

INTEGRATION ANALYSIS AND VALUE OF CONCENTRATING SOLAR POWER WITH THERMAL ENERGY STORAGE



BrightSource

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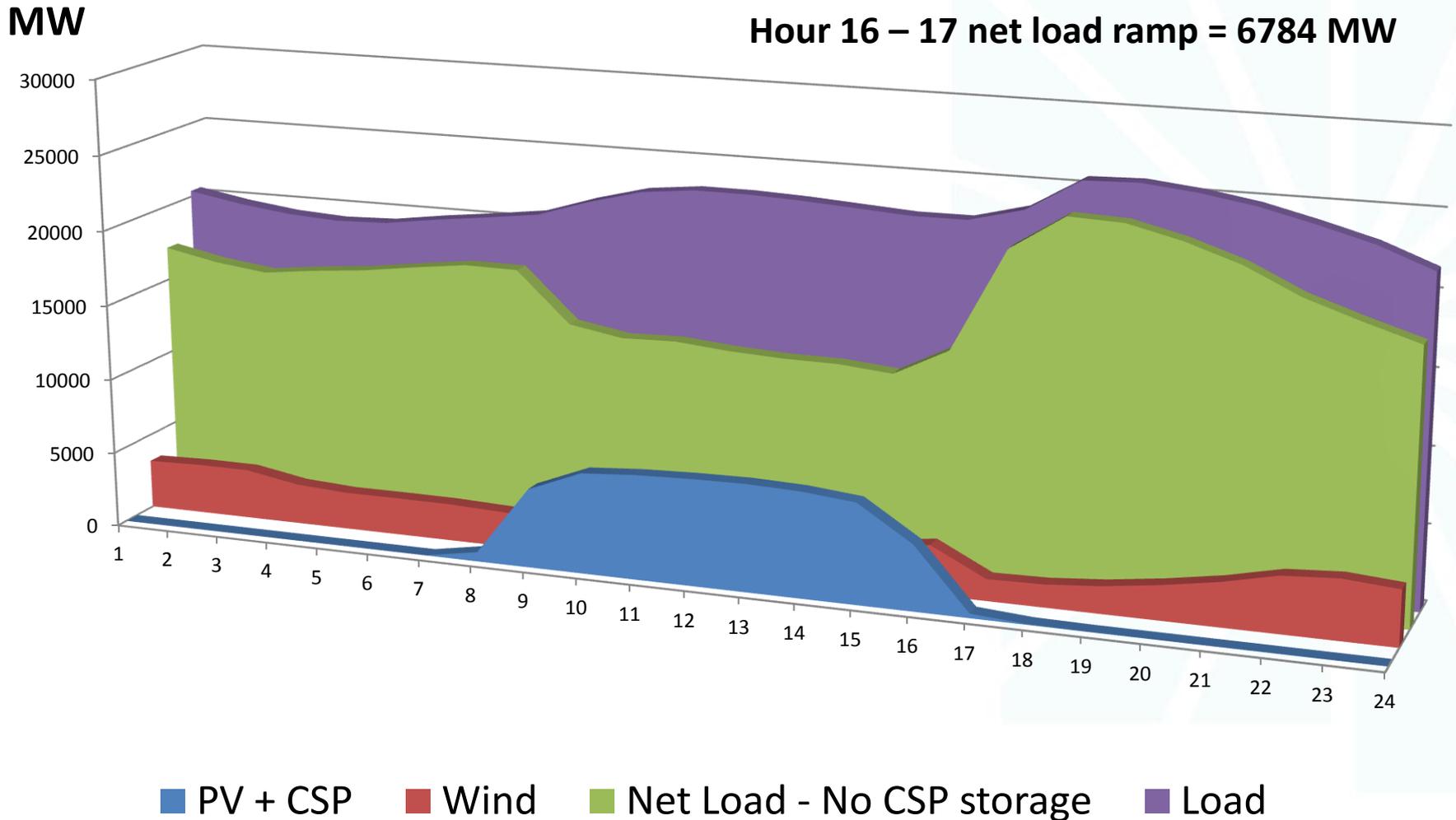
Additional value of CSP with thermal energy storage

- Reduction of system integration costs associated with variable energy resources
- Optimizing scheduling of energy and ancillary services from thermal storage
- Higher long-term Resource Adequacy capacity benefits than less flexible solar resources
- Other operational, emissions and reliability benefits

