Energy+Environmental Economics

Briefing on E3 Higher RPS Study for Little Hoover Commission

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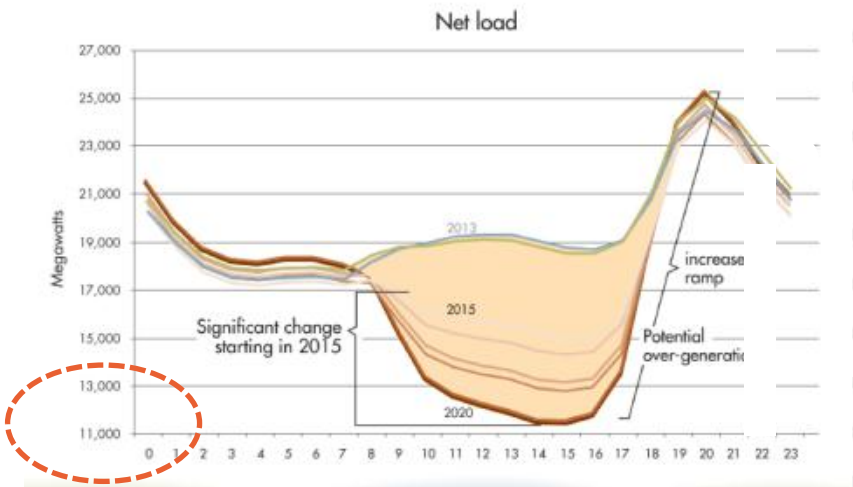
Study focus: operational challenges from high renewable penetration (40-50%)

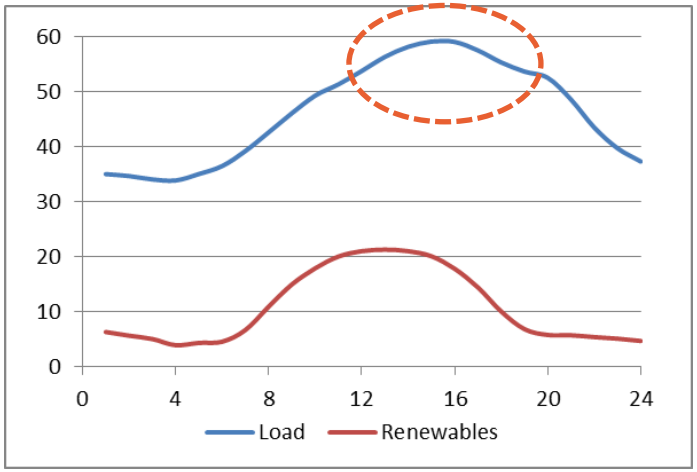
- The CAISO duck chart *illustrates* operational challenges at 33% RPS
- It shows just a *single day* in March as renewables rise to 33%

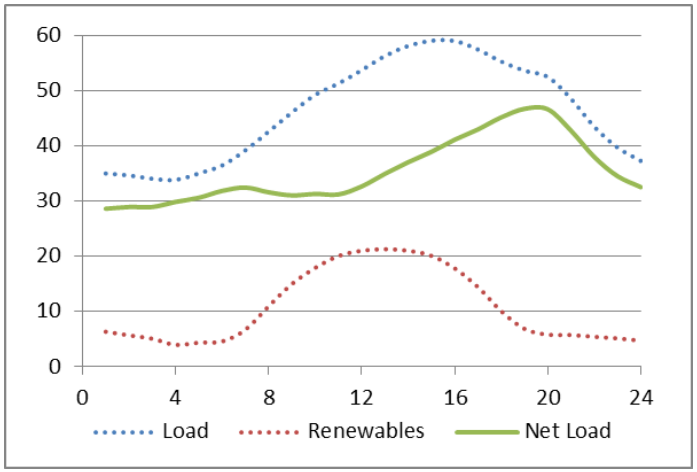


- E3's study looks at *thousands* of potential operating days as renewables rise to 50%
- **Core question:** *How serious and pervasive are operating challenges as renewable penetration rises above 33%?*

