

# Flexible Resource Adequacy Criteria and Must Offer Obligation Working Group Meeting

Karl Meeusen, Ph.D.  
September 26, 2017

# FRACMOO 2 Working Group Meeting Agenda – 9/26/2017

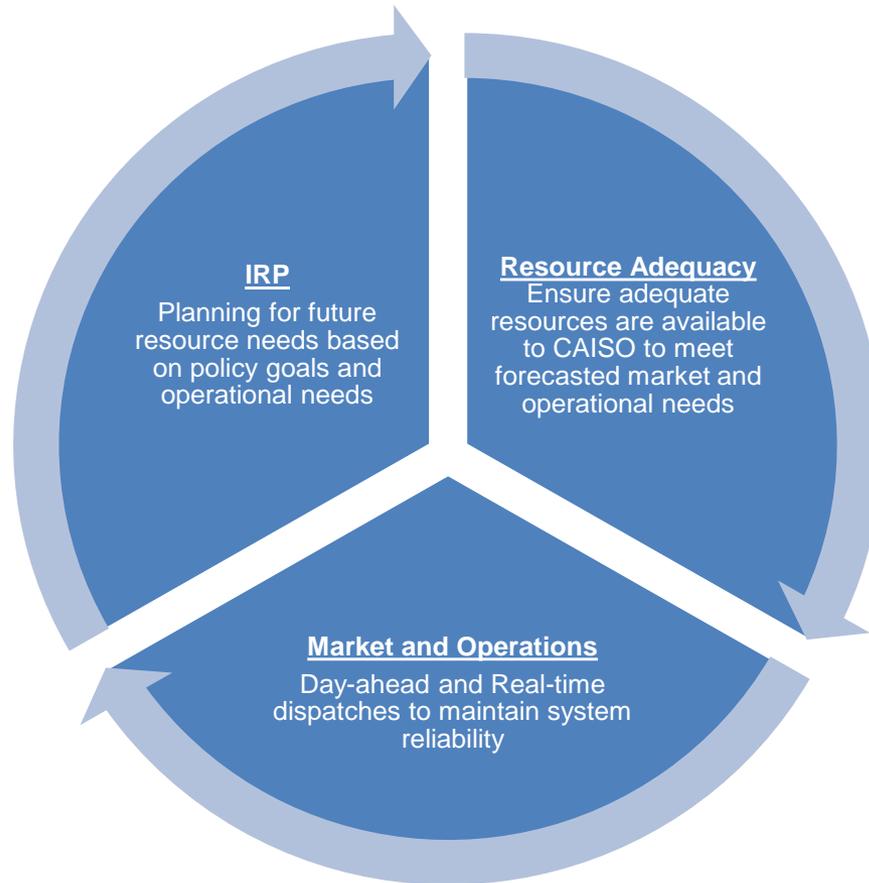
<b>Time</b>	<b>Topic</b>	<b>Presenter</b>
10:00 – 10:15	Introduction	Greg Cook
10:15 – 10:30	Overview	Karl Meeusen
10:30 – 11:15	Ramping needs	Clyde Loutan
11:15 – 12:00	Uncertainty and Load following	Abhishek Hundiwale, Karl Meeusen
12:00 – 1:00	Lunch	
1:00 – 1:30	Summary and Recommendations	Karl Meeusen
1:30 – 4:00	Overview of Conceptual Flexible RA Framework	

# Introduction

Greg Cook

Director – Market and Infrastructure Policy

# Long term planning must prepare for new operational needs as generation fleet evolves to meet state policies



A unified vision should guide planning, procurement, and operations

# Goals and objectives of RA program

## Originally stated CPUC RA Objectives:

1. Provide sufficient resources to the ISO to ensure the safe and reliable operation of the grid in real time.
2. Provide appropriate incentives for the siting and construction of new resources needed for reliability in the future

## Current RA programs needs going forward:

- Provide signals to help ensure the efficient retention and retirement of existing resources
- Provide a resource portfolio to the ISO that meets grid reliability needs through economic market dispatch
  - Flexible RA should ensure access to the flexibility of the fleet to ensure reliable grid operation all hours of the year

