APPENDIX A

ISO Materials Presented at the CPUC Resource Adequacy Workshop

March 20, 2013

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Methodology for Determining Flexible Capacity Procurement Requirements

Presented at the CPUC RA Workshop
March 20, 2013 (Revised March 22, 2013 to reflect 80% fixed tilt solar fleet)

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Overview

- Review of Actual Operational Observations from 2013
- Data Collection and Study Methodology for Calculating the Flexible Capacity Requirements
- 3-hour ramping requirements: Results for 2014-2016 assessments
- Calculating and Assessing Effective Flexible Capacity (EFC) of the Fleet
- Flexible RA Capacity Procurement Requirement Process Timeline

Key Takeaways

- Net Load Ramps have already exceeded 7,500 MW in 3-Hours
- The ISO is using an established and CPUC vetted methodology
- The most significant ramping needs occur in off-peak months and exceed 10,000 MW in 3-hours
- Ramps exceeding 3-hour length will continue to occur
- While there is enough EFC, the current RA procurement framework may not ensure that flexibility is available to the ISO when needed
- A flexible capacity procurement obligation will enhance operational certainty as early as 2014
- It is feasible and necessary to implement a Flexible Capacity procurement obligation for 2014

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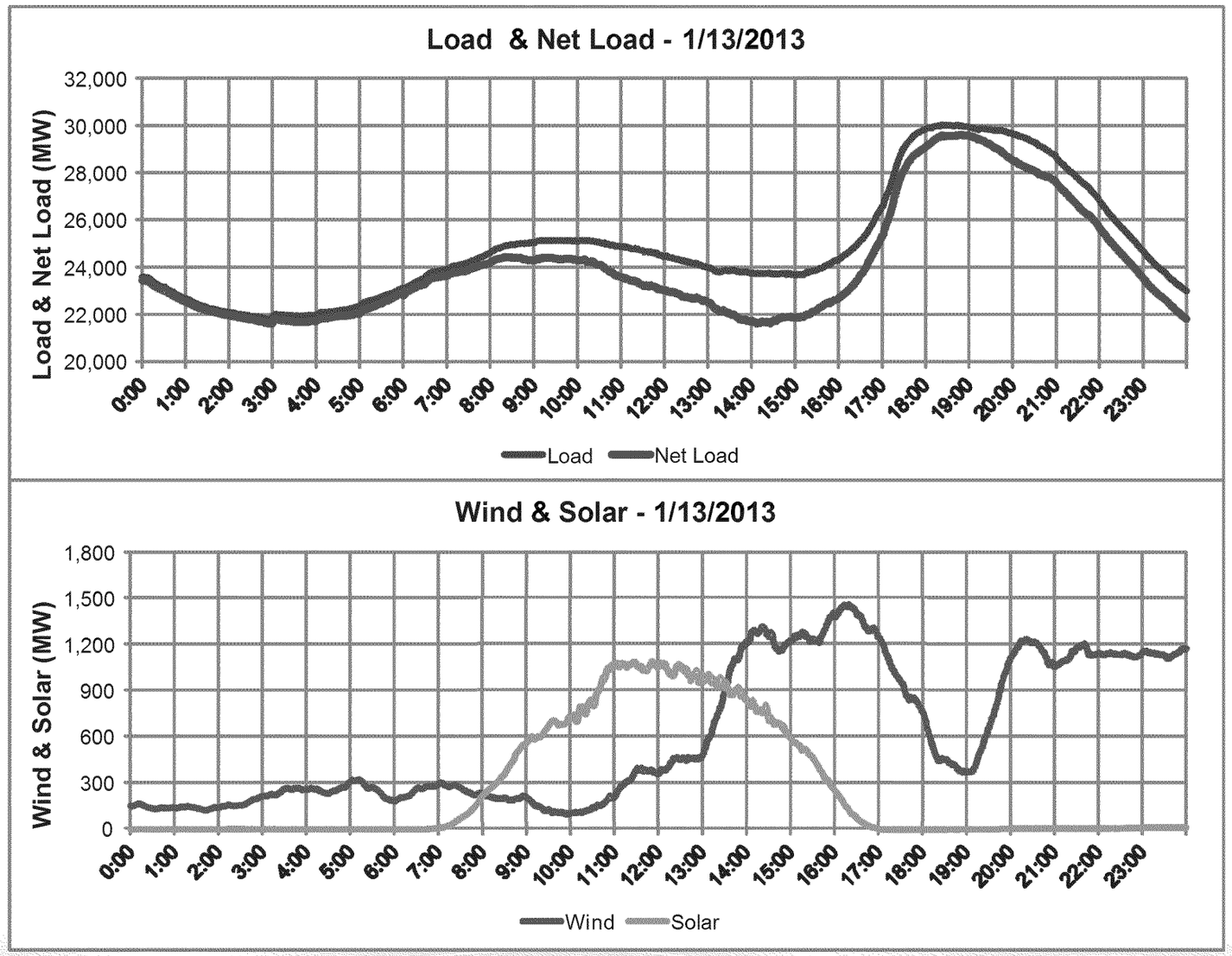
Review of Actual Operational Observations from 2013*

* Additional Actual 2013 operational observations are contained in the Appendix

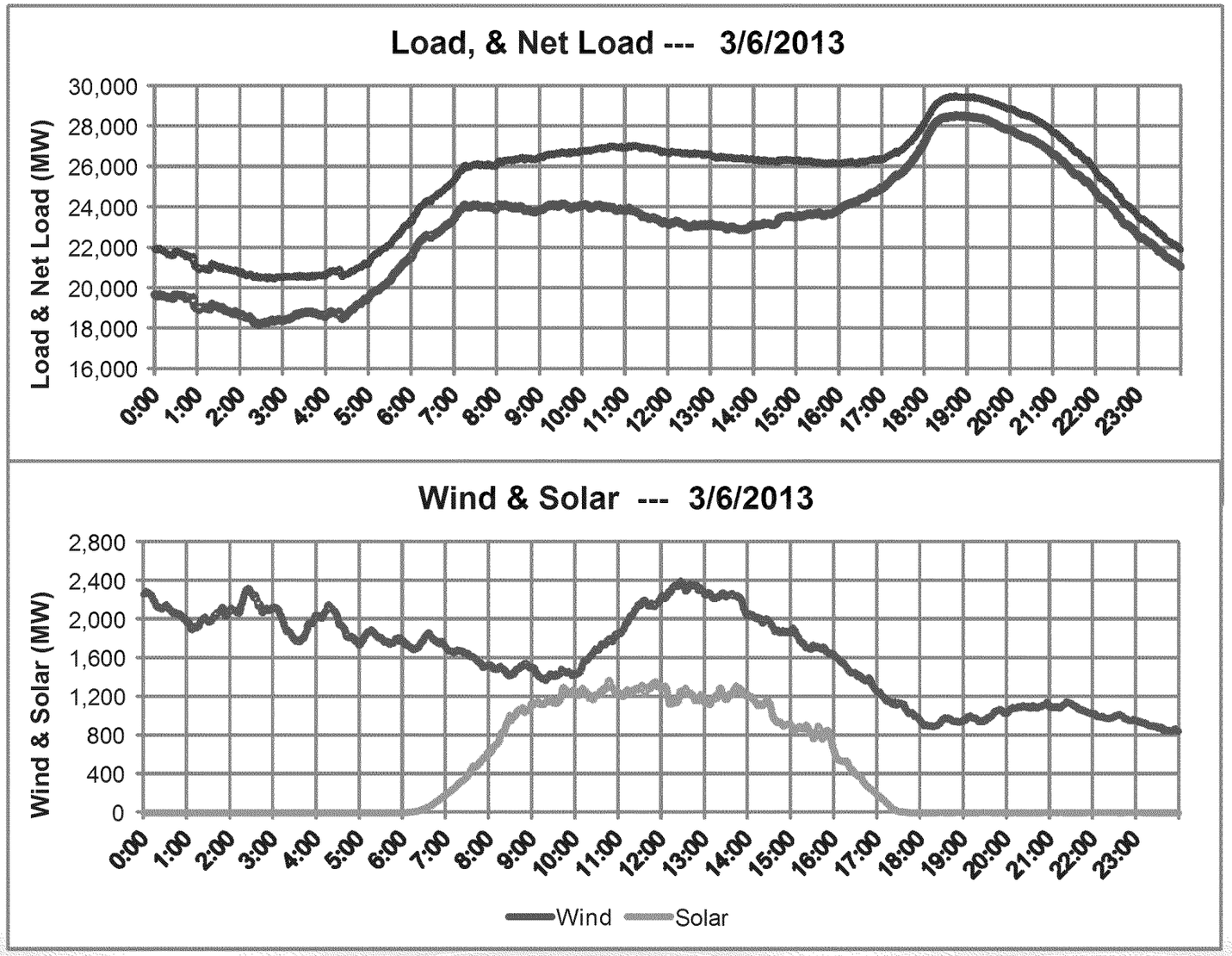
Wind and solar output drop simultaneously, resulting in a 7,500 MW 3-Hour Net Load ramp: January 13, 2013