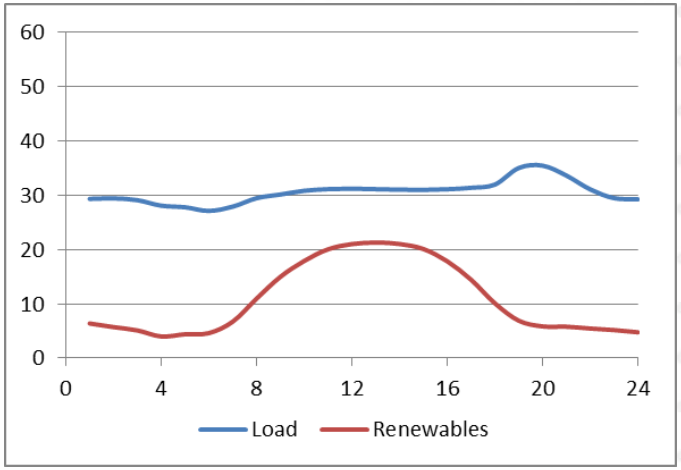
With higher renewables managing *Net Load* will be the challenge

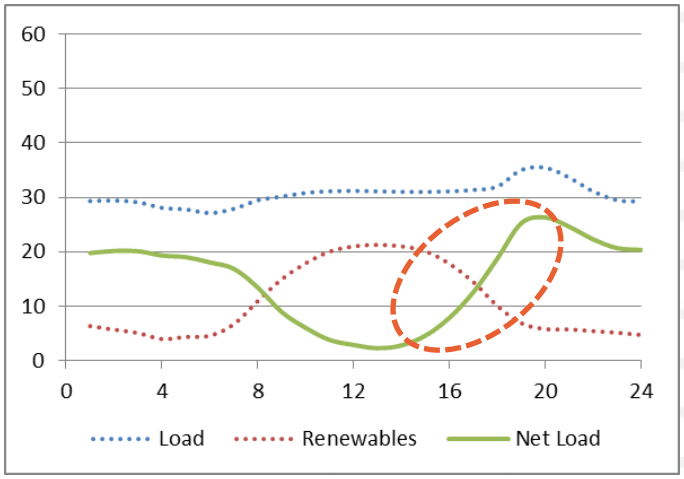
Sweltering Summer Day "Dog Days"





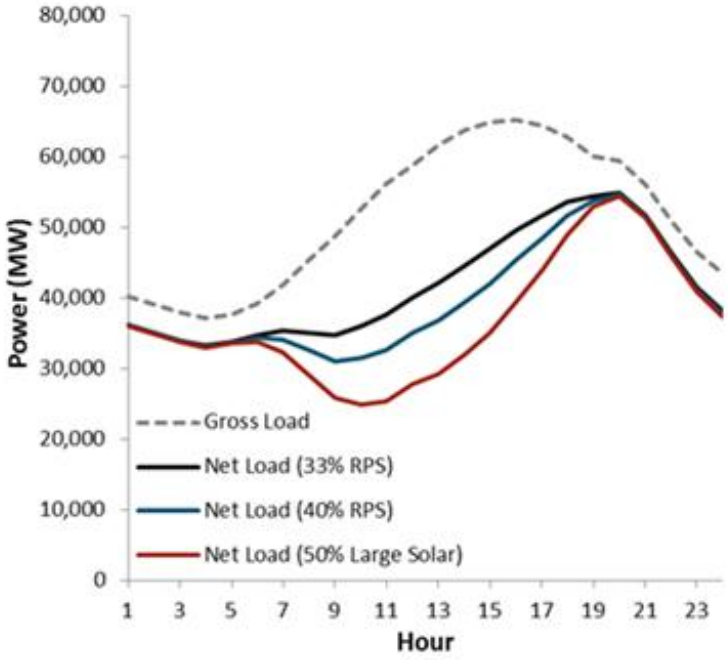
Delightful Spring Day "Duck Days"