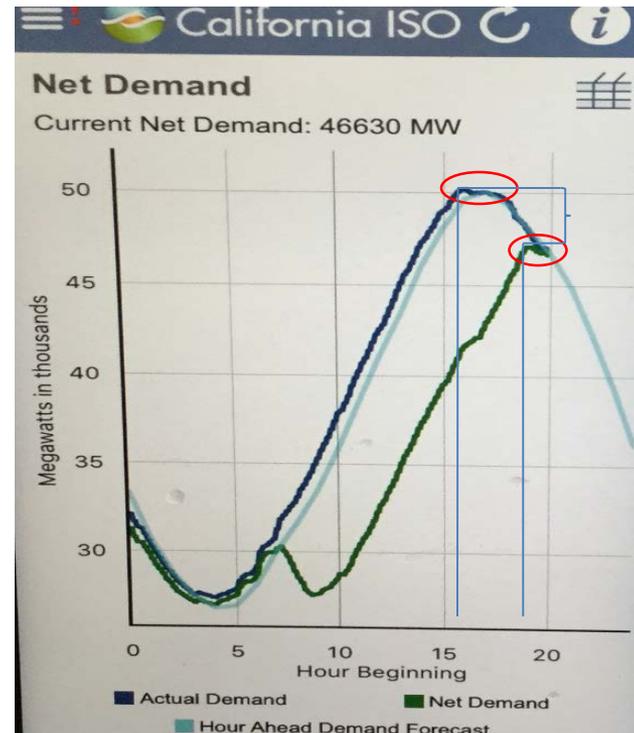
# Objectives of FRACMOO2 initiative

- Develop efficient linkage between RA and energy markets to ensure the ISO is able to meet grid reliability needs through its markets:
  - Load less non-dispatchable generation
  - Load ramps
  - Uncertainty: Load forecast error, VER forecast error, and outages and other resource deviations
- Provide a framework for intertie resources to be part of the solution in meeting the system's flexibility capacity requirements
- Provide LSEs and LRAs flexibility to meet system, local, and flexible capacity needs in a way that best aligns with their business and policy objectives

***Provide signals to help ensure the efficient retention and retirement of existing resources***

# Long term vision: Ensure the RA portfolio meets the balancing area's reliability needs all hours of the year

- Satisfies gross and net-Load peaks
- Provides energy sufficiency; meets all non-peak hour needs
- Has sufficient ramping capacity and speed
- Ensures sufficient “dispatchability”- frequency and duration