- Maximum 3-Hour Load ramp was 6,285 MW
- Maximum 3-Hour Net Load ramp was 7,524 MW
- From 13:00, 807 MW of wind increased in 70 minutes during declining demand
- During the evening load ramp, wind dropped of by 991 MW and solar by 118 MW in 2 hours starting at 16:19



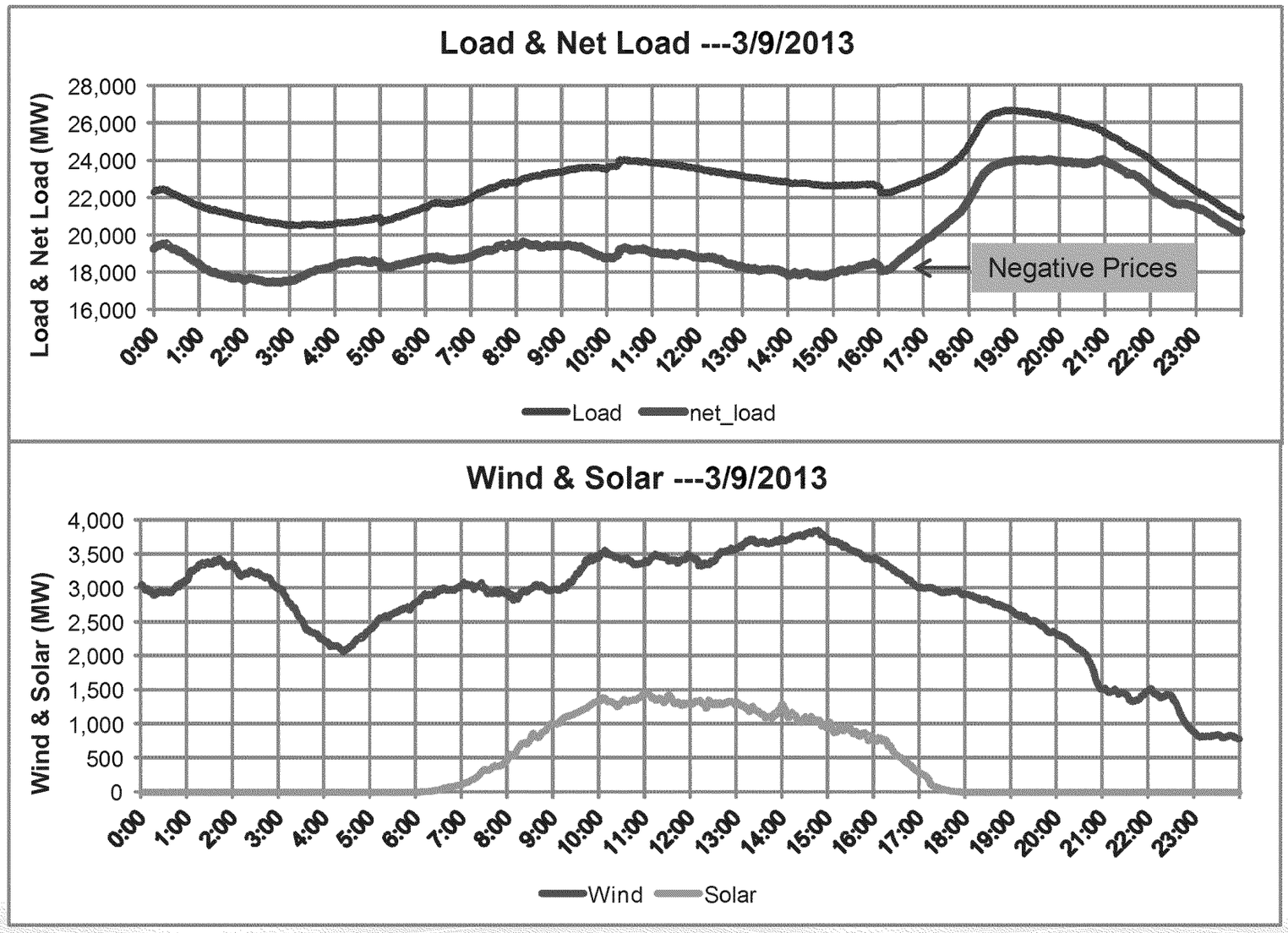
Wind and solar peaked and dropped simultaneously resulting in two distinct ramp-up periods

- Wind peaked at 2,391 MW @ 12:27
- Solar peaked at 1,367 MW @ 10:47
- Noticeable change in load and net load shape across mid-day
- Load increased by 3,500 MW in 2.5 hours
- Net Load increased by 5,000 MW in 3.5 hours



Wind production above 3,600 MW resulted in a net load below 18,000 MW and RTD negative prices for 11 5-minute intervals

- Wind production above 3,600 MW
- Solar production around 1,000 MW
- Net Load below 18,000 MW
- Nine 5-minute intervals of negative RTD prices for HE15
- Two 5-minute intervals of negative RTD prices for HE 16



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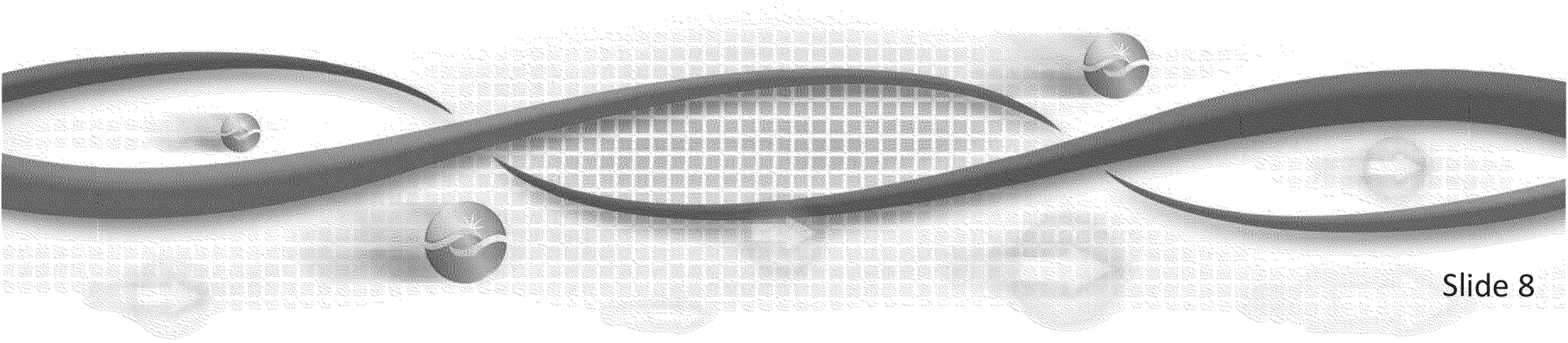
Data Collection and Study Methodology for Calculating the Flexible Capacity Requirements