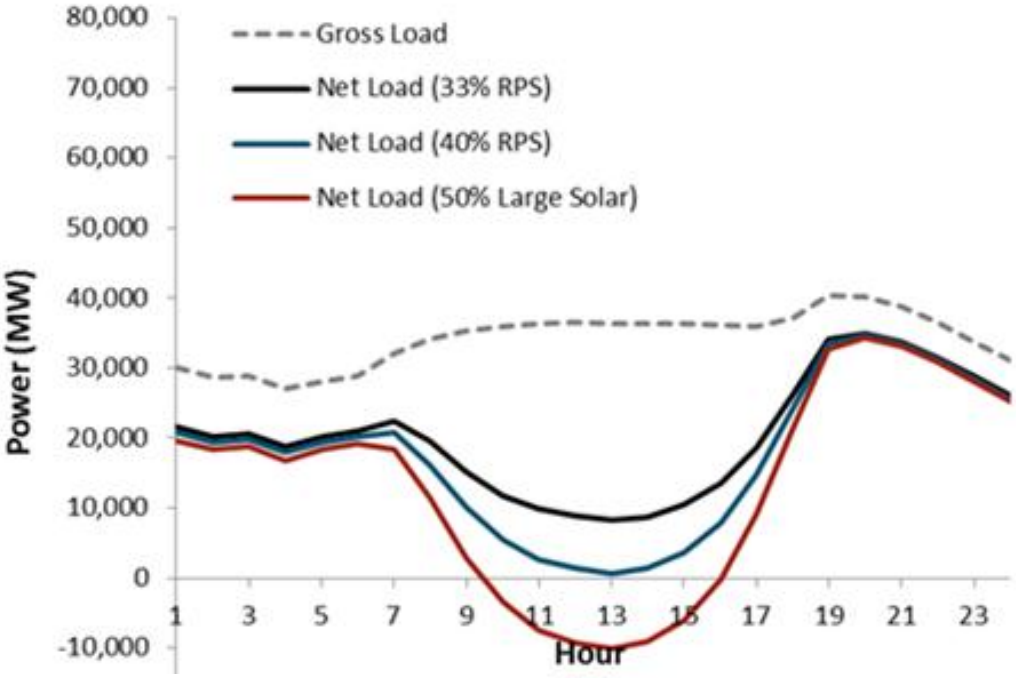


High Variable Renewable Penetration Stresses the Grid in New Ways

"Dog Days"
Highest Load Day



"Duck Days"
Highest Ramp Day

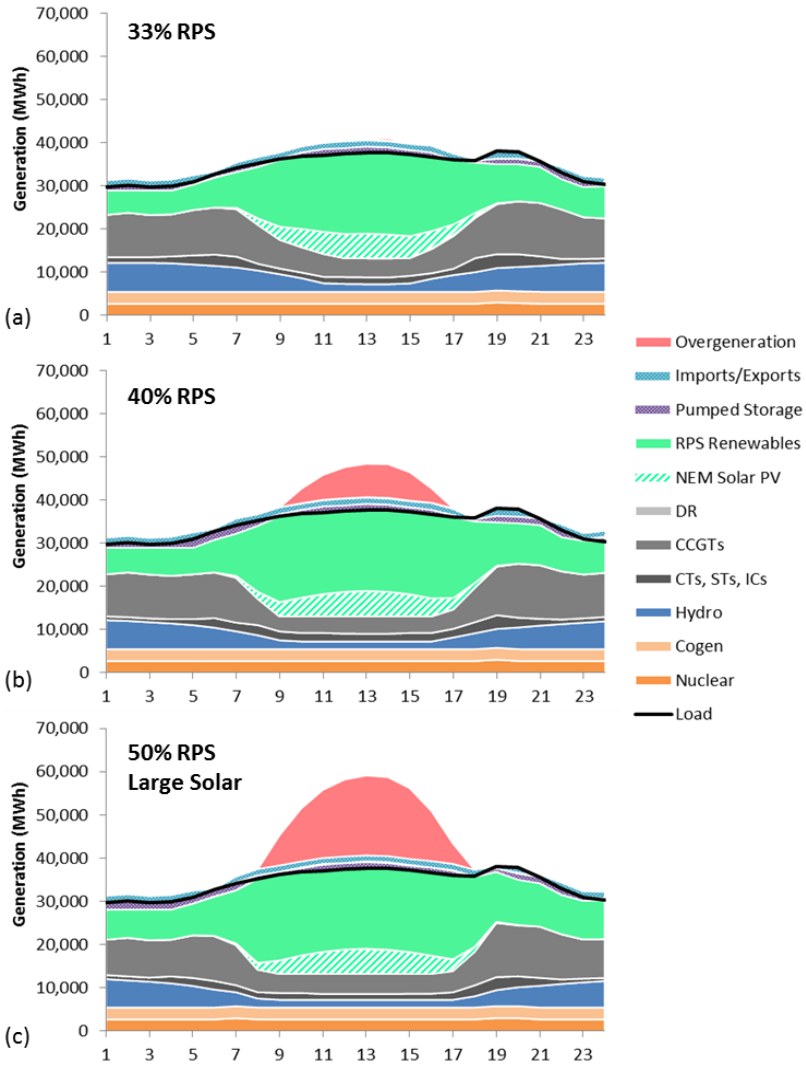


- **Historical system planning challenge: meet gross peak load on hottest days**