# Overview

Karl Meeusen, Ph.D.  
Senior Advisor  
Infrastructure and Regulatory Policy

# Overview

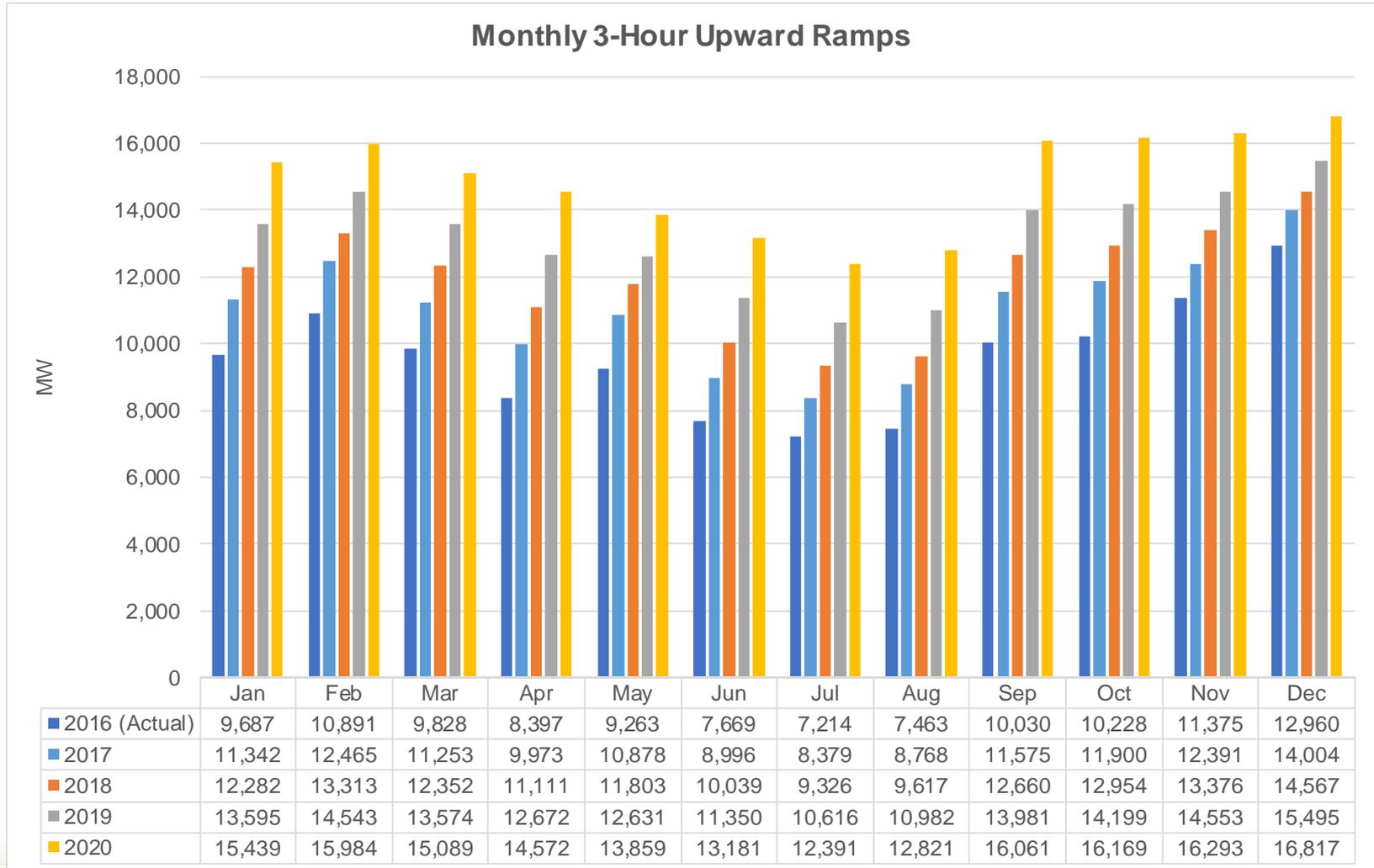
- Ramping needs
  - Need for capability of sustained ramping and ramping speed (up and down) is increasing
  - Forecasted net load continues to drop, indicating additional trade-off between ramping vs curtailment
- Uncertainty
  - Some portion of ramping needs can be addressed through IFM dispatch, however uncertainty after IFM can only be met with resources available in real-time
- Flexible RA conceptual framework
  - A new framework is needed that provides the ISO access to flexible capabilities of the RA fleet to meet the variability, uncertainty, and ramping needs of the system