Slide 8

Expected IOU RPS portfolio build-out has been updated

- The three IOUs provided their latest RPS data
  - Data based on IOU 2012 RPS Compliance Reports
  - The ISO obtained public version of contracted MW of RPS plans
- Information collected on resources included:
  - Location
  - Contracted capacity
  - On-line date
  - Technology

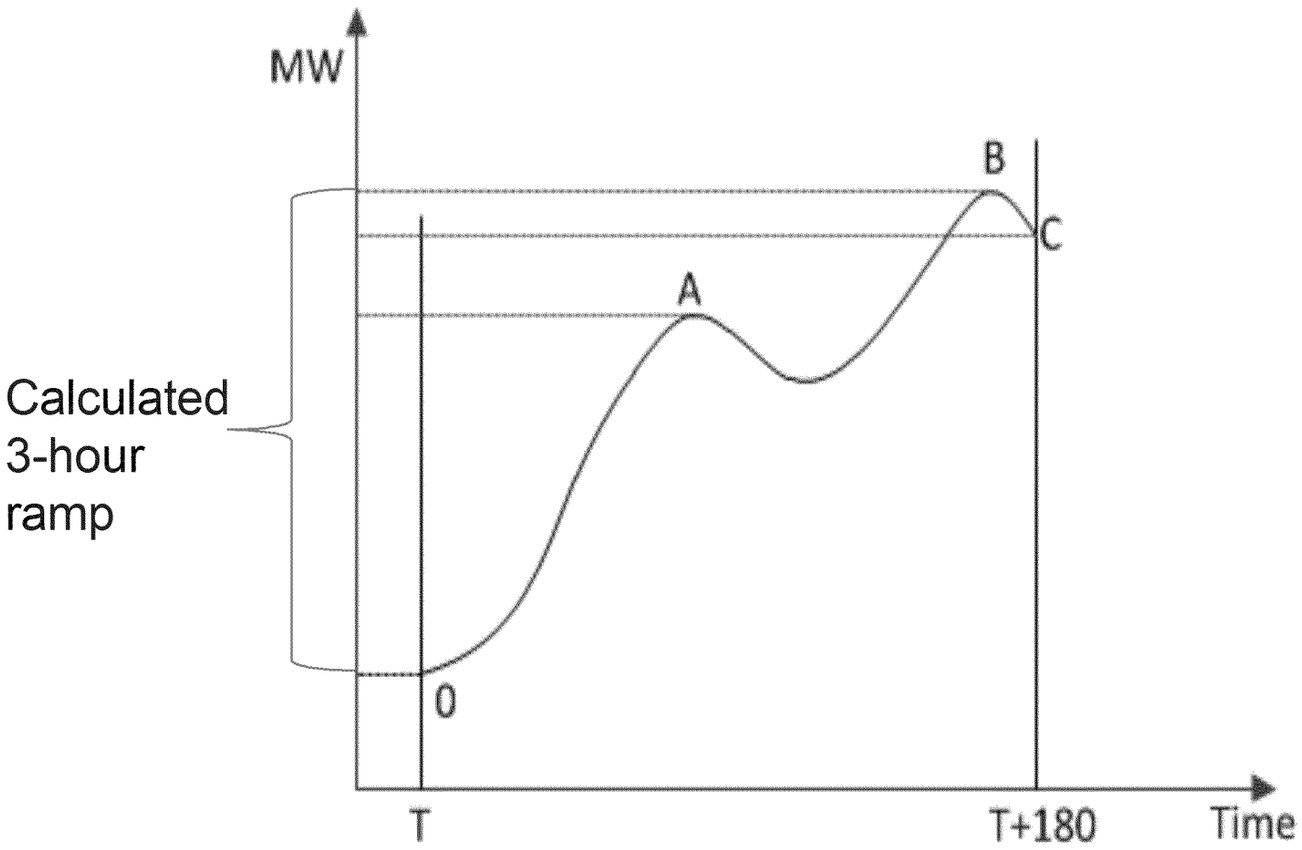
Using LTPP Base Case Assumption, Updated System-wide RPS Build-Out Shows 11,000 MW New Intermittent resources by 2017

- Relies on the same methodology and renewable profiles used in R.12-03-014
- Modified Assumptions:
  - Updated RPS data as previously defined*
  - Total Small PV figures are based on 2010 LTPP Assumptions

		Existing 2012	2013	2014	2015	2016	2017
Total Small PV (Demand Side) 2010 LTPP Assumptions		367	733	1100	1467	1833	2200
ISO	Solar PV	1,345	1,645	3,193	3,727	4,205	5,076
ISO	Solar Thermal	419	373	748	968	1,718	1,918
ISO	Wind	5,800	1,224	1,402	1,685	1,695	1,695
Sub Total of Intermitant Resources		***7,931***	***11,906***	***14,374***	***15,779***	***17,382***	***18,821***
Incremental New Additions in Each Year			3975	2,468	1,405	1,603	1,439

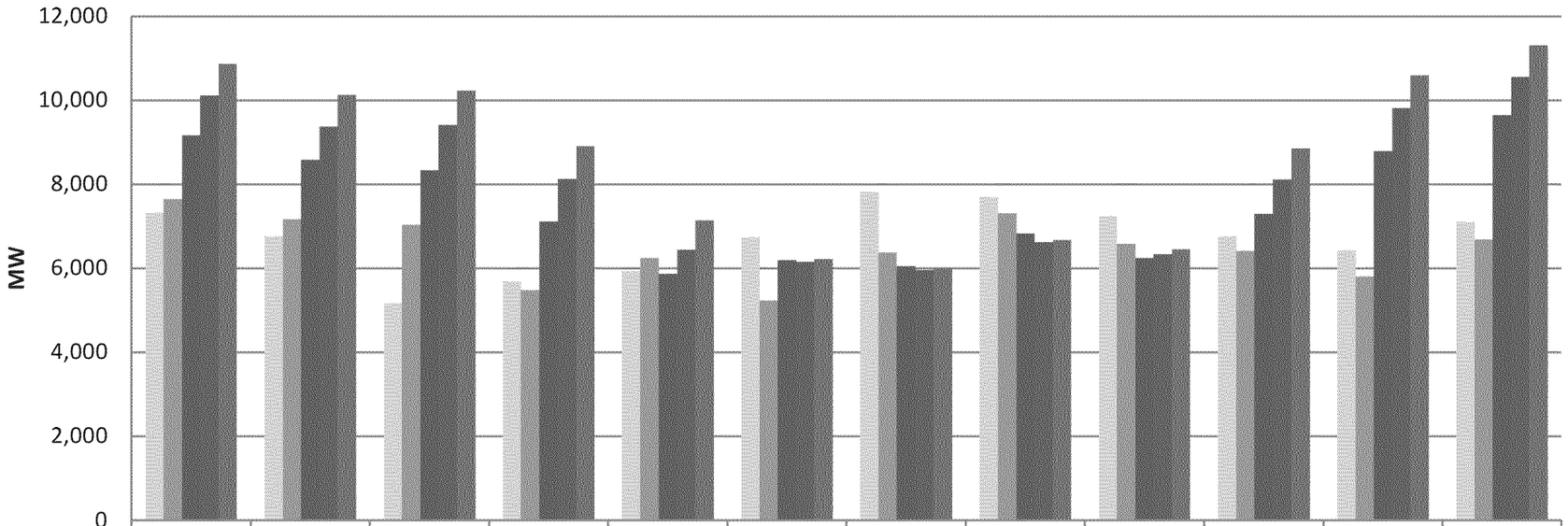
* Additional detail regarding individual IOU build out is provided in the Appendix

