Valuing Storage in RPM

Planning Committee
July 2, 2014

Our Members:
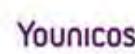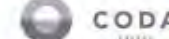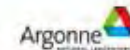
Energy Storage

- **Duration**: variety of technologies operate wide range of hours

  - Energy storage is not a fixed duration resource

  - Storage best characterized by energy (MWh), not power (MW) or time

  - Most storage technologies can deliver their rated MWh over time periods from less than an hour to many hours or days

- **Dispatchable**: 24/7 365 days per year

  - Field experience confirms 24/7/365 operation

- **Dedicated**: grid-connected resources fully under PJM control

- **Improve Utilization:** Ability to optimize efficiency of the grid

  - ➢ *Value to PJM planning, operations, and markets*

Capacity Value of Energy Storage

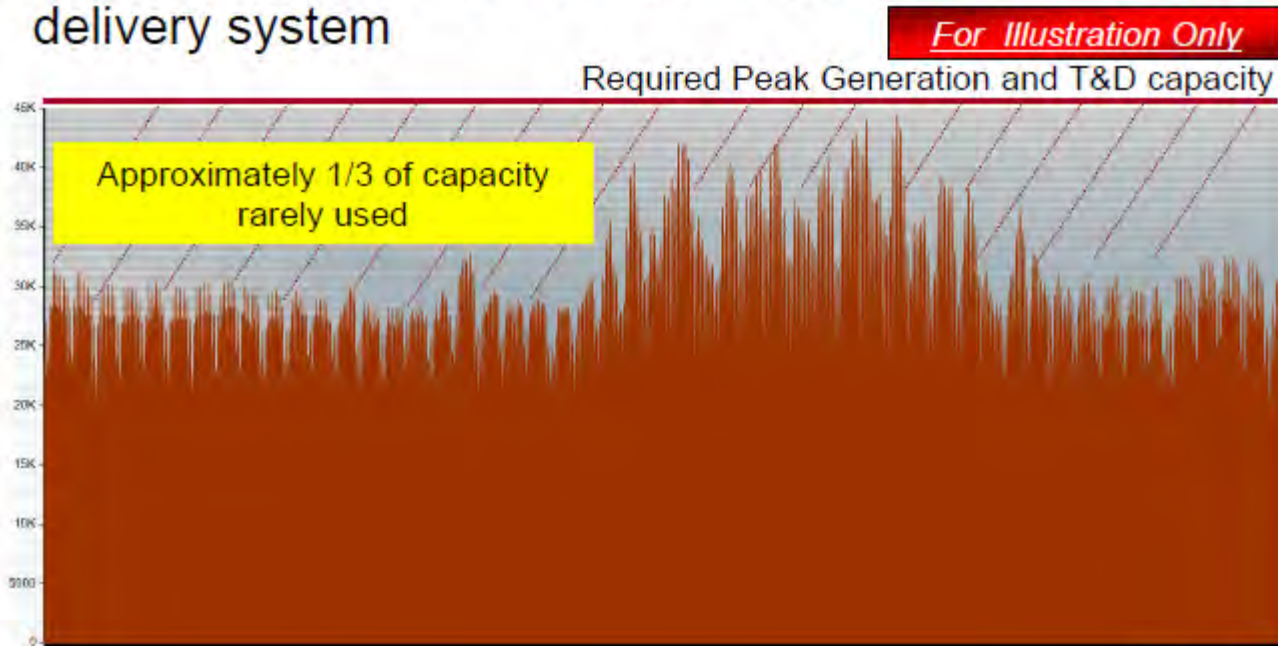- **Storage should earn an RPM capacity that reflects its contribution to reliability.**

- **The tariff does not have a general definition of capacity.**

- **Our working definition is:**

    One MW of UCAP allows the addition of 1/(1+IRM)MW of peak load with no increase in LOLE.

- **This presentation suggests a quantitative approach to valuing storage, grounded in reliability benefits.**

Graphs presented by EPRI at California PUC Energy Storage Workshop March 25, 2013
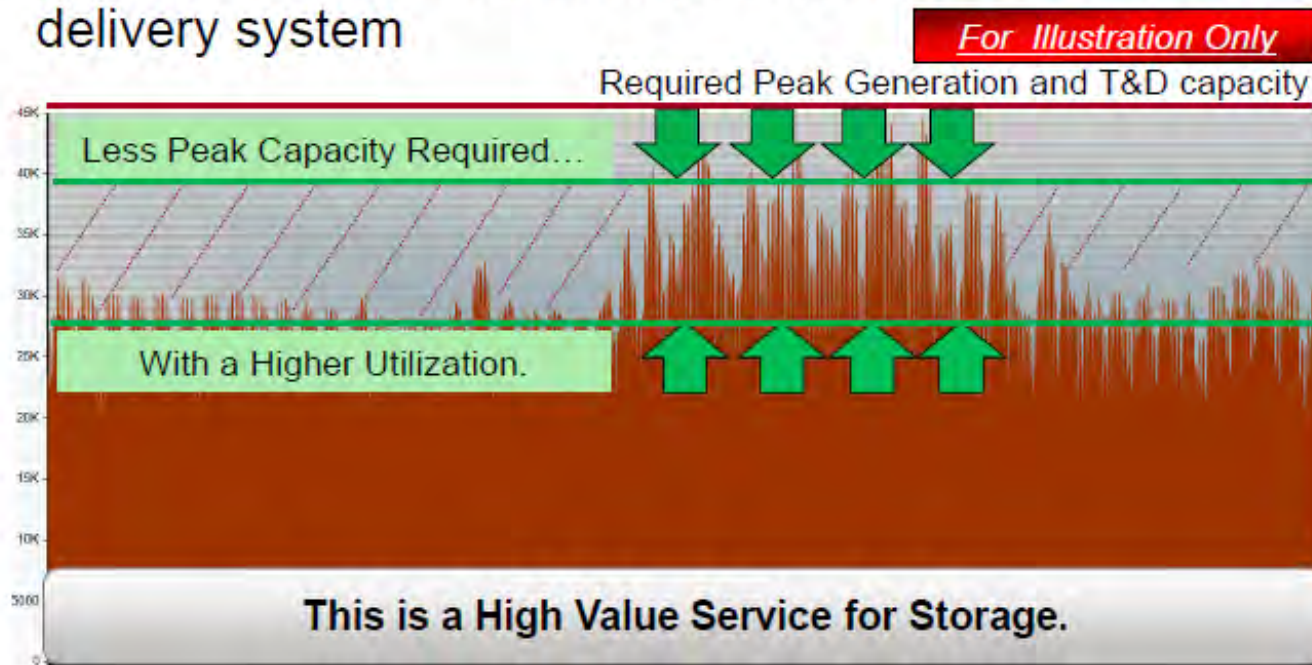
Cost-effective Peak Capacity