# Preliminary assessment of Multi-hour and Intra-hour ramping needs

Clyde Loutan

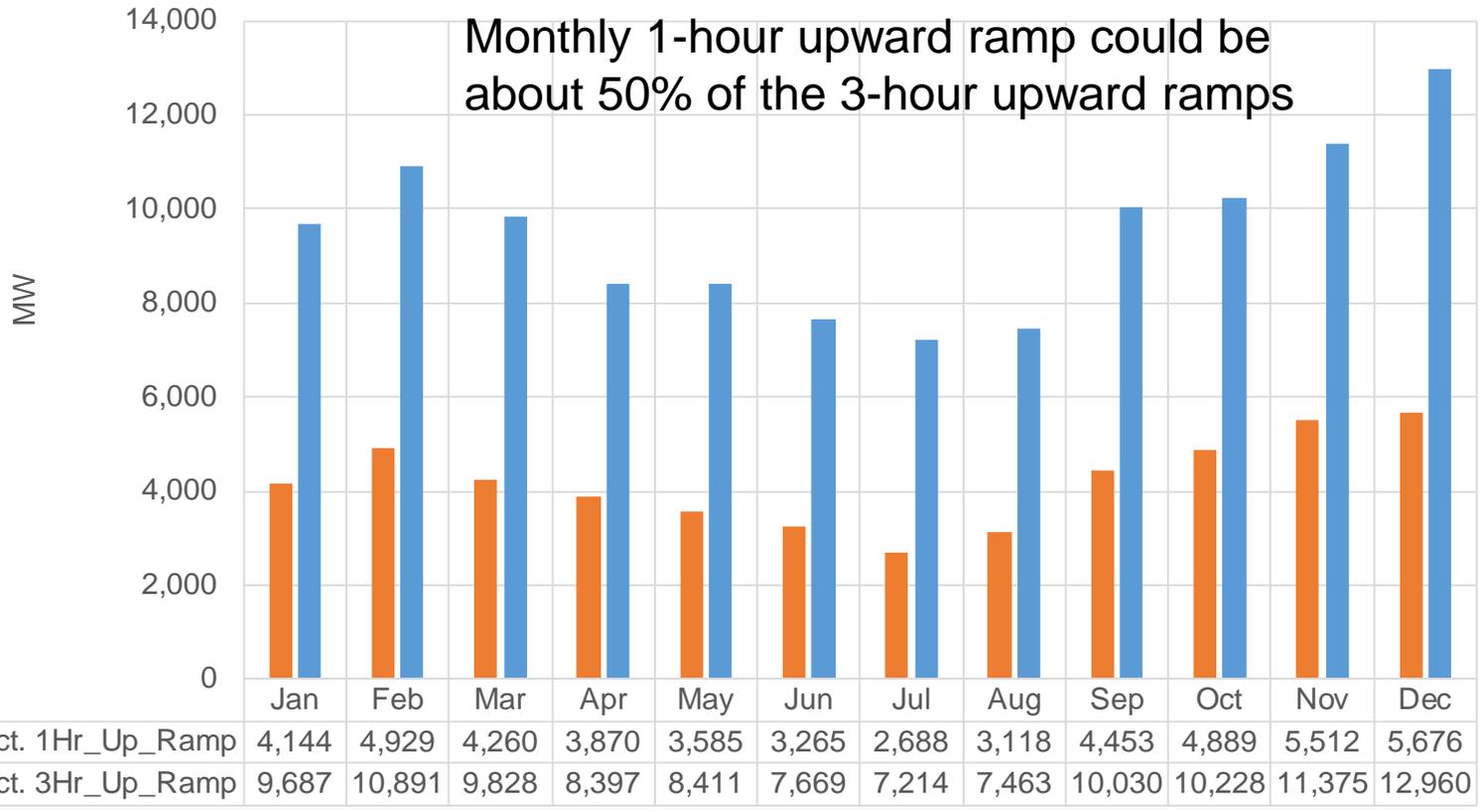
Principal – Renewable Energy Integration