The 3-hour ramping need is calculated using the largest ramp during each 180 minute period



ISO tested all points using each methodology. Points B and C produced nearly identical needs for all months

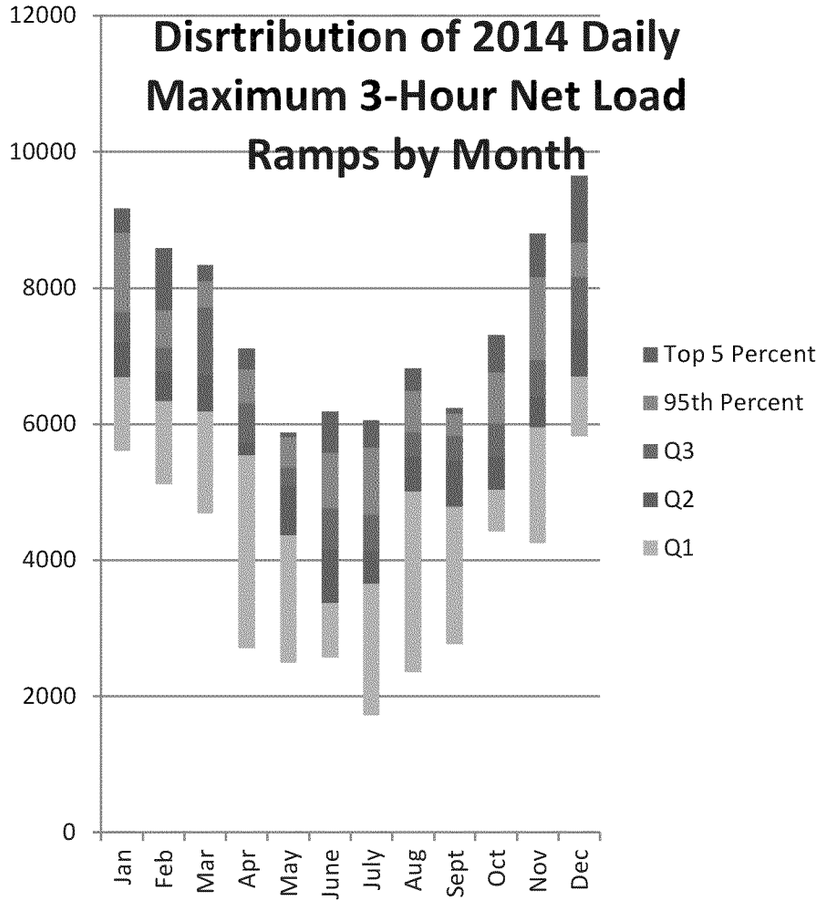
The maximum 3-hour net load ramp increases in each shoulder month by about 800-1000 MW year over year (revised to reflect 80% fixed tilt solar fleet)

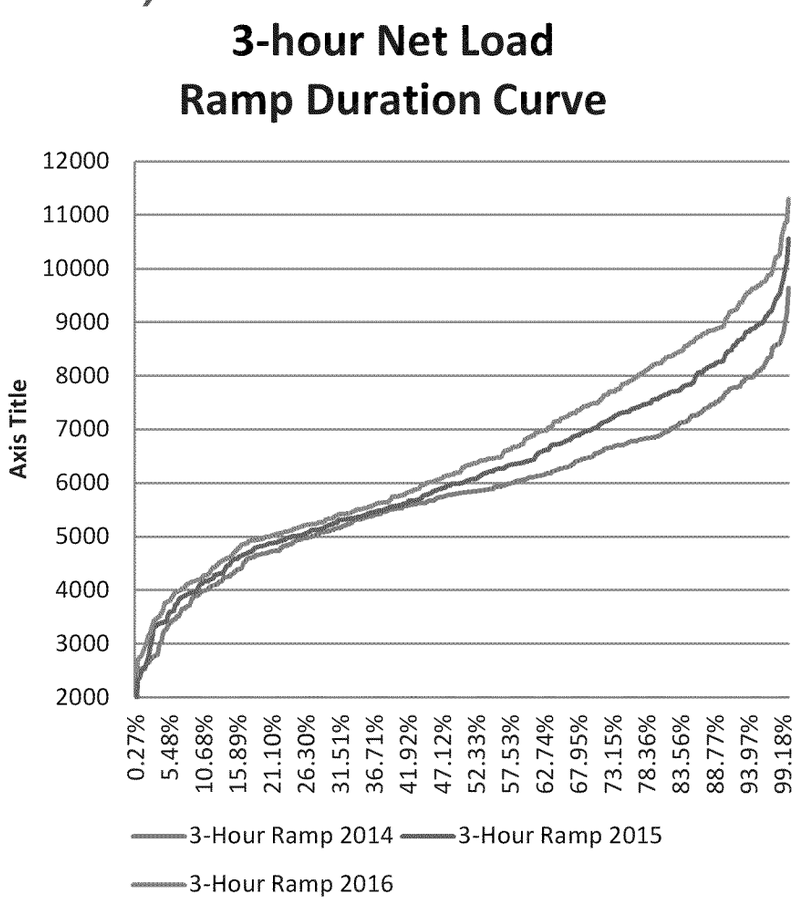


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011	7,319	6,770	5,168	5,688	5,942	6,732	7,815	7,702	7,251	6,767	6,433	7,098
2012	7,654	7,169	7,031	5,484	6,250	5,237	6,367	7,316	6,591	6,422	5,801	6,687
2014	9,167	8,584	8,341	7,113	5,873	6,189	6,054	6,824	6,239	7,304	8,799	9,648
2015	10,113	9,375	9,422	8,130	6,439	6,164	5,955	6,617	6,340	8,121	9,817	10,559
2016	10,877	10,129	10,235	8,903	7,140	6,220	6,006	6,673	6,454	8,858	10,597	11,306

* 2011 and 2012 use actual ramp data, while 2014-2016 use minute-by-minute forecasted ramp data

There are opportunities for use-limited and DR resources to address "super-ramps" (revised to reflect 80% fixed tilt solar fleet)





The proposed interim flexible capacity methodology should provide the ISO with sufficient flexible capacity

- Methodology

Flexibility Requirement$_{MTHy}$ = Max[(3RR$_{HRx}$)$_{MTHy}$] + Max(MSSC, 3.5%*E(PL$_{MTHy}$)) +

Where:

Max[(3RR$_{HRx}$)$_{MTHy}$] = Largest three hour contiguous ramp starting in hour x for month y