- **High renewable penetration makes net peak lower and later**
- **Need enough generating capacity**

- **Historically an easy day to manage**
- **Emerging system planning challenge: manage diurnal swings in net load**
- **Need enough flexibility**

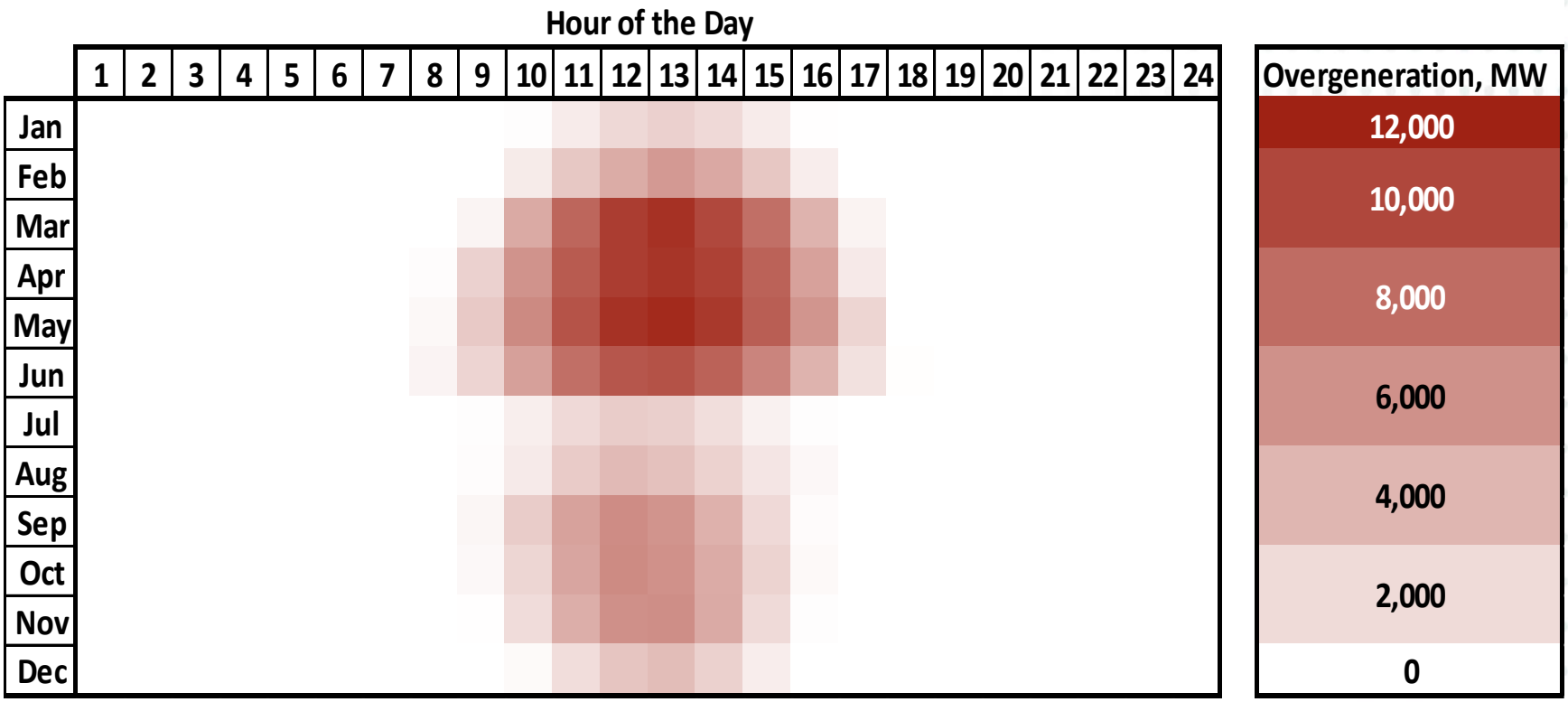
Example Day in April under 33%, 40% and 50% RPS

