Defined



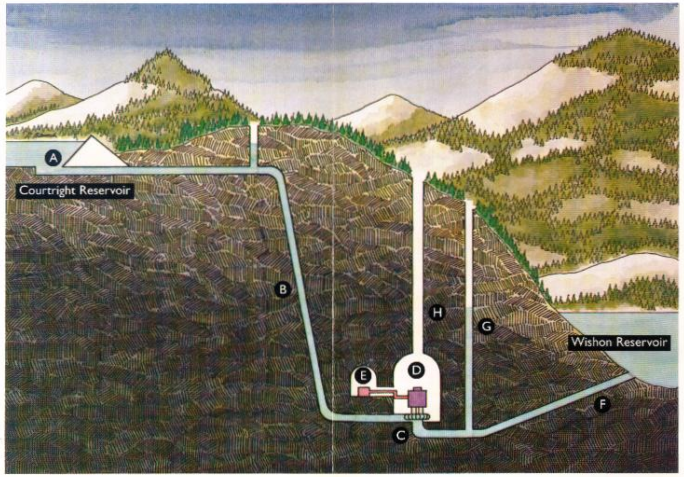
Sources for Flexibility



Source: P. Denholm, NREL, 2010; B. Nickell, DOE, 2008

PG&E's Storage Projects

Helms Pumped Storage Plant

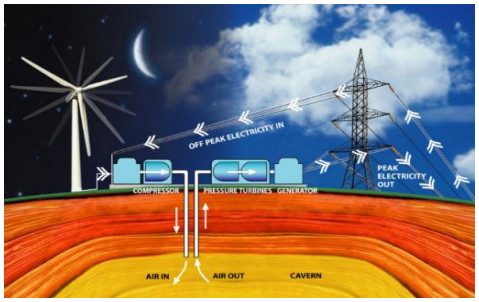


Location	Central California
Commissioned	June 30, 1984
Installed Capacity	Three units; 1,212 MW generating; 930 MW pumping

- Storage of economy energy at night and spring run-off
- Alleviate over generation and minimum load conditions
- Meet fluctuations in demand and act as reserves

Current Storage Initiatives

CAES

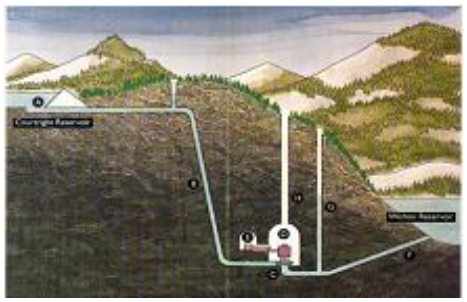


- Existing salt dome reservoir
- Partnership with DOE, CEC, CPUC
- 300MW, up to 10* hours storage

NaS Battery

- 4 MW system in San Jose
- 2 MW system at Vaca-Dixon substation
- Test load shaping, providing ancillary services, balancing solar

Pumped Hydro



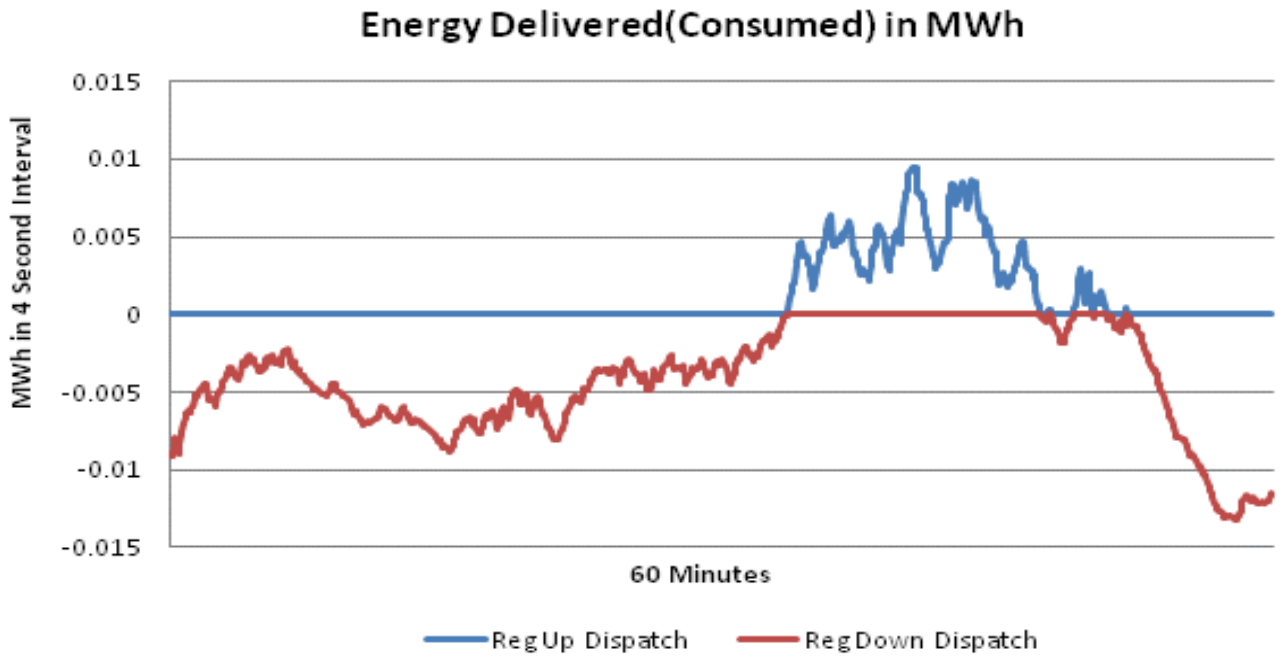
- Mokelumne
- Proposal to connect 2 reservoirs

* Final project size to be determined

Current Industry Initiatives

CAISO: REM Initiative

- Regulation Energy Management (REM)
- Program to test usefulness of limited energy resources (batteries) for regulation services



Source: CAISO, "Regulation Energy Management Draft Final Proposal" Dec 14, 2010

CPUC AB2514

Directs California Public Utilities Commission to:

- Determine targets, if any, to procure viable and cost-effective energy storage
- Adopt by October 1, 2013, an energy storage system procurement target, if appropriate.

Approved by Governor September 29, 2010

CPUC initiated Order Instituting Rulemaking (OIR) on December 21, 2010

Conclusion

- At penetrations of 33% of electricity from renewable resources, changes will be required in the supply portfolio.
- At higher penetrations, highly flexible resources will be essential.
- A mix of supply-side and demand-side resources (including storage) will create a flexible electric supply portfolio.
- On-going industry initiatives to investigate storage in California

Thank You

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