E(PL) = Expected peak load

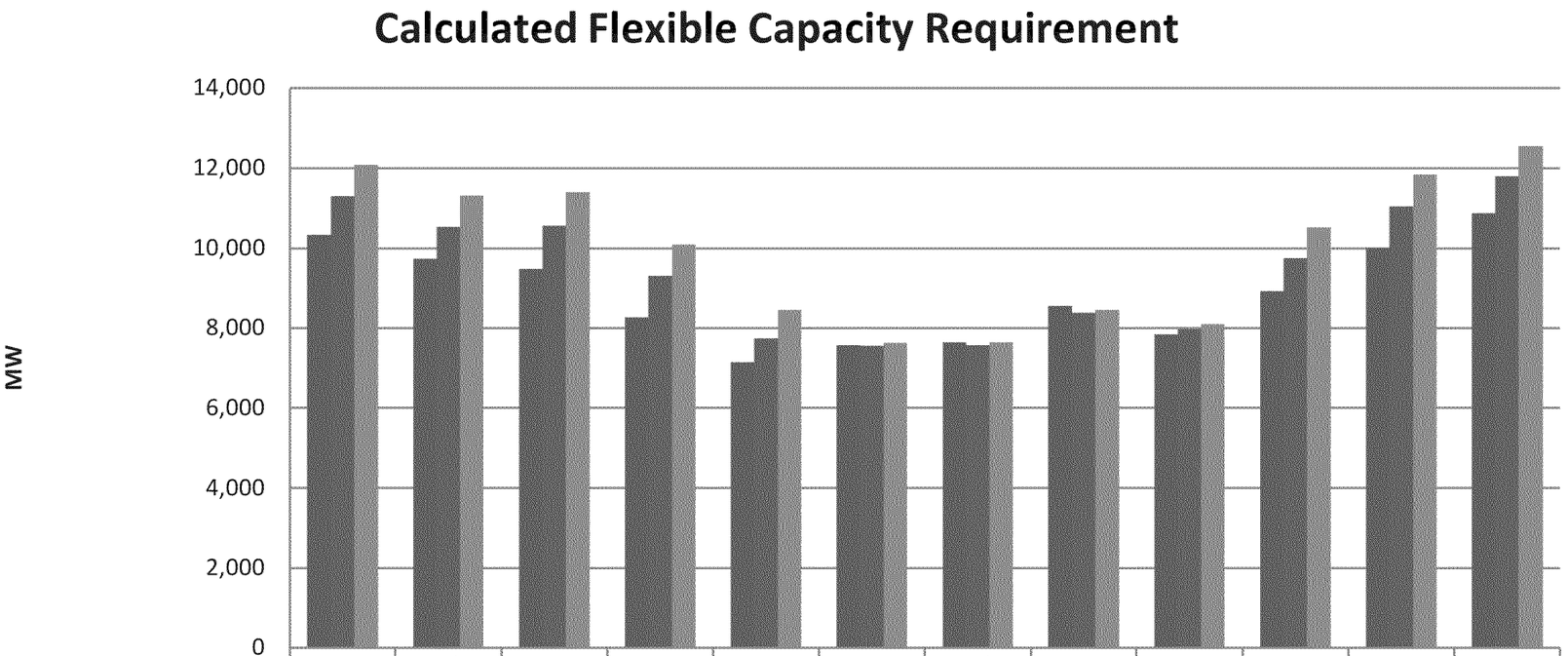
MTHy = Month y

MSSC = Most Severe Single Contingency

= Annually adjustable error term to address load forecast errors and variability

- Methodology for 2017 and beyond needs to be developed

The forecasted peak ramping needs are greatest in the shoulder months and growing over time (revised to reflect 80% fixed tilt solar fleet)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total_Flex_Need_2014	10,335	9,732	9,474	8,272	7,151	7,563	7,646	8,563	7,841	8,916	10,007	10,869
Total_Flex_Need_2015	11,296	10,539	10,570	9,305	7,734	7,556	7,568	8,380	7,964	9,754	11,042	11,796
Total_Flex_Need_2016	12,077	11,310	11,400	10,095	8,454	7,631	7,643	8,460	8,100	10,515	11,839	12,560

Flexibility Requirement$_{MTHy}$= Max[(3RR$_{HRx}$)$_{MTHy}$] + Max(MSSC, 3.5%*E(PL$_{MTHy}$)) +

Note: In the 2014-2016 assessments, the MSSC is never larger than the 3.5%*E(PL$_{MTHy}$)

Summary of Findings

- Flexibility Capacity Need is largest in off-peak months
  - Flexible capacity will need to make up a greater percentage of the RA fleet in off-peak months
- The flexible capacity needs increase by about 800-1000 MW year over year in non-peak months
  - Increase almost exclusively caused by 3-hour ramp, not increase in peak load
- The most extreme ramps grow over time, showing increased ramping needs
- Daily maximum 3-hour ramps have significant monthly variance
  - Presents opportunity for Use-Limited resources, Demand Response, and Storage to meet “super ramps”

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Calculating and Assessing Effective Flexible Capacity of the Fleet

Joint Parties proposal allows parties to determine a resource's effective flexible capacity

Start-up time greater than 90 minutes

EFC = Minimum of (NQC-Pmin) or (180 min * RRavg)

Start-up time less than 90 minutes

EFC = Minimum of (NQC) or (Pmin + (180 min – SUT) * RRavg)

Where:

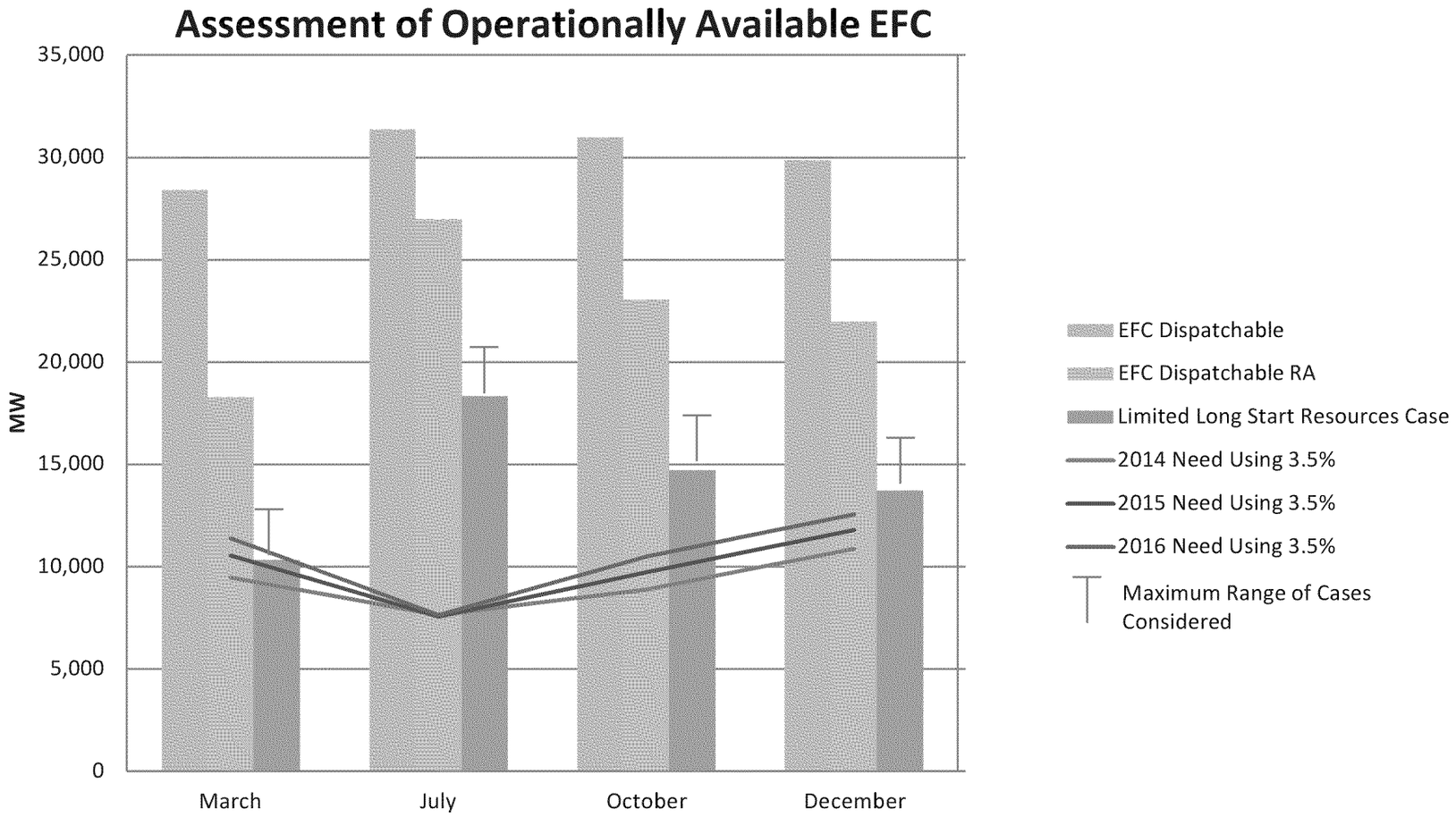
EFC: Effective Flexible Capacity

NQC: Net Qualifying Capacity

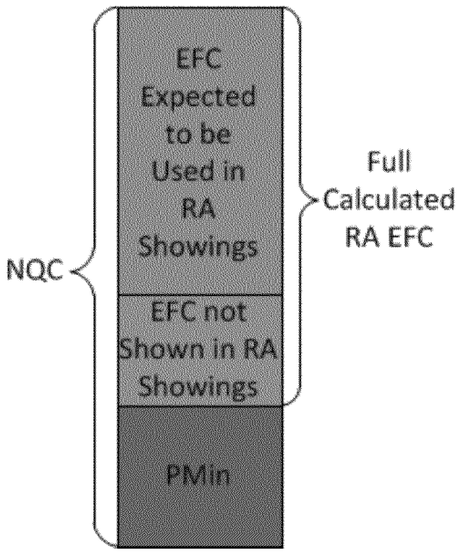
SUT: Start up Time

RRavg: Average Ramp Rate

Need a procurement rule to ensure sufficient flexibility in the procured RA resources (revised to reflect 80% fixed tilt solar fleet)



Need procurement rule that accounts for and ensures flexible capability is available for operational use



- Just because a resource has a calculated EFC, does not mean it will be listed as flexible in an RA showing and available for operational use.
- Simple case assessments* reflect potential of reduction of EFC for actual operation use due to:
  - Hydro conditions/run of river
  - Self-scheduling
  - Outages
  - Elections by resources to be inflexible

* Assumed reductions and additional cases are detailed in the Appendix

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Flexible RA Capacity Procurement Requirement Process Timeline

2014 Flexible RA Capacity Procurement Requirement Process Timeline

Flexible Capacity Requirement Setting (Activities occurring in the year prior to RA compliance year)	
• FCR methodology and assumptions paper and EFC amounts by eligible resource presented at CPUC workshop	Mar 20, 2013
• Parties submit comments on workshop and ISO proposed 2014 flexibility requirements	Set by CPUC
• Publish draft final LCR study and EFC list of eligible flexible capacity resources	Mar 28, 2013
ISO stakeholder meeting to discuss LCR / FCR results	Apr 4, 2013
Stakeholders submit comments	Apr 18, 2013
• Final 2014 LCR & FCR study	May 1, 2013
• CPUC proposed and final annual RA decision incorporating LCR and FCR obligations	May / June 2013
CPUC Procurement Obligation Allocation (System, local and flexible obligations for the following RA compliance year)	
• LSEs receive Year-Ahead obligations	Jul 31, 2013
• Revised load forecasts for following RA compliance year	Aug 17, 2013
• LSEs receive revised RA obligations	Sep 17, 2013
Showings (Activities occurring during the RA compliance year)	
• Year-ahead showing of system, local, and flexible capacity (show 100% local and 90% system and flexible)	Oct 31, 2013
• Month-ahead showings, including local and flexible true-ups	2014 Operating Month (T) – 45 days
• ISO notifies LSEs and suppliers of any deficiencies of system, local, and or flexible capacity	T-25 days
• LSEs demonstrate to the ISO that identified deficiencies have been cured	T-11 days

Illustrative 2015 & Beyond FCR Process Timeline

Flexible Capacity Requirement Setting (Activities occurring in the year prior to RA compliance year)	
Receive CEC load forecast used for TPP expansion plan	By Jan
Receive updated RPS build-out data from the IOUs	By Jan
Publish annual FCR assumptions paper	By Jan
– ISO stakeholder meeting to discuss assumptions	Feb
– Stakeholders submit comments	Feb
– Posting of comments with ISO response	Feb
Draft LCR and FCR study completed (including EFC list of eligible flexible capacity resources)	Mar 4
– Local & flexible capacity needs stakeholder meeting	Mar 7
Publish draft final LCR & FCR needs study	Mar 28
– ISO stakeholder meeting to discuss LCR / FCR results	Apr 4
– Stakeholders submit comments	Apr 18
Final 2014 LCR & FCR study	May 1
CPUC proposed and final annual RA decision incorporating LCR and FCR procurement obligations	May / June
CPUC Procurement Obligation Allocation (System, local and flexible obligations for the following RA compliance year)	
LSEs receive Year-Ahead obligations	Jul 31
Revised load forecasts for following RA compliance year	Aug 17
LSEs receive revised RA obligations	Sep 17
Showings (Activities occurring during the RA compliance year)	
Year-ahead showing of system, local, and flexible capacity (show 100% local and 90% system and flexible)	Oct 31
Month-ahead showings, including local and flexible true-ups	T -45 days
ISO notifies LSEs and suppliers of any deficiencies of system, local, and or flexible capacity	T-25 days
Final opportunity for LSEs to demonstrate to the ISO that any identified deficiencies have been cured	T-11 days

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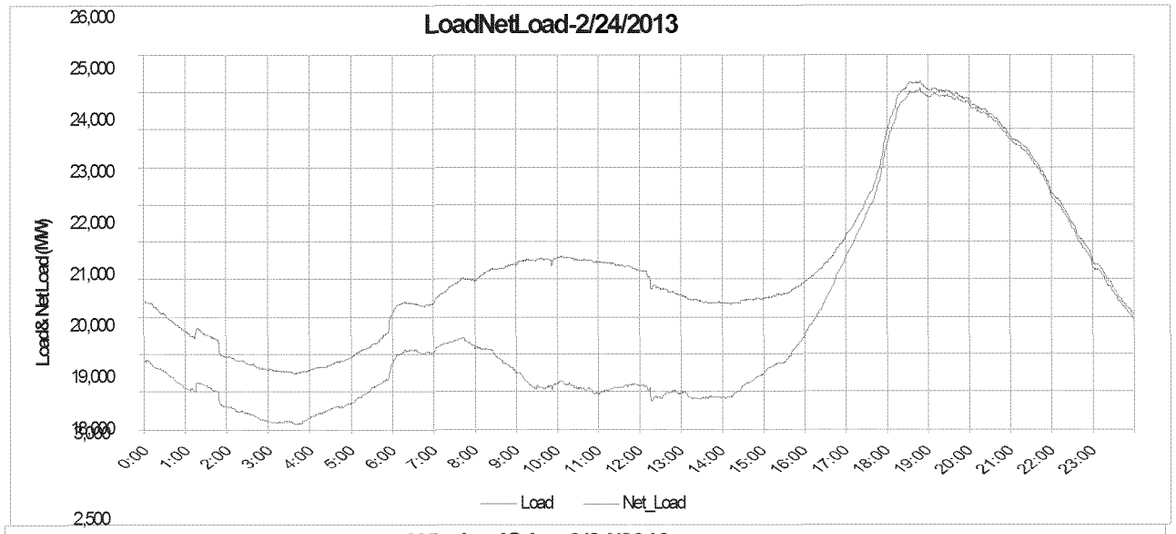
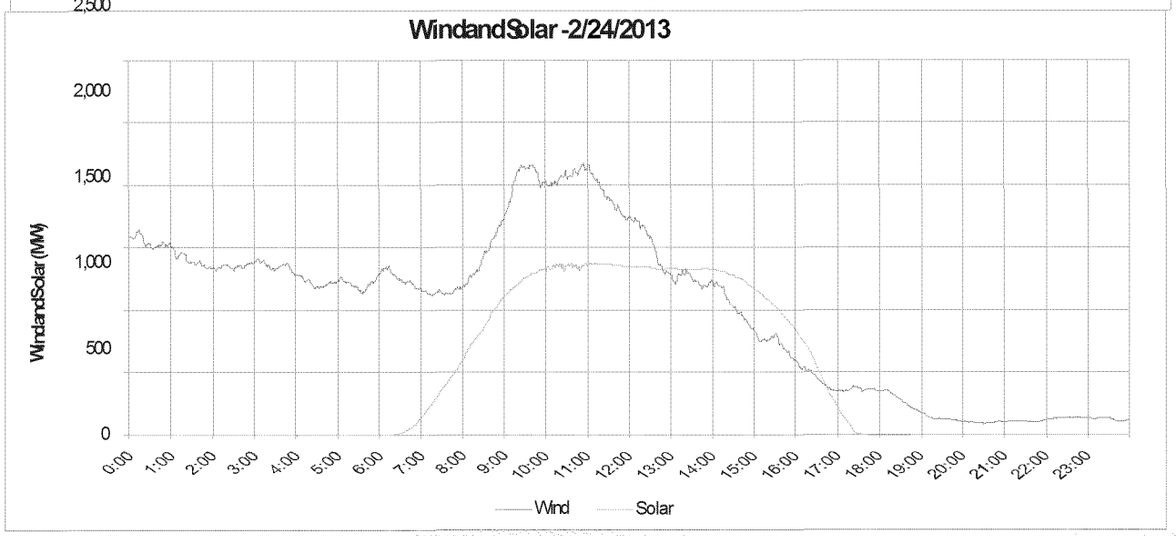
Appendix