Integration Costs can be Significantly Diminished – Directly and Indirectly

- Lower production forecast error than other variable energy renewables (day-ahead, hour-ahead)
- Decisions to use energy from storage for smoothing of intra-hour production variability on cloudy days
- Potential to slow rate of morning net load ramp
- Potential to slow rate of late afternoon net load ramp
- Solar dispatchability could offset the need for new integration resources (beyond the capability of the planned generation fleet)

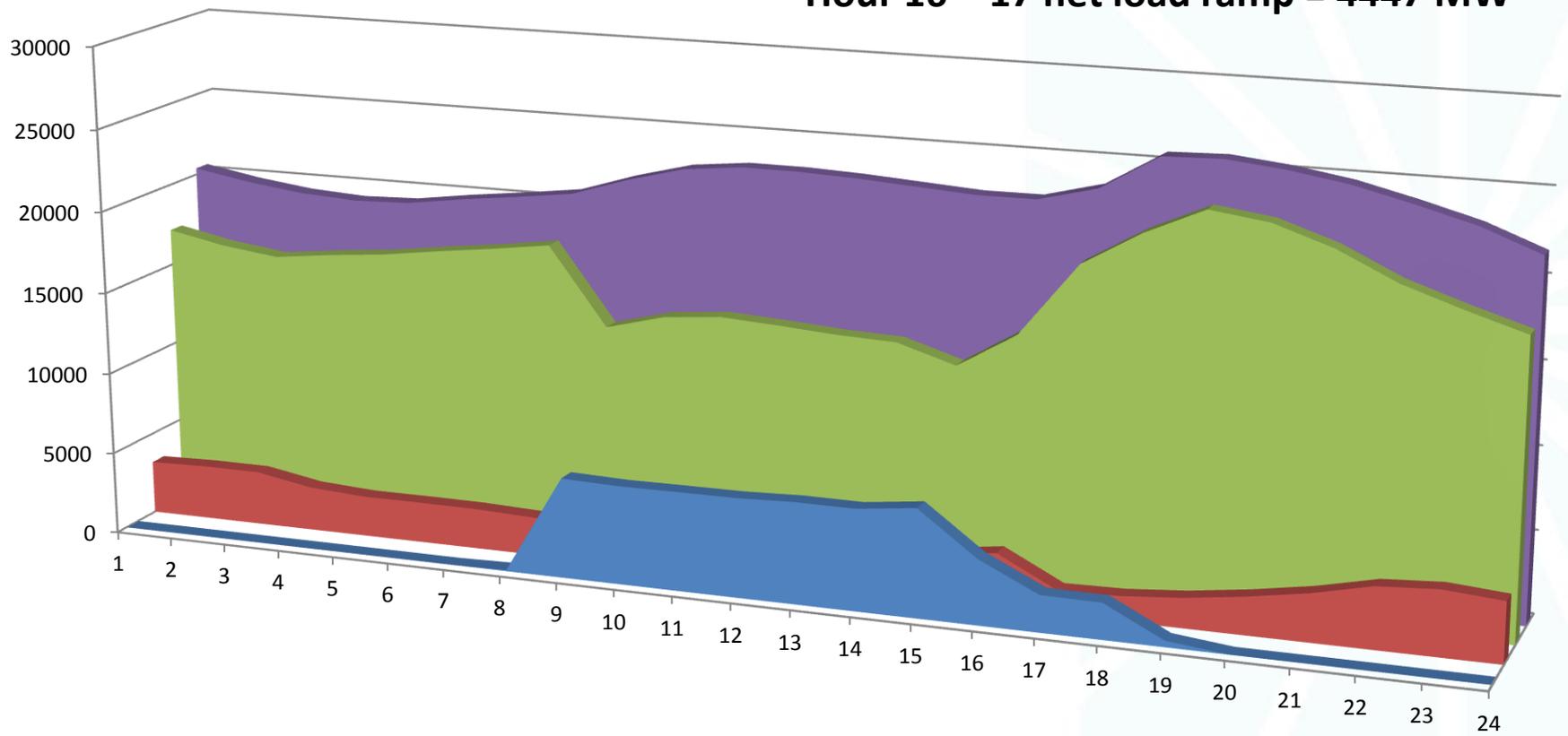
Simple example: Net load ramp in late afternoon – without thermal storage on simulated November 22, 2020, CPUC Trajectory Case (2010 vintage)