-Ability to charge at lower off-peak heat rates.
-Support for min. load requirements for other resources.
-No direct emissions from peak demand.

Peakers

Intermediate Generation

Baseload Generation
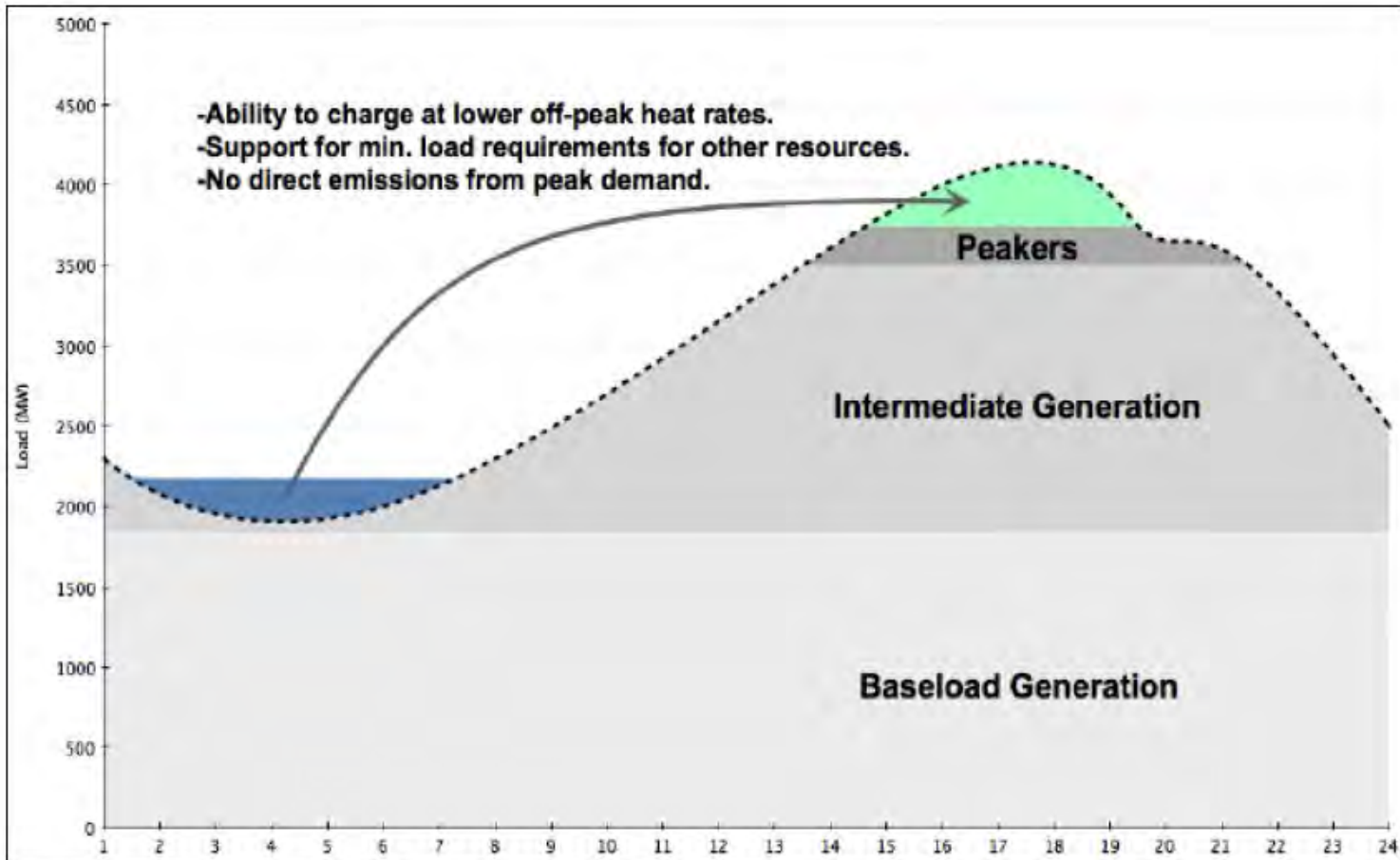
Storage has the unique ability to provide peak power using lower cost off-peak power

Applying to PJM Planning Analysis

- **Goal is to determine increase in load carrying capacity of PJM system with addition of storage.**

- **Should be consistent with other PJM planning procedures**

- **Approach:**

  - 7 years of hourly load data was obtained from PJM website.