# Expected 3-hour ramps increase through 2020 with build out of renewables and addition of behind-the-meter resources

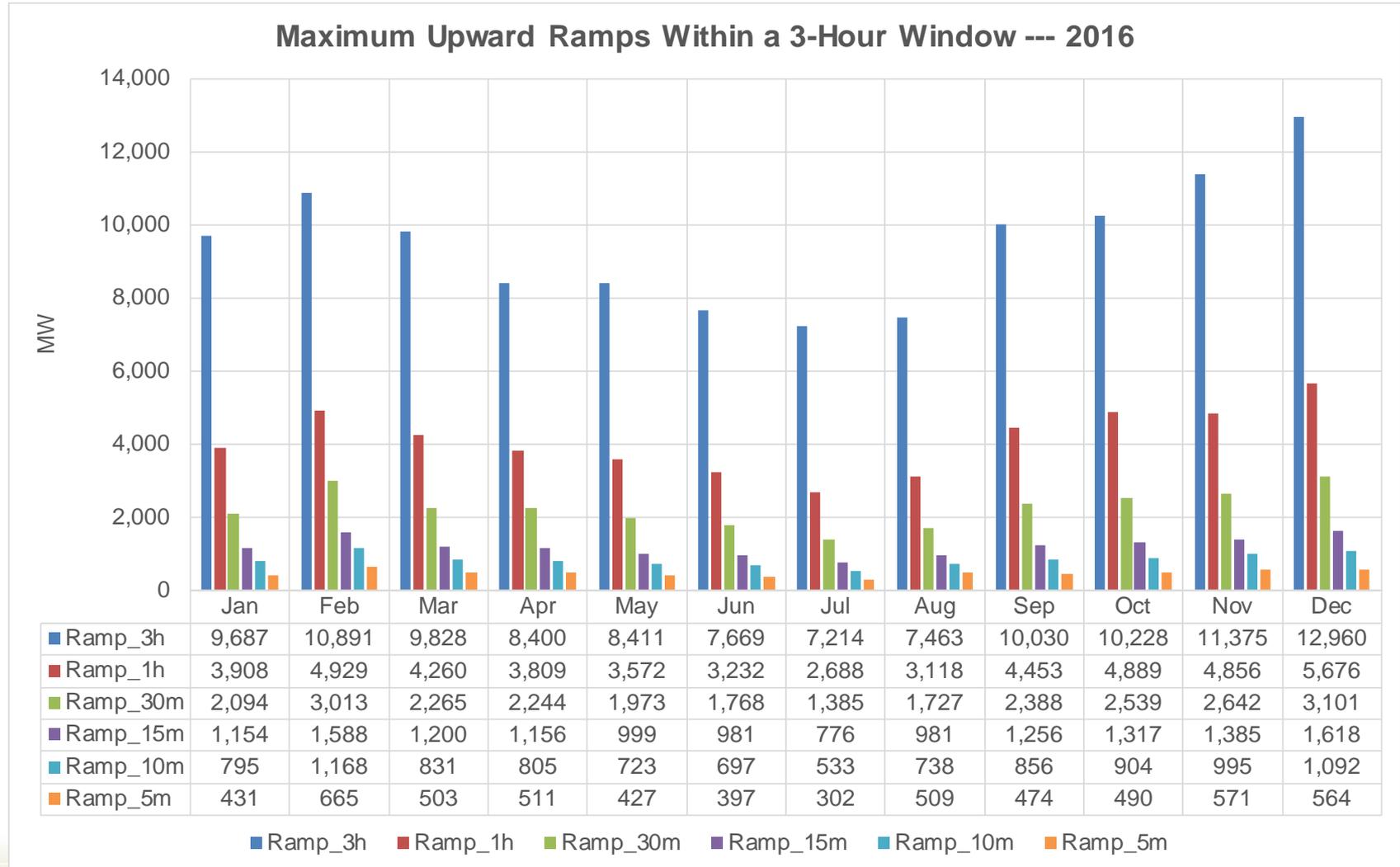


# 3-hour flex capacity is relevant but is insufficient to meet all flexible ramping needs going forward, additional speed is needed

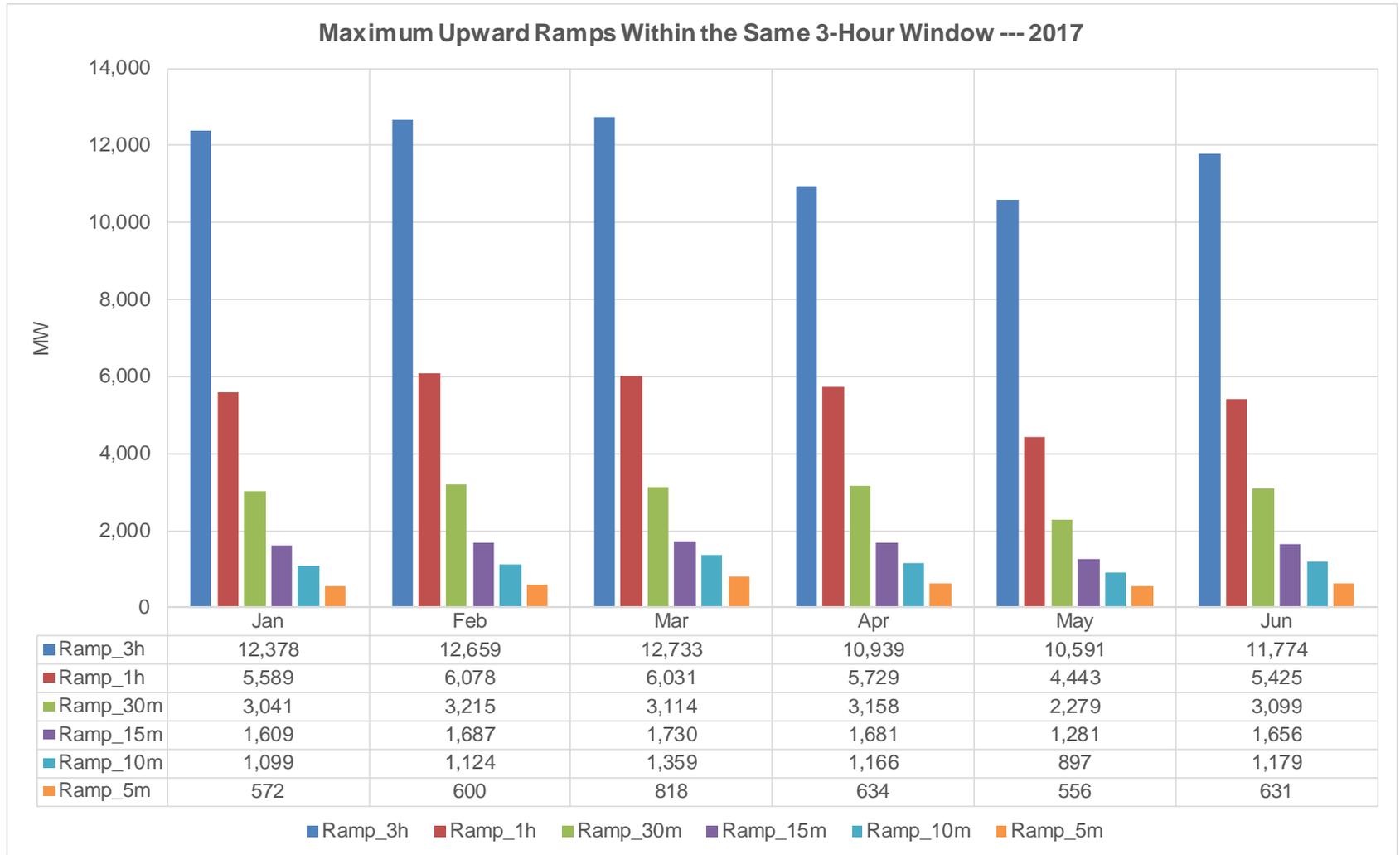
Actual 1-Hour & 3-Hour Upward Monthly Ramps --- 2016