Simple example (*cont.*): Net load ramp – CSP with 2 hour thermal storage (not optimized) on simulated November 22, 2020, CPUC Trajectory Case (2010 vintage)

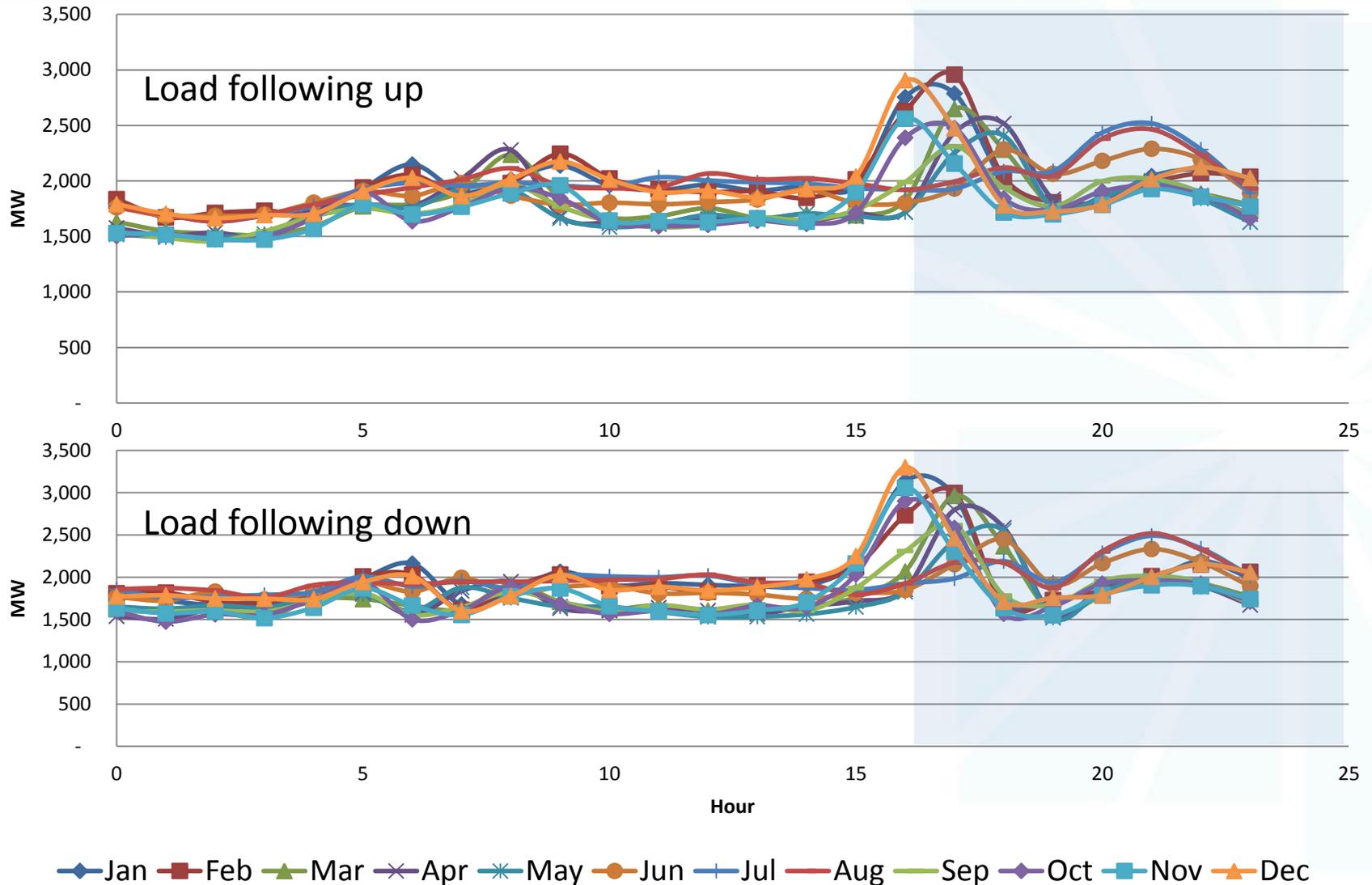
MW

Hour 16 – 17 net load ramp = 4447 MW

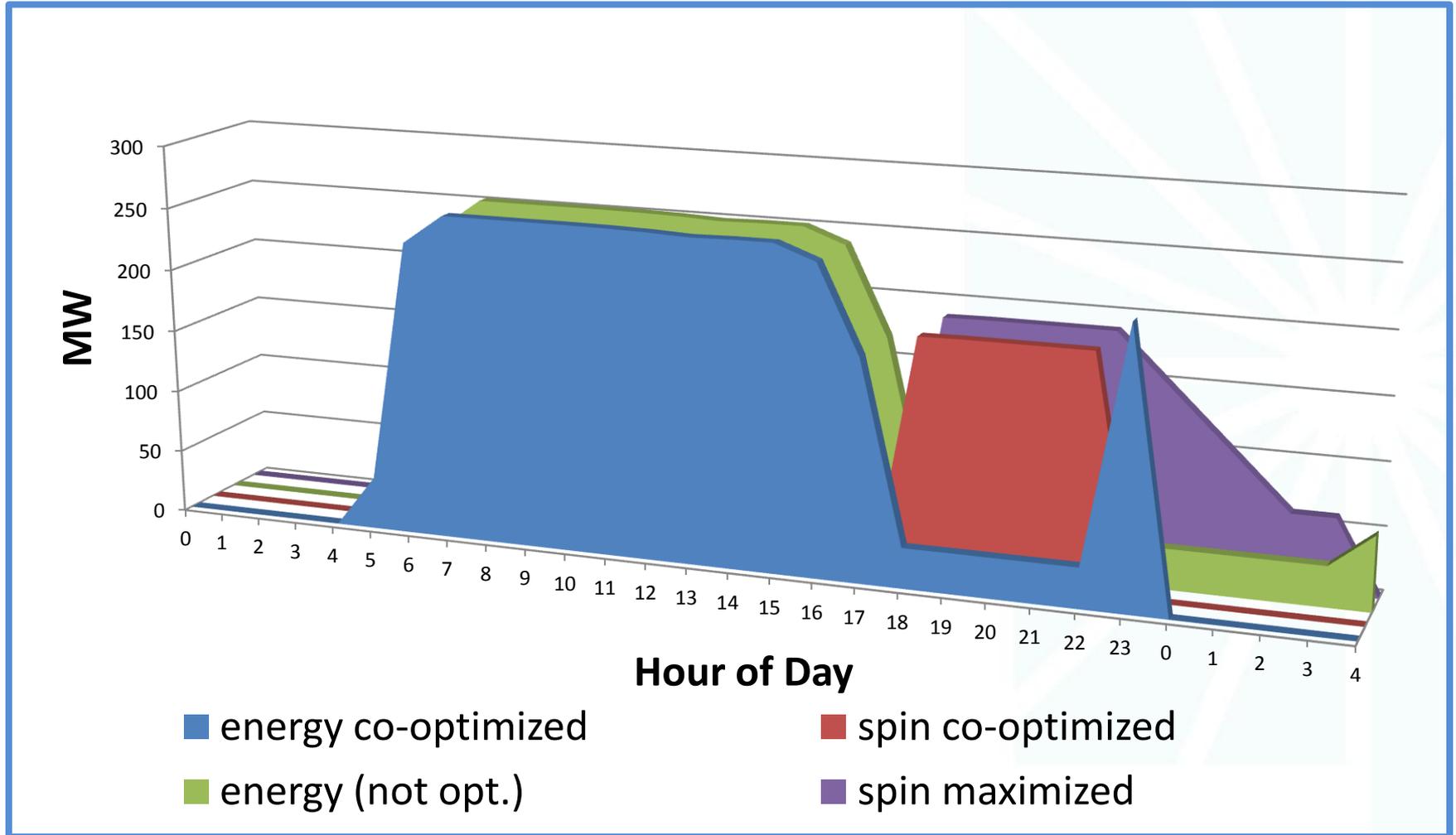


■ Reduced PV + CSP 2 hours ■ Wind ■ Net Load - CSP + storage ■ Load

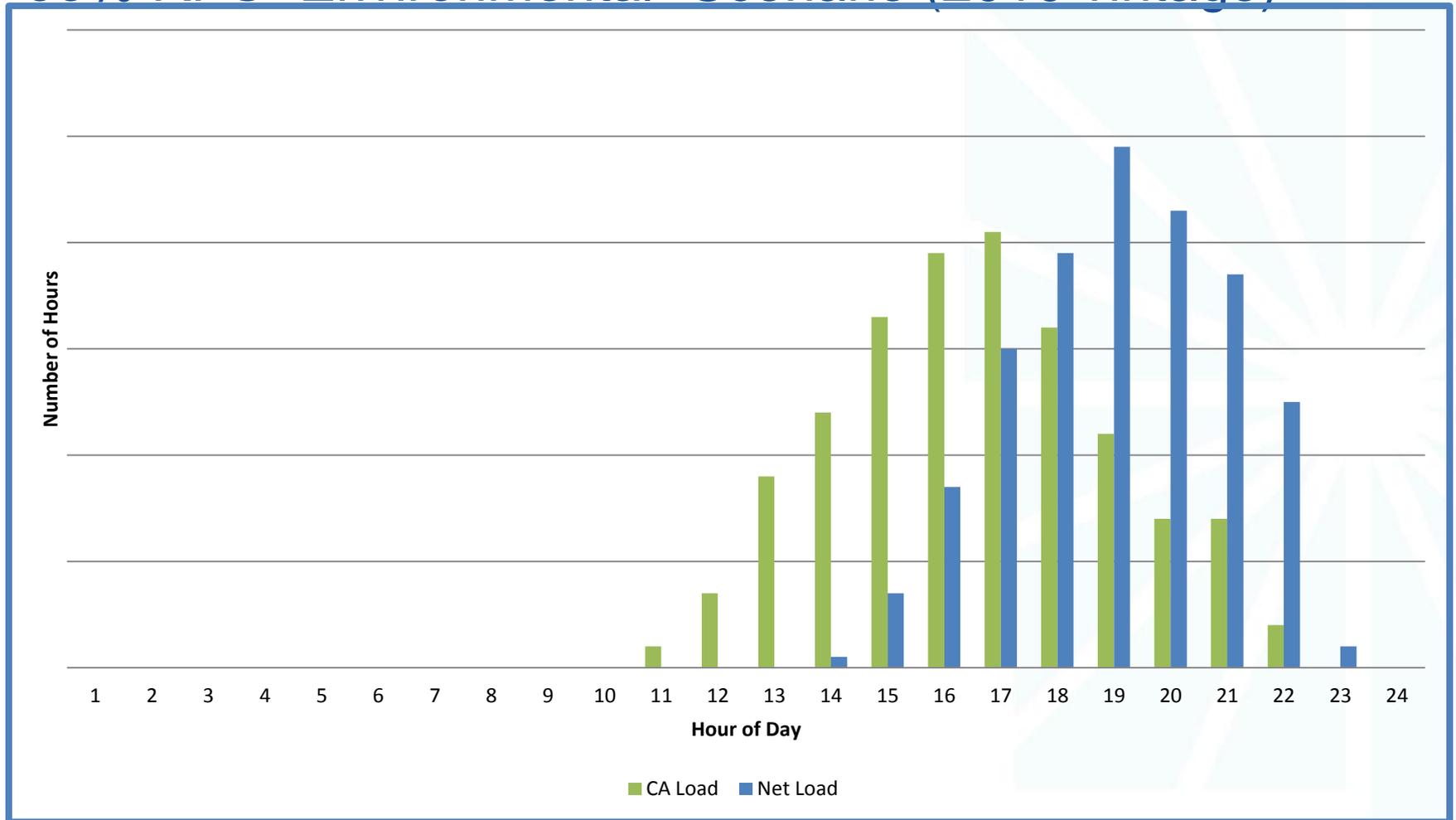
Late afternoon ramps will be consistent and forecast errors will require load following reserves: CAISO estimates of average hourly load-following requirements, CPUC Trajectory Case, 2020



Thermal storage dispatch can be used to optimize energy and ancillary service provision – allowing for clean energy back-up of wind overnight if desirable



Dispatchable Solar Energy can serve the shifting net load peak: Top 250 load and net load Hours in the CPUC 33% RPS “Environmental” Scenario (2010 vintage)



Some next steps

- CAISO/CPUC integration studies of 33% RPS to provide additional clarity on operational needs and integration costs over 2012-13
- Several studies in development or in process to provide quantitative valuation of CSP with thermal storage
 - National Renewable Energy Laboratory
 - Lawrence Berkeley Lab
 - CEC with KEMA
 - EPRI
- CPUC 2012 RPS proceeding evaluating the inclusion of integration costs in RPS valuation methodology