  - To account for growth of PJM, years prior to DY2013 scaled up so each year's annual average load equal to average load in DY2013.

  - Assume addition of 10,000MWh of storage.

  - Storage was modeled with simple "charge during valleys, discharge during peaks" strategy.

Value on Summer Days

Benefit of 10GWh storage (MW)			
MW Peak Load Served	**Best 10% of days**	**Avg.**	**90% of days**
CP20 Days	3,996	3,509	>3,015
Summer Weekdays	4,112	3,399	>2,477

Legend: ☐ Storage CP20 Days ■ CP20 Days ☐ Storage Summer Weekdays ■ Summer Weekdays

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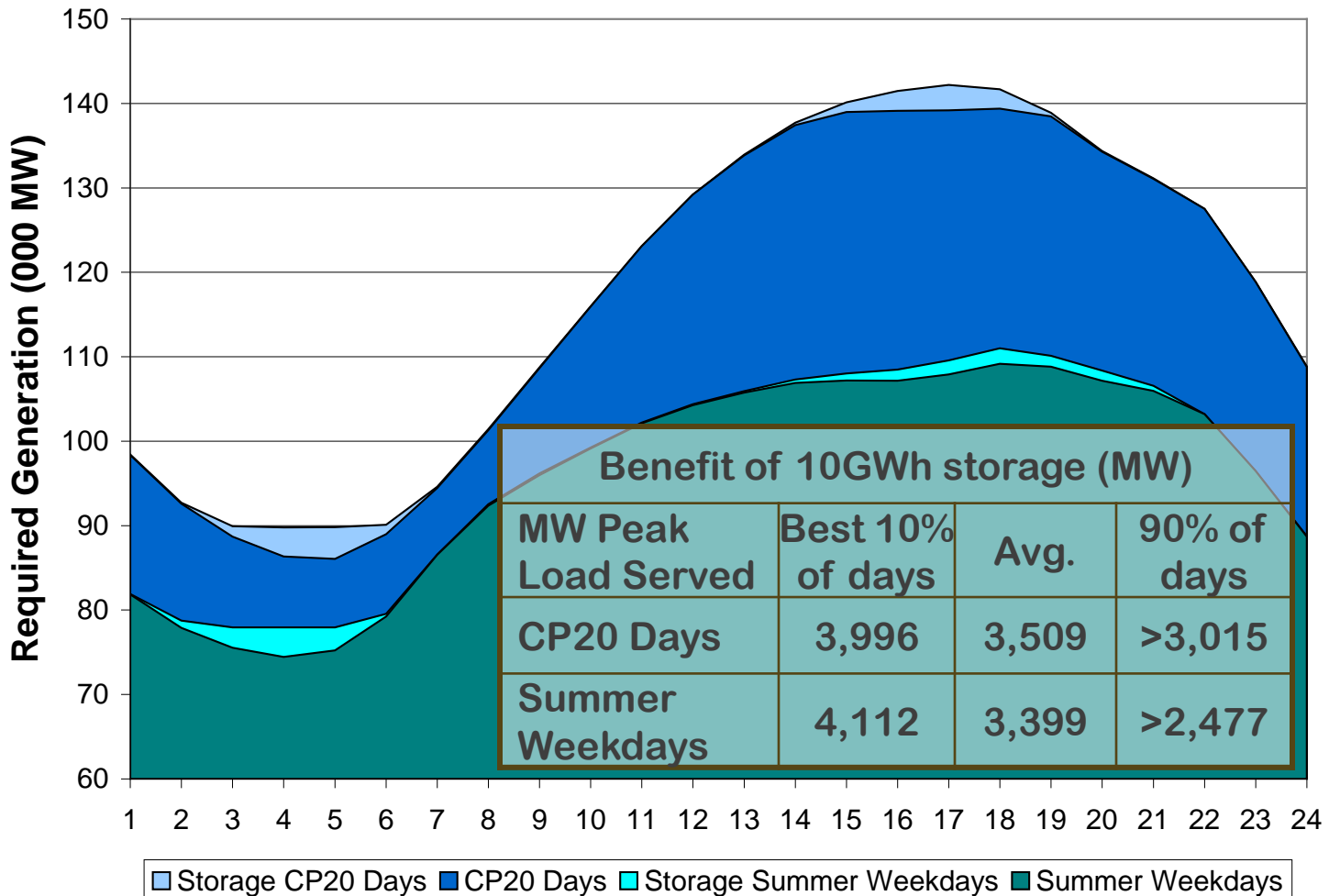
Fixed Duration Reduces Benefits