# Maximum upward ramps for different timeframes within the same three-hour window --- 2016



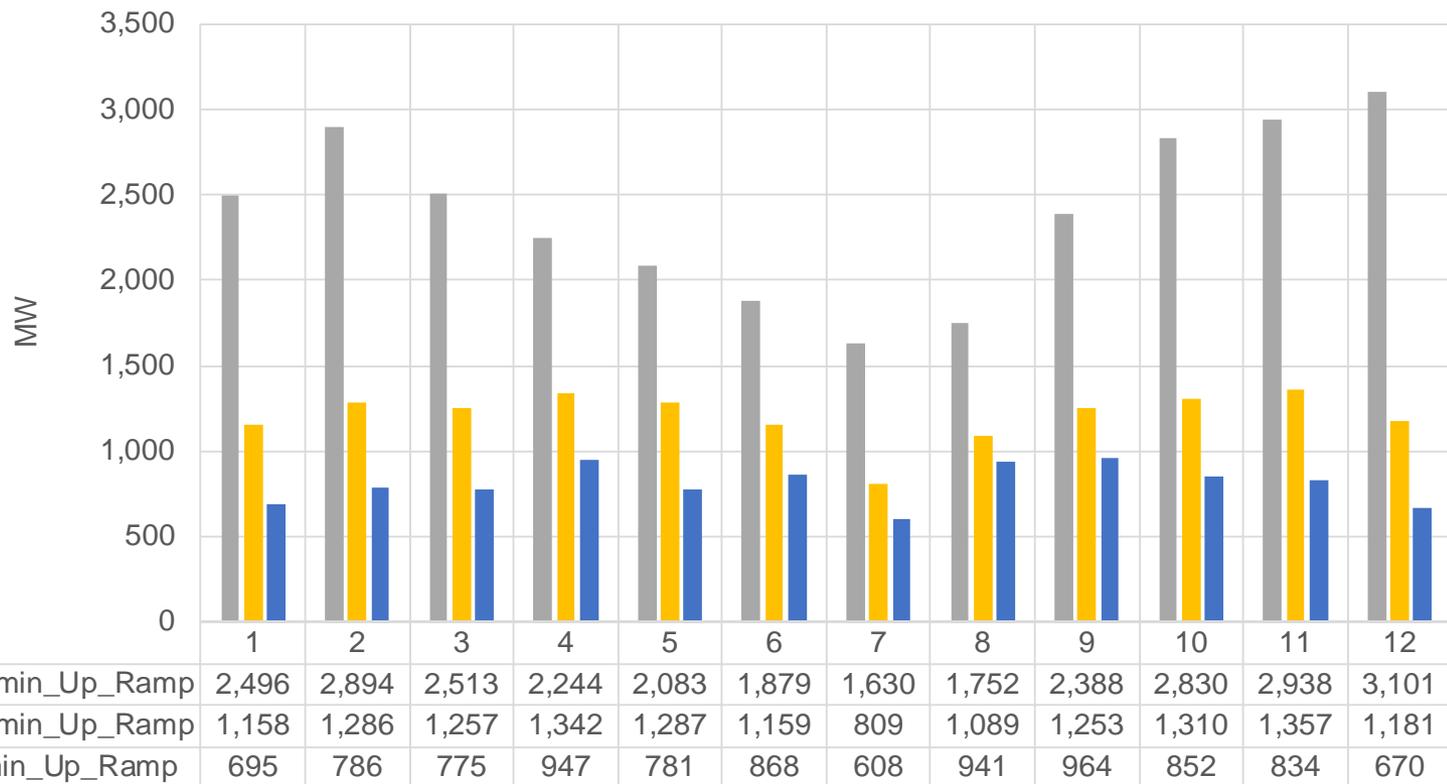
# Maximum upward ramps for different timeframes within the same three-hour window --- 2017