- **Chart shows increasing overgeneration above 33%**
  - Overgeneration is very high on some days under the 50% Large Solar case
  - Fossil generation is reduced to minimum levels needed for reliability
- **Renewable curtailment is a critical strategy to maintain reliability**
  - Reduces overgeneration
  - Mitigates ramping events



Overgeneration Is Extensive and Can Occur in Any Month

Average overgeneration (MW) by month-hour, 50% Large Solar Case:

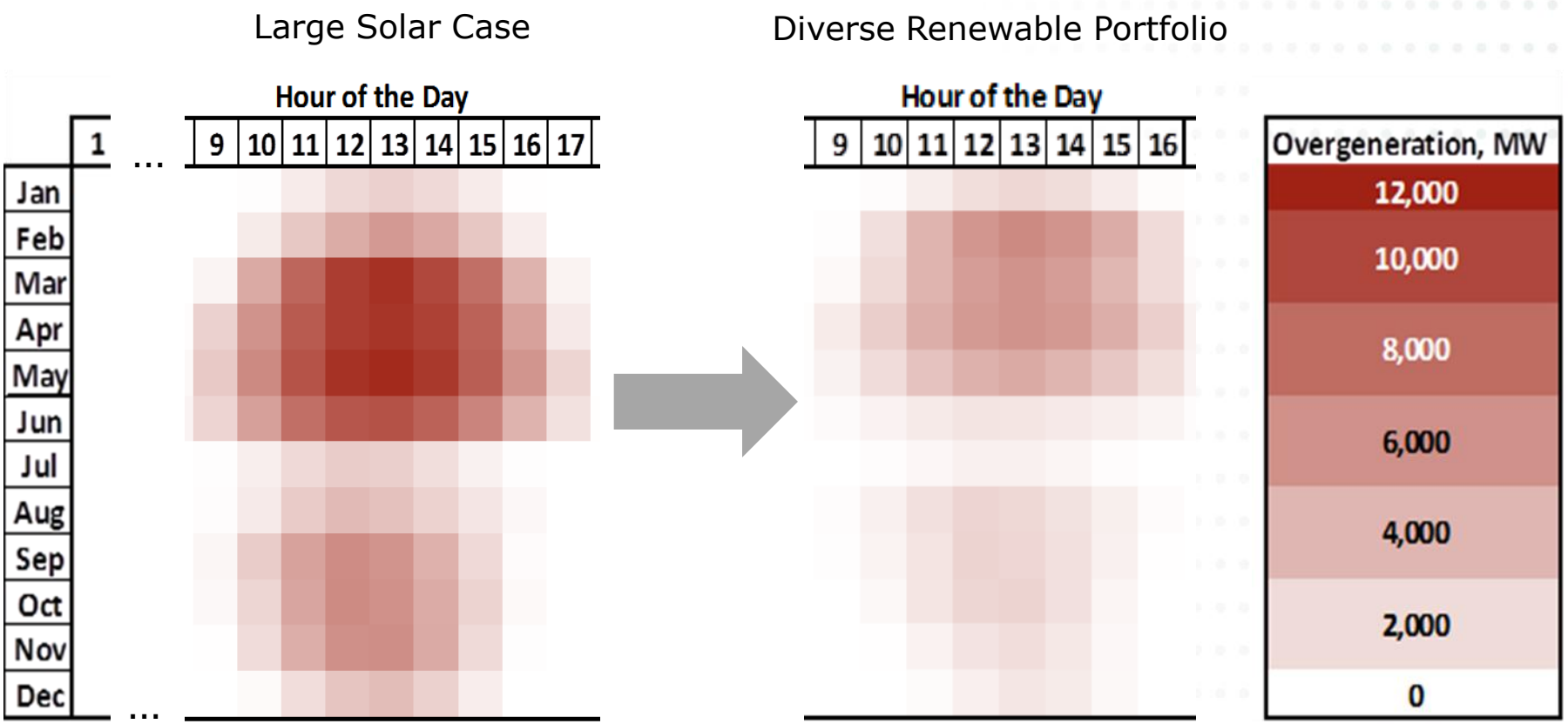


E3 investigated several potential solutions, most were found to be effective

+ **Potential solutions:**
  - Diversified portfolio (more wind and geothermal, less solar) ✓
  - Enhanced regional coordination ✓
  - Conventional demand response (down only)
  - Advanced demand response (down **and** up) ✓
  - Energy storage ✓
+ **Solutions considered individually (each @ 5000 MW)**
+ **Solutions may be combined:**
  - Further study needed to identify optimal combination
  - Best mix of solutions depends on renewable portfolio