Wind and solar output drop simultaneously, resulting in a 7,100 MW Net load ramp: Actual Data from 2/24/2013

- 1,300 MW of solar & 800 MW of wind dropped off in 21/2 hours as load increased
- Wind & solar contribution at peak was about 300 MW
- Maximum ramp approx. 8,000 MW in 5-hours
- Maximum 3-Hour ramp 7,171 MW
- Steep evening ramps are real and expected to increase with more renewable resources





RPS Data Collection – By IOU

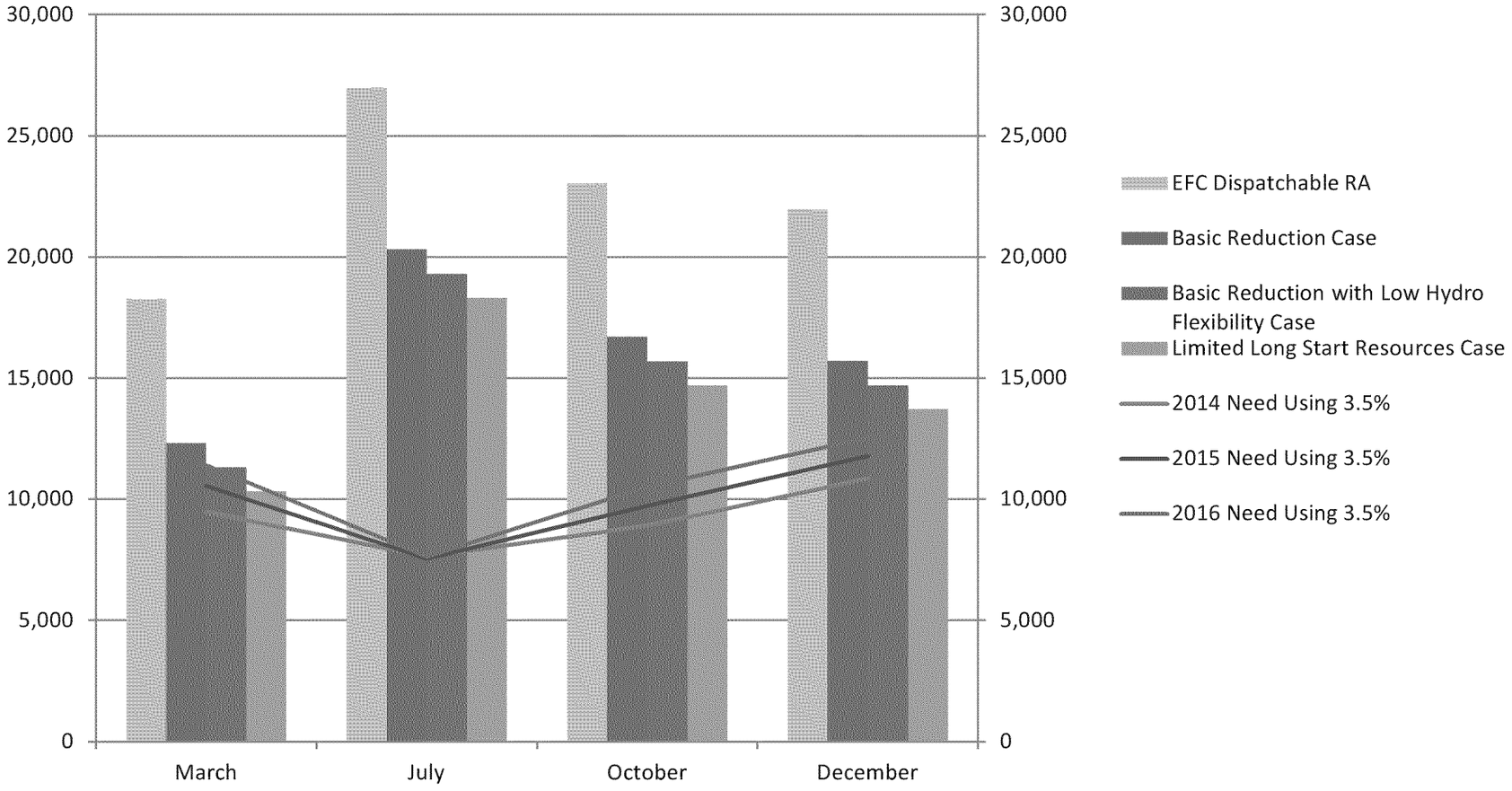
		2013	2014	2015	2016	2017
Load (Replicating Base Case Scenario from R.12-03-014)		48870	49577	50240	50951	51625
Total by IOU, Technology, and Year		2013	2014	2015	2016	2017
PG&E	Solar PV	1,026	1,646	1,929	2,131	2,202
PG&E	Solar Thermal	373	748	968	1,718	1,918
PG&E	Wind	29	29	42	52	52
SubTotal of PG&E New Additions		1,428	2,423	2,940	3,901	4,173
Incremental PG&E Additions		1,428	995	517	961	272
SCE	Solar PV - Ground mount	0	381	468	578	1,378
SCE	Solar PV - Rooftop	0	43	43	43	43
SCE	Wind	0	0	270	270	270
SubTotal of SCE New Additions		0	423	780	890	1,690
Incremental SCE Additions in Each Year		0	423	357	110	800
SDGE	Solar PV	619	1,123	1,288	1,454	1,454
SDGE	Wind	1,195	1,373	1,373	1,373	1,373
SubTotal of SDG&E New Additions		1,814	2,496	2,661	2,827	2,827
Incremental SDGE Additions in Each Year		1,814	682	165	166	0

Reductions to EFC used in ISO case assessments, using 2012 Month-ahead RA showings

	Run-of-River Hydro Reductions	Reduction in Hydro based on Hydro conditions**	Reductions for continued Self Scheduling	EFC OTC retirement in 2015	Reductions based on election of inflexibility elections	Assumed outage rate of all remaining resources
Basic Reduction Case	1000	1000	2000	500	0	8%
Basic Reduction with Low Hydro Case	1000	2000	2000	500	0	8%
Limited Long Start Resources	1000	1000	2000	500	2000	8%