# Actual Intra-hour upward ramping needs for 2016.

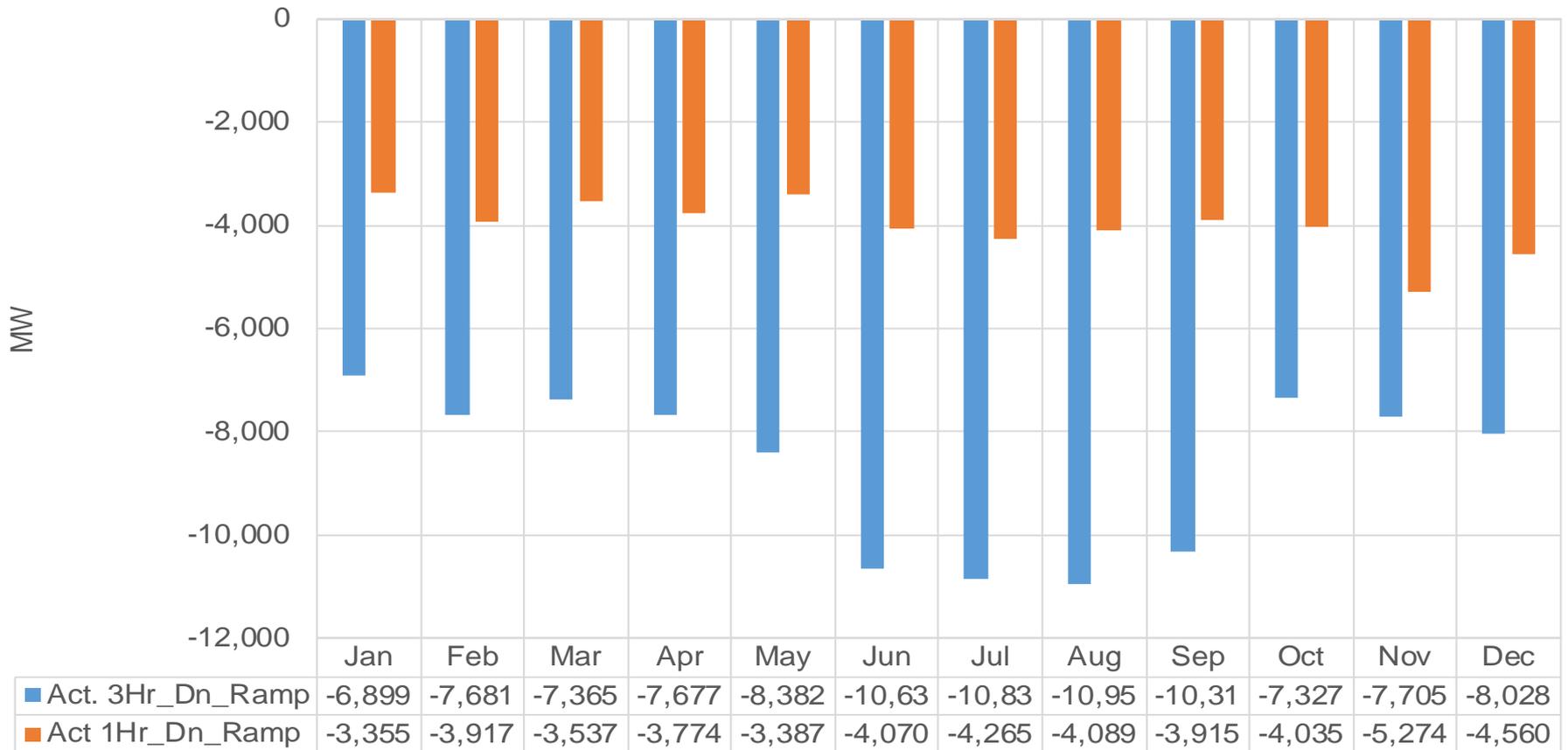
## Need to add regulation dispatched (~200 to 400 MW) to 10-minute and 5-minute ramps