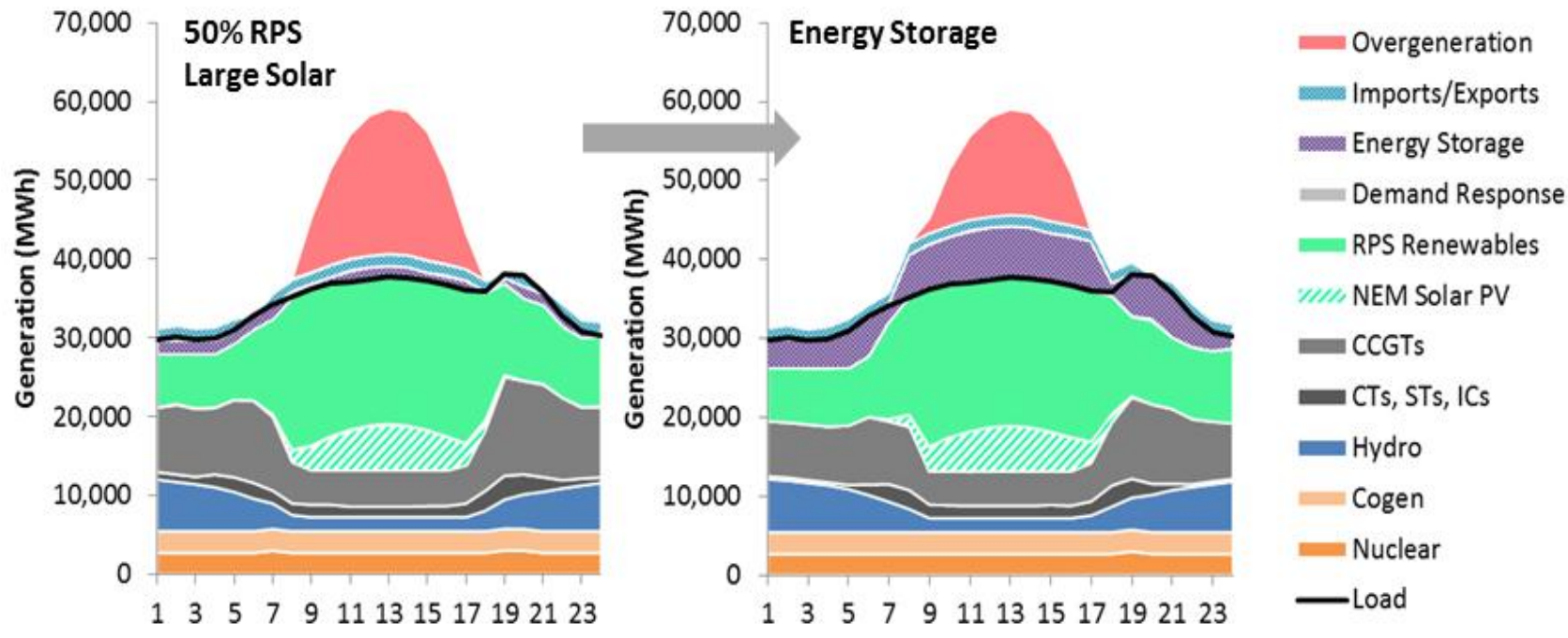
Effect of diversifying the renewable portfolio