- **Requiring set output durations is equivalent to lowering maximum output**

10,000 MWh Storage becomes
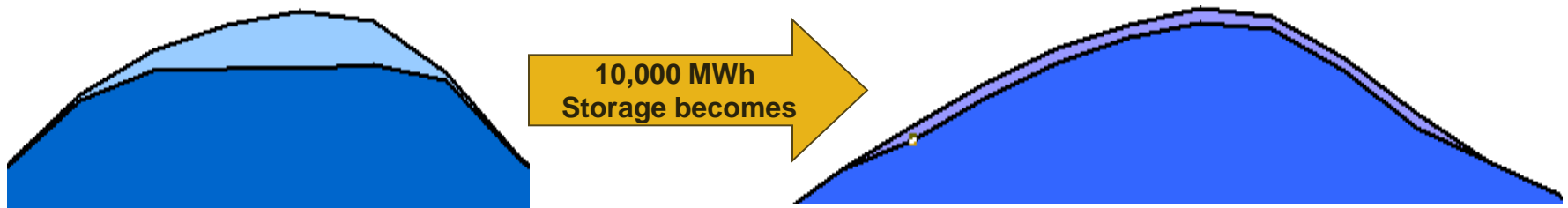
- **Reduces the load carrying benefits**

- **Shifts capacity from when needed to when its not**

- **For maximum benefit, storage often needs to be able to deliver 25% or more of its total energy during the peak hour of the day.**

- **A resource rated for high power can reduce output if needed, but the reverse is not true**

- **Developers will build to market requirements.**

- **If power is limited to 1/6th of energy, storage looses more than half its load carrying value. If power is limited to 1/10th of energy, only one quarter of load carrying value remains.**

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Reliability on Non-Peak Days

Reliability on Non-Peak Days

- **Meeting peak loads is only one aspect of reliability**

- **Recent risky days seem to not have been on system peak days**

- **Over the last 7 years, there have been 54 emergency days**

  - **Defined as any day with Load Management, Max Emergency Gen, Primary Reserve Alert, Voltage Reduction Alert, Voltage Reduction, Load Dump Warning, or Load Dump Action.**

- **59% of these days were in the CP20 for their year**

- **Almost half of emergency days were not in the top 20 high load days of their year**

- **Almost a quarter of emergency days were not in the top 50 high load days of their year**

- **Storage has many unique benefits that go far beyond meeting peaks**

Benefits of Storage

Discharging	Charging
• Ability to rapidly and accurately follow dispatch instructions	• Extends ramp periods
• Peak shaving, with lower cost energy	• Allows earlier unit start up
• Reduce thermal unit start/stop costs because the use of "peakers" is reduced	• Allows units with minimum outputs to be run earlier or longer without uplift
• Granular dispatch - On "high flat peak" days, overcomes the peak shifting and other limits of block-loaded DR	• Absorbs excess interchange
	• Makes use of otherwise wasted value of block-loaded DR
• Perfect compensation for start failures, unit trips, and other contingencies without calling reserves	• Obvious value during Min Gen events
• Reacts to import recalls and other issues of external capacity resources and interchange	• Controls voltage excursions after transmission contingencies
	• Reduces costs associated with "must run" minimum generation from thermal units because storage is withdrawing energy during off-peak
• Nodal – Can relieve transmission constraints on hot days unlike DR	
• Moving energy to where it is needed is recognized as having capacity value (e.g, QTUs).	• Reduces renewable energy curtailments or negative pricing because storage is withdrawing energy during off-peak

Flexible Capacity
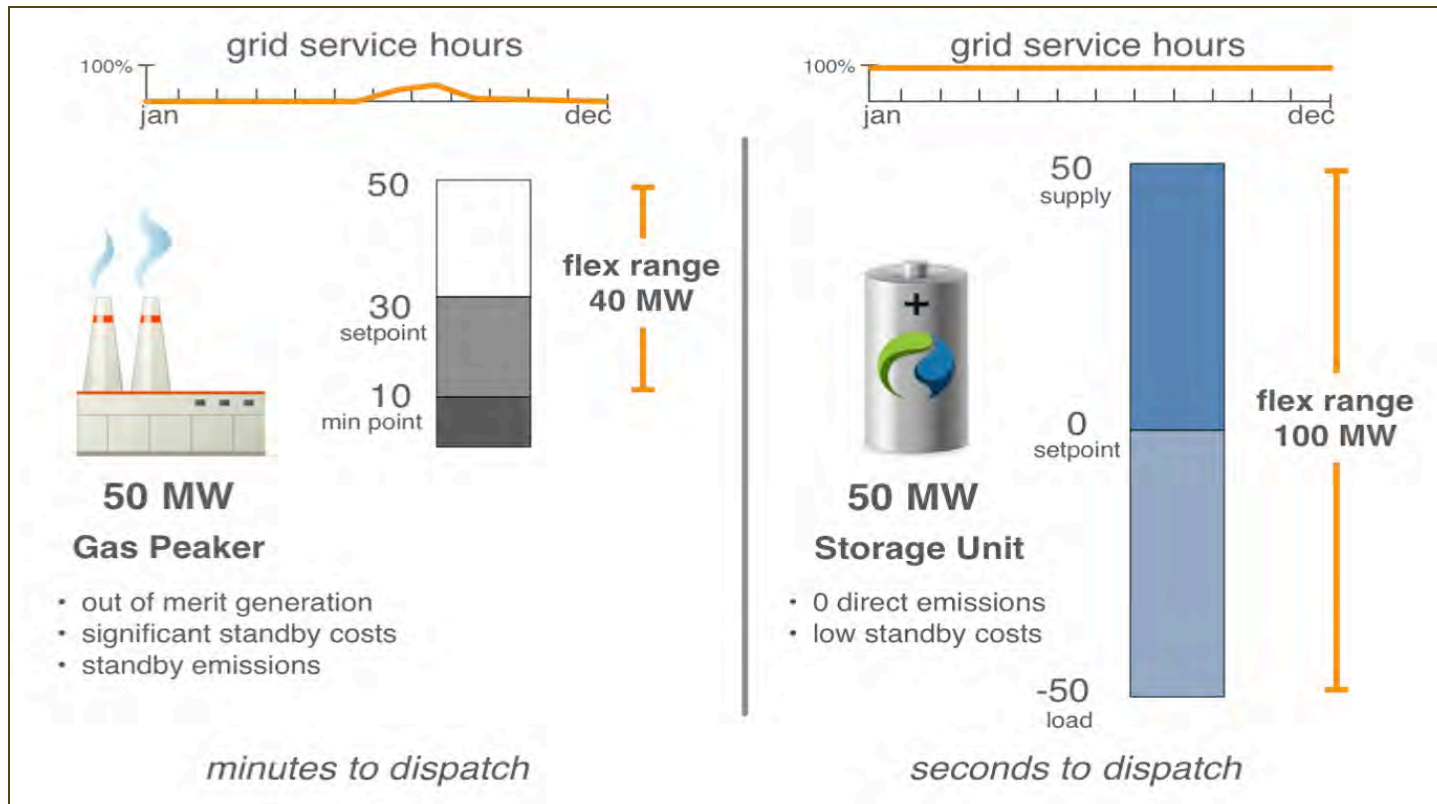
Energy storage brought online primarily to meet capacity requirements is able to provide value across all hours of the year, unlike new gas-fired peakers which are used in relatively few hours