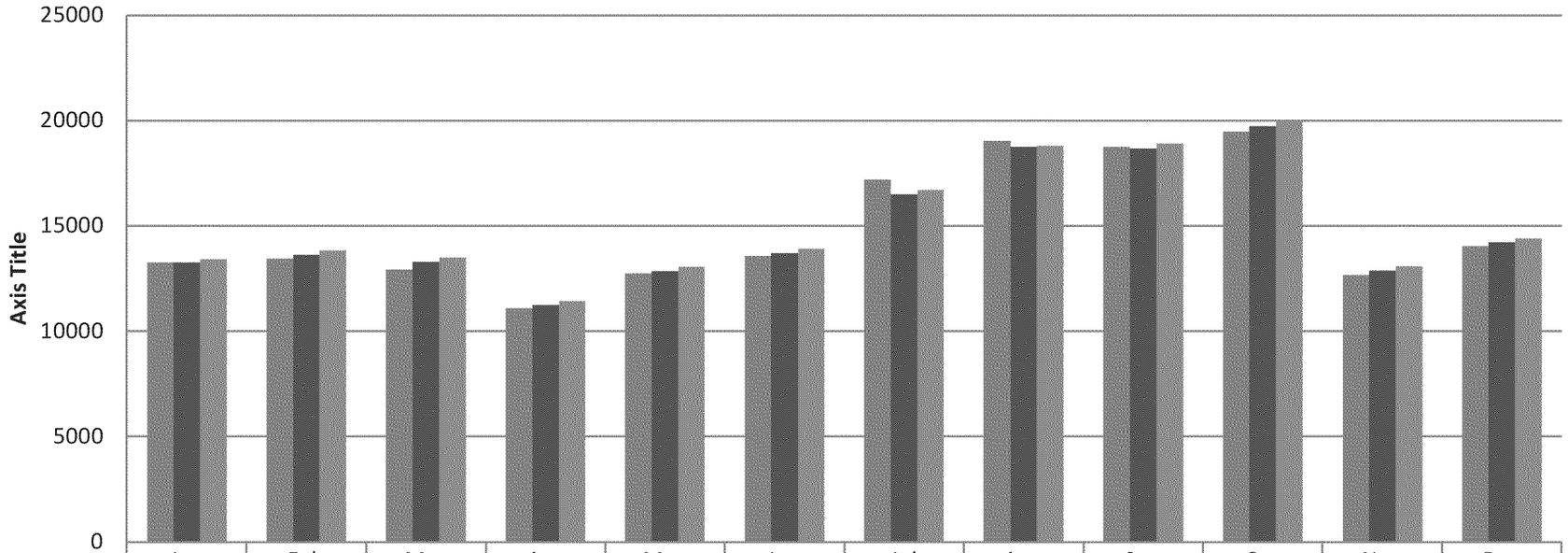
* Full RA EFC calculated based on 2012 actual month-ahead RA showings
** Assumes all non-run-of river qualify as flexible capacity.

Need a procurement rule to ensure sufficient flexibility is procured from the RA Fleet (revised to reflect 80% fixed tilt solar fleet)



The ISO will still have to address net-load variations that last longer than the 3-Hour Ramp (revised to reflect 80% fixed tilt solar fleet)

Peak-to-Trough: Largest Differences in Net load in a Single Day (Independent of Continuity and Duration)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	13271.54	13461.743	12943.627	11087.585	12747.24	13578.29	17194.048	19040.102	18770.391	19477.244	12680.985	14034.5
2015	13273.241	13636.134	13284.429	11264.17	12866.275	13696.968	16497.829	18745.225	18665.008	19727.107	12890.602	14239.379
2016	13,425	13,821	13,503	11,446	13,054	13,914	16,700	18,828	18,919	20,021	13,084	14,420

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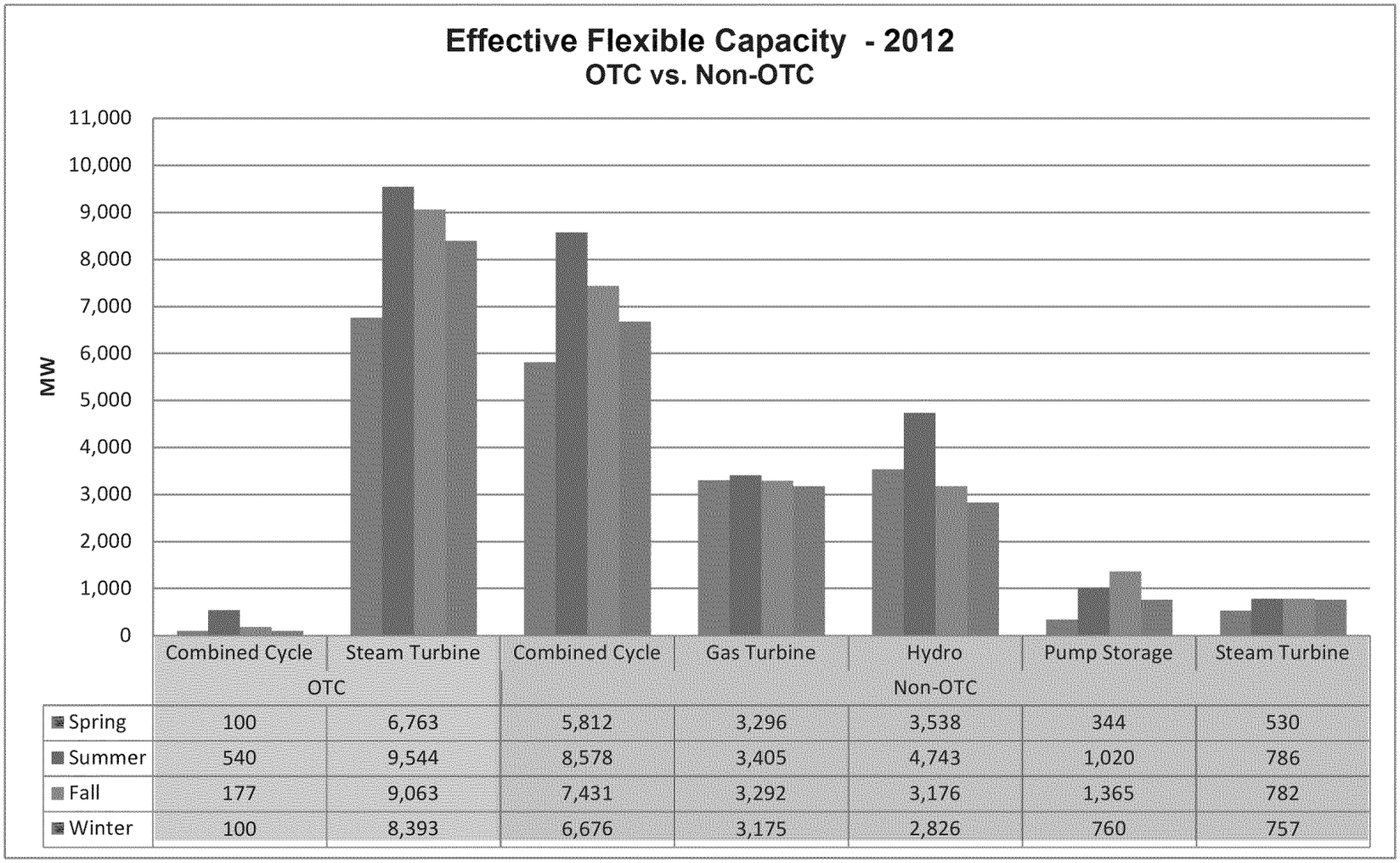
Available EFC will reduce significantly as OTC resources retire



	OTC		Non-OTC				
	Combined Cycle	Steam Turbine	Combined Cycle	Gas Turbine	Hydro	Pump Storage	Steam Turbine
Spring	100	6,763	5,812	3,296	3,538	344	530
Summer	540	9,544	8,578	3,405	4,743	1,020	786
Fall	177	9,063	7,431	3,292	3,176	1,365	782
Winter	100	8,393	6,676	3,175	2,826	760	757