Average Hourly Overgeneration in 2030



Potential Integration Solution: Energy Storage Case

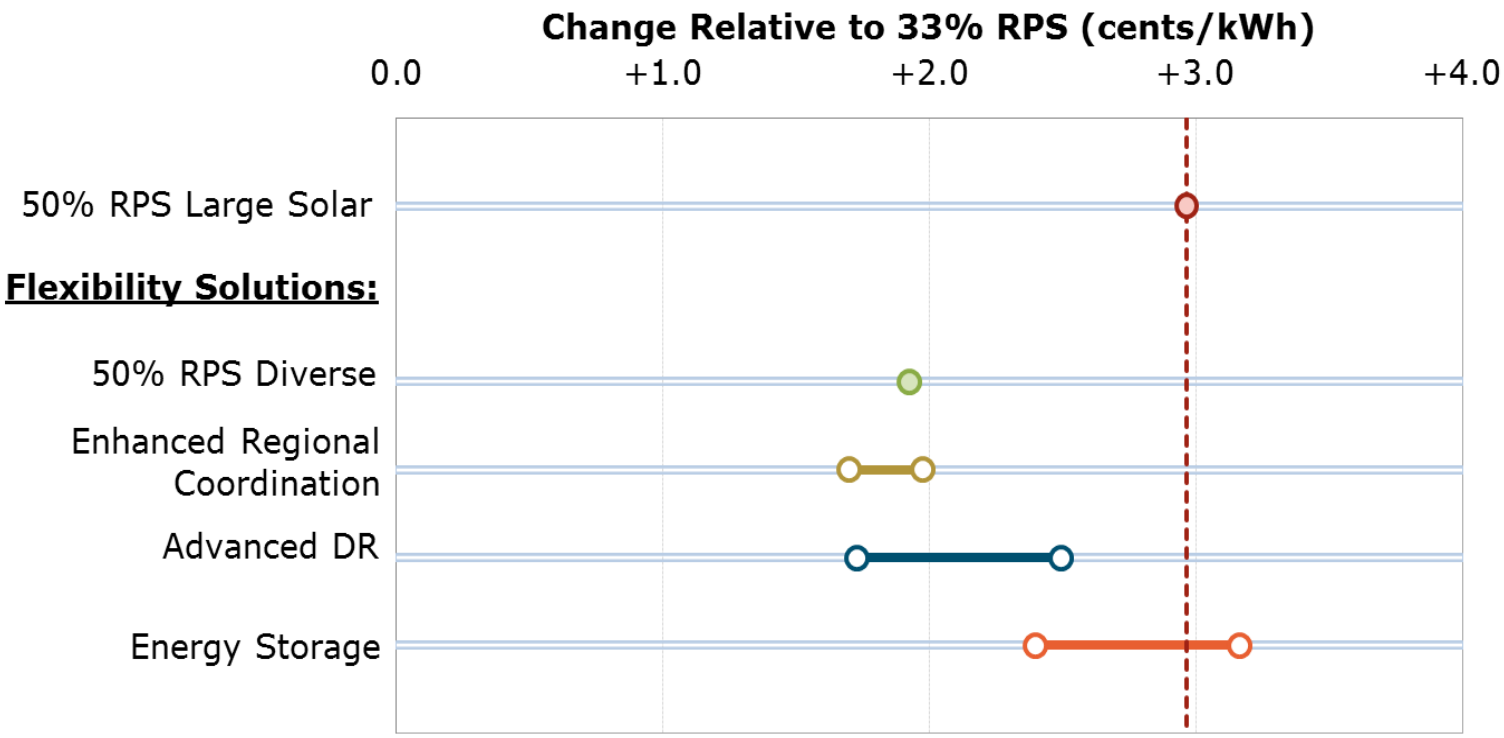
- **Assuming 5,000 MW of diurnal energy storage in CA reduces overgeneration from 9% in the 50% RPS Large Solar case to 4% of total renewable energy.**
- **Storage charges during the day & discharges at night.**



Example April day

Change in Average Rates of Flexibility Solution Cases Relative to 33% RPS (2012 cents/kWh)