Winter Reliability Benefits
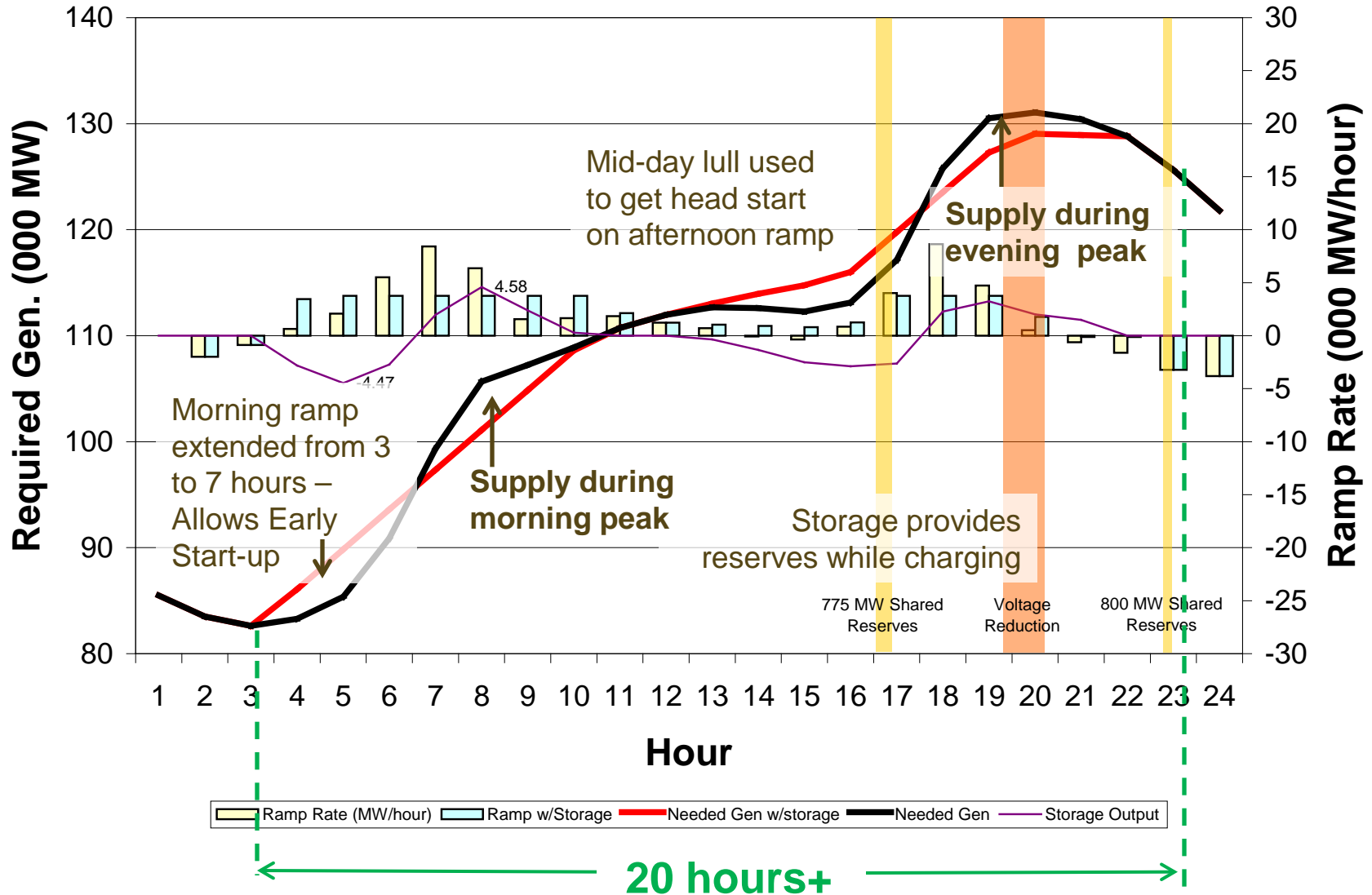
- Available in Winter, unlike Limited products

- Allows "early start up" of thermal plants in early morning hours without uplift

  - Annual DR not available until 10 am

- Quickly fill in stack for resources tripping off or failing to start

- Ability to supply during 2 critical peaks

  - Jan/Feb: HE 8-9, HE 19-20

- Potential to absorb wind overnight

  - Avoid Min Gen Issues

Cold Weather: Jan 6, 2014

Mid-day lull used to get head start on afternoon ramp

Supply during evening peak

Morning ramp extended from 3 to 7 hours – Allows Early Start-up

Supply during morning peak

Storage provides reserves while charging

775 MW Shared Reserves

Voltage Reduction

800 MW Shared Reserves

Required Gen. (000 MW)

Ramp Rate (000 MW/hour)

Hour

Ramp Rate (MW/hour) — Ramp w/Storage — Needed Gen w/storage — Needed Gen — Storage Output

20 hours+

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Typical Winter Day (Average Jan 21 – 30, 2014)
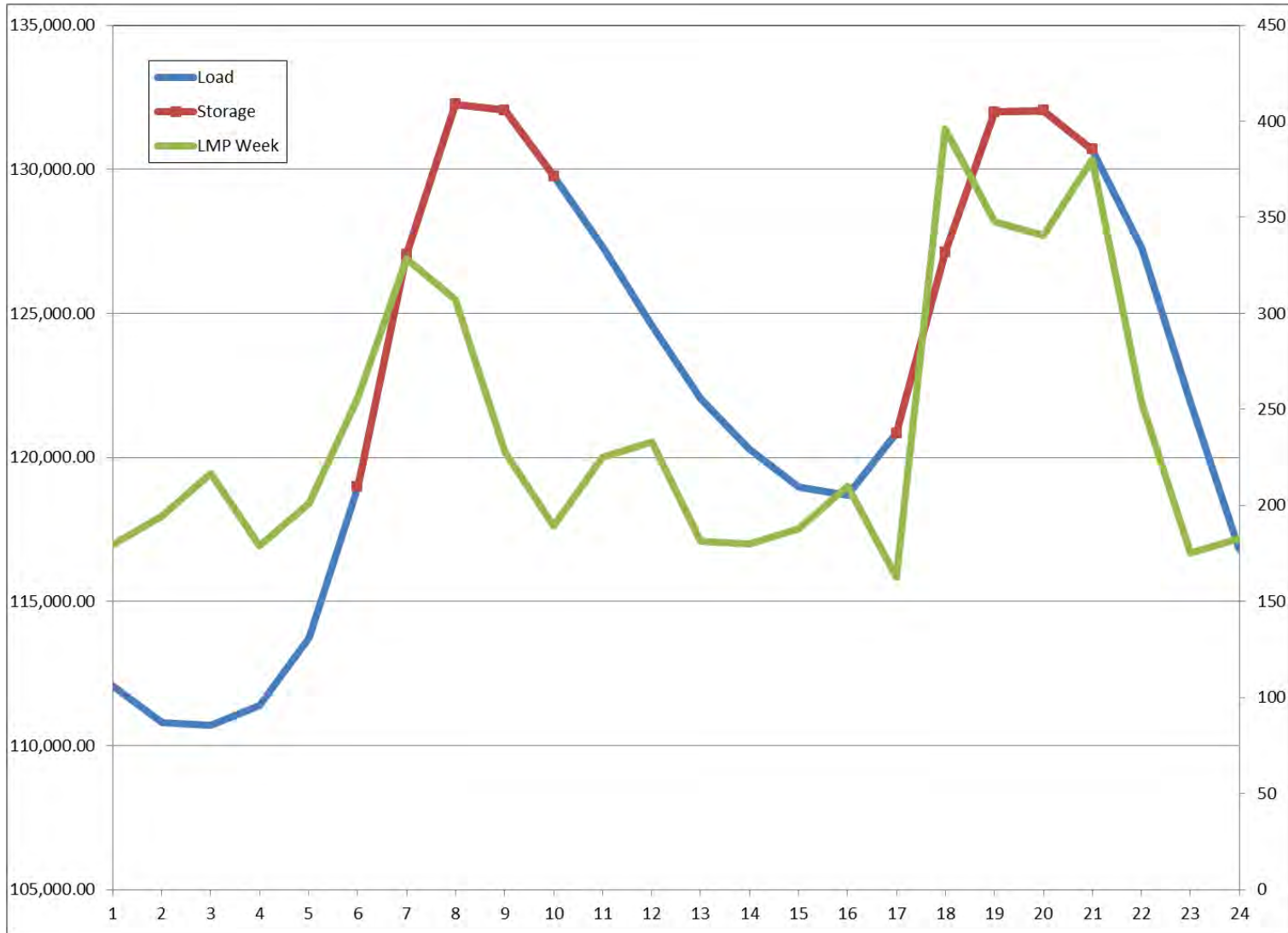
Scenario has 850MWh of storage in ATSI.

Charge by ramping 15 minutes early. This creates ~300MW of reserves for 5.75 hours

Storage follows load and DR to manage peak. Combined benefit more than the sum of the parts.