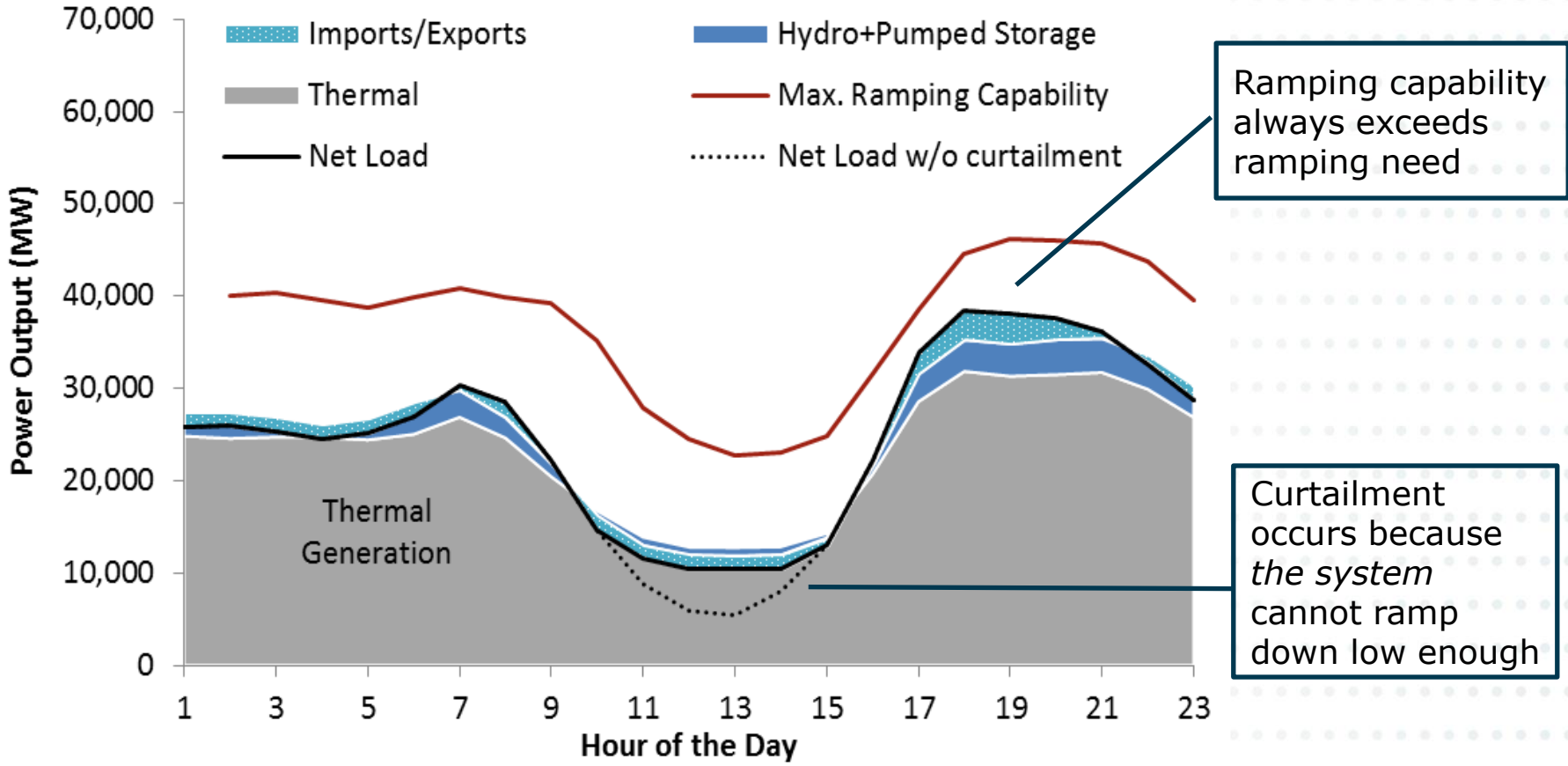
- **5,000 MW of flexibility solutions reduce the cost of meeting a 50% RPS in 2030, but result in higher average rates compared to the 33% RPS scenario**



Insufficient downward flexibility of *the system* causes curtailment

Conventional fleet performance and flexibility

Representative day with the largest net load ramp



50% RPS Large Solar Case, no flexibility solutions implemented

Potential Next Steps to Accommodate Higher Renewables

1. **Increase regional coordination**
   - Allows sharing of flexible resources across West to support renewable integration
2. **Pursue a diverse portfolio of renewable resources**
3. **Implement a long-term, sustainable solution to address overgeneration before the issue becomes more challenging**
4. **Implement distributed generation solutions**
   - Sustainable, cost-based procurement strategy; reexamination of retail rate design & net energy metering policy; distribution-level solutions and upgrades, including smart inverters with low-voltage ride-through capabilities that allow distributed PV to operate under grid faults