12:40 - ATSI Zone Long Lead Notified

14:40 - ATSI Zone Long Lead Activated

18:00 - ATSI Zone Long Lead Released

Peak Reduction	
DR alone	281MW
Storage alone	386MW
Together	**722MW**

13 hours+
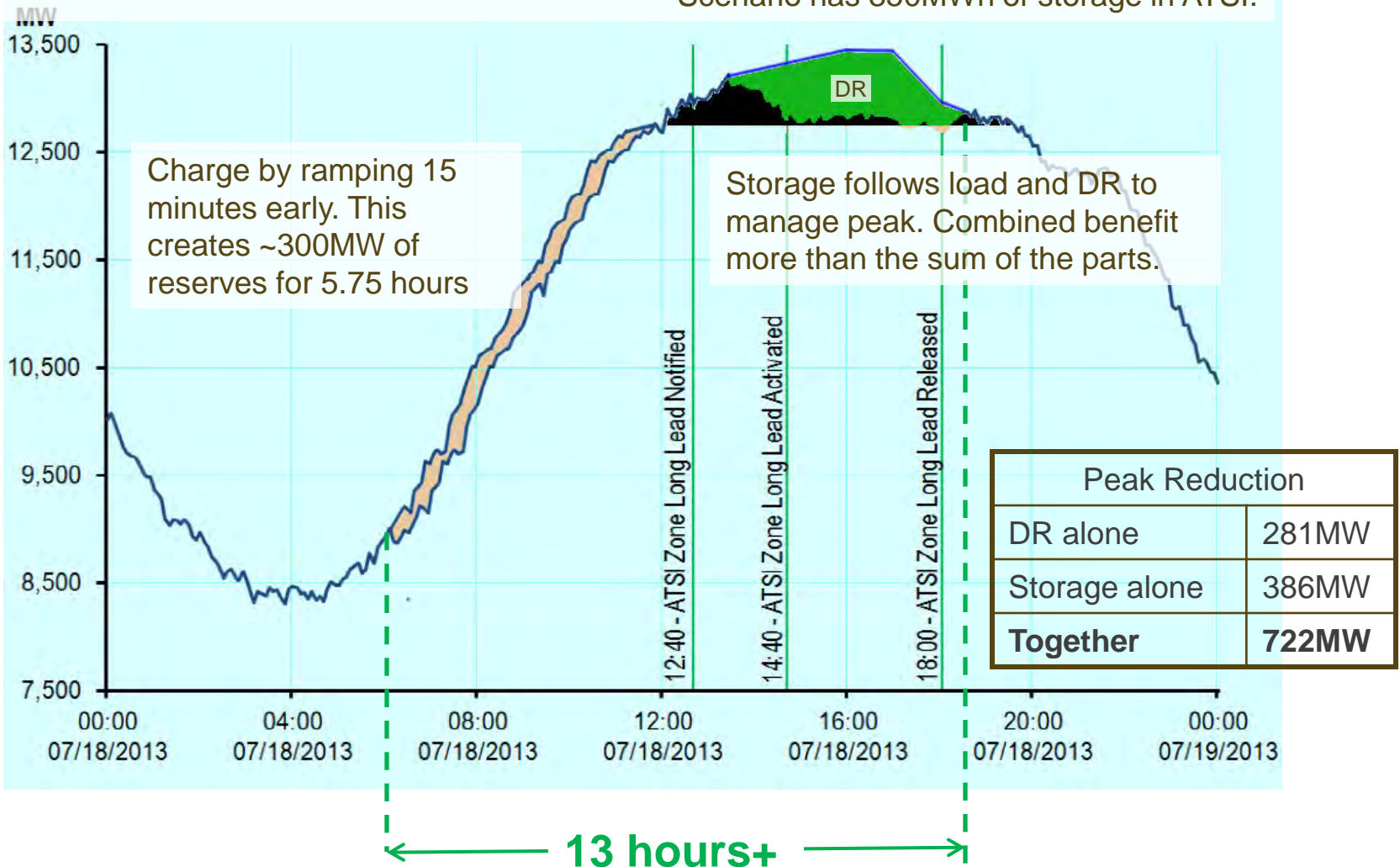
Capacity of Value of Storage

Storage: Comparison to other Resources

Storage	Generation	DR
Nodally dispatched	Nodally dispatched	At unknown nodes
24 hour resource with operational parameters •Charge time/rate managed by PJM	24 hour resource with operational parameters •Minimum run time, minimum down time, max starts per day	6 or 10 hour resource Limited calls, times of year and/or times of day
Must offer requirement	Must offer requirement	None
Individually dispatched, flexibility throughout entire range, with high accuracy	Individually dispatched, with Pmin and Pmax, ramp times	Dispatched in large, inflexible blocks
No notification time, "instantaneous"	Start up time varies	30-minute notification (up to 2 hours today)
Annual – available summer and winter, No fuel risk, No emissions issues	Annual – but fuel availability risk in winter, emissions limitations	Limited – only summer Annual – summer and winter

Storage resembles Highly Flexible Generation not Limited or even Annual DR

California ISO Proposed Storage rules

- *"Given the flexibility of many energy storage technologies and the high degree of availability the ISO expects of these resources, the ISO does not need to apply a minimum number of hours a non-generator resource must be available."*

- ISO has not identified any limitation that would preclude storage from being available comparable to conventional thermal resources

- ISO can optimize the dispatch through both the charge and discharge

- Storage that is fully discharged (charged) because of ISO dispatch instructions is available to the ISO but has hit an operational constraint

- No operational or environmental limits appear to justify the ISO classifying a non-generator resource as a use-limited resource

CAISO, Reliability Services Straw Proposal, June 5, 2014

# California ISO Proposed Storage rules

The ISO is proposing default qualifying capacity provisions for non-generator resources

- Default qualifying capacity calculation based on the resource's discharge capability
- The ISO will provide two different default qualifying capacity provisions:
  - Regulation energy management (REM)
    - Based on their ability to provide energy for 15 minutes
  - Energy and regulation
    - Based on the amount of output the resource can sustain over a four-hour period
- Cannot choose the REM for the default qualifying capacity provisions and the energy option for EFC or vice versa
- Must be a participating generator or a system resource
  - Requires the resource be at least 0.5 MW

California ISO

- **System Qualifying Capacity**

- **Effective Flexible Capacity**

Effective Flexible Capacity (EFC)
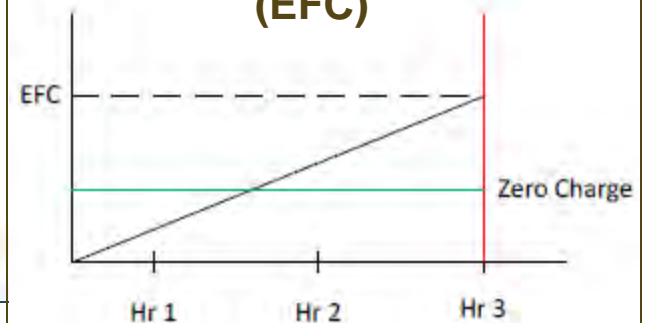
Proposed RPM Storage rules

➤ **Treat as Generation**

- Similar to pumped hydro storage
- Clears with other annual resources with no restrictions
- No change in RPM auction clearing mechanisms
- Interconnection, metering, and telemetry requirements same as generators

➤ **Energy Market: 24/7/365 Must Offer**

- As other Generation Capacity Resources: must submit offer data into the Day-ahead Market and may elect either to Self-Schedule or offer the resource to PJM for scheduling as a PJM RTO-Scheduled Resource. (M11)
- Offer parameters may include charge rate/time (e.g. pumped hydro)
- Energy scheduling and dispatch must respect charge state and limits
- Available 24/7/365 subject to normal forced/planned outages

Determining UCAP Value

- **Very few resource types have their UCAP reduced due to parameter limitations.**

- **Only example suggests UCAP could be set so the resource is parameter limited on no more than 10% of CP20 days.**

- **Results:**

  - On the 140 CP20 days in our sample, 10,000MWh of storage met between 2,791MW and 5,499MW of peak load.

  - On 90% of those days (126 days), the 10,000 MWh storage met 3,015MW or more of peak load.

10GWh storage, MW Power served			
	Best 10% of days	Avg.	90% of days
CP20 Days	3,996	3,509	>3,015
Summer Weekdays	4,112	3,399	>2,477

This suggests 3.3MWh of storage has the equivalent load serving capability of 1MW$_{UCAP}$ of generation.
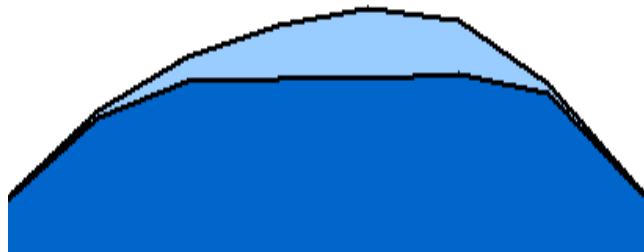
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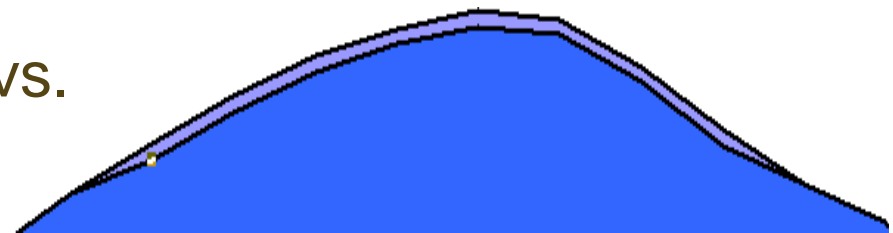
➢ **Capacity Valuation**

- UCAP determined by Nameplate Energy Rating/3.3 * (1-EFORd)
- UCAP also limited to maximum output * (1-EFORd)
  - Example: 3 MW/10 MWh storage resource with 5% EFORd:

    10MWh/3.3 * (1-.05) = 2.88 MW
  - Minimum UCAP 100kW, as other RPM resources.

Results in storage sized in both power and energy rating to meet peak requirements

10,000 MWh
Storage

VS.

10,000 MWh
Storage

- **Performance Measurement**
  - All EFORd and EFORp rules apply
  - Annual tests to demonstrate both power and energy
  - Out of charge is not a forced outage, unless due to failure to follow dispatch
- **Annual & initial test to determine capacity value**
- **Must offer requirement in RPM auctions as other generation**
- **Ability to include ACR & EAS offset (per normal generation offers in capacity market)**
  - EAS determined by MMU
  - ACR entered by market participant, including normal maintenance to maintain nameplate capacity value.
  - ACR – EAS offset = Capacity market offer