Actual Intra-Hour Upward Monthly Ramps --- 2016



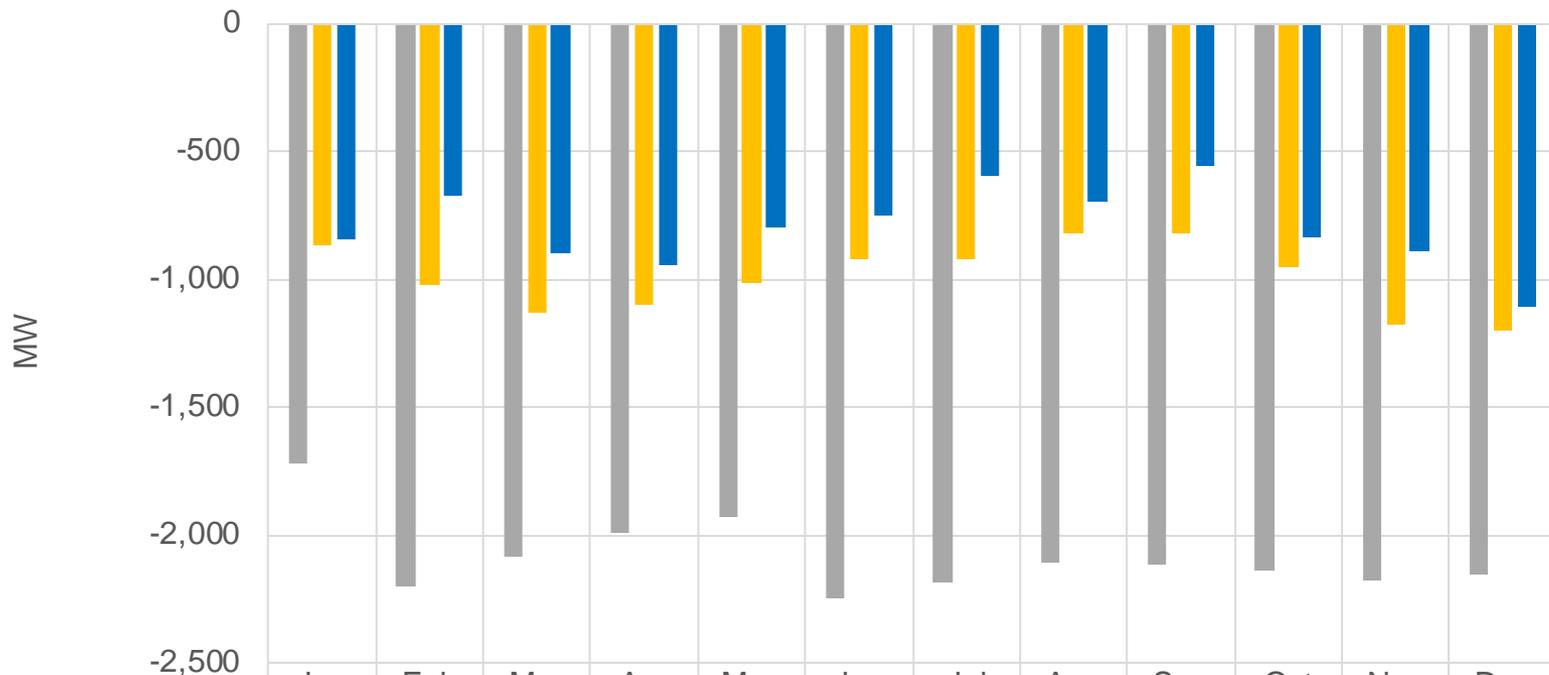
# Actual monthly 1-hour and 3-hour downward ramps for 2016 were greater during the summer months

Actual 1-Hour & 3-Hour Downward Monthly Ramps --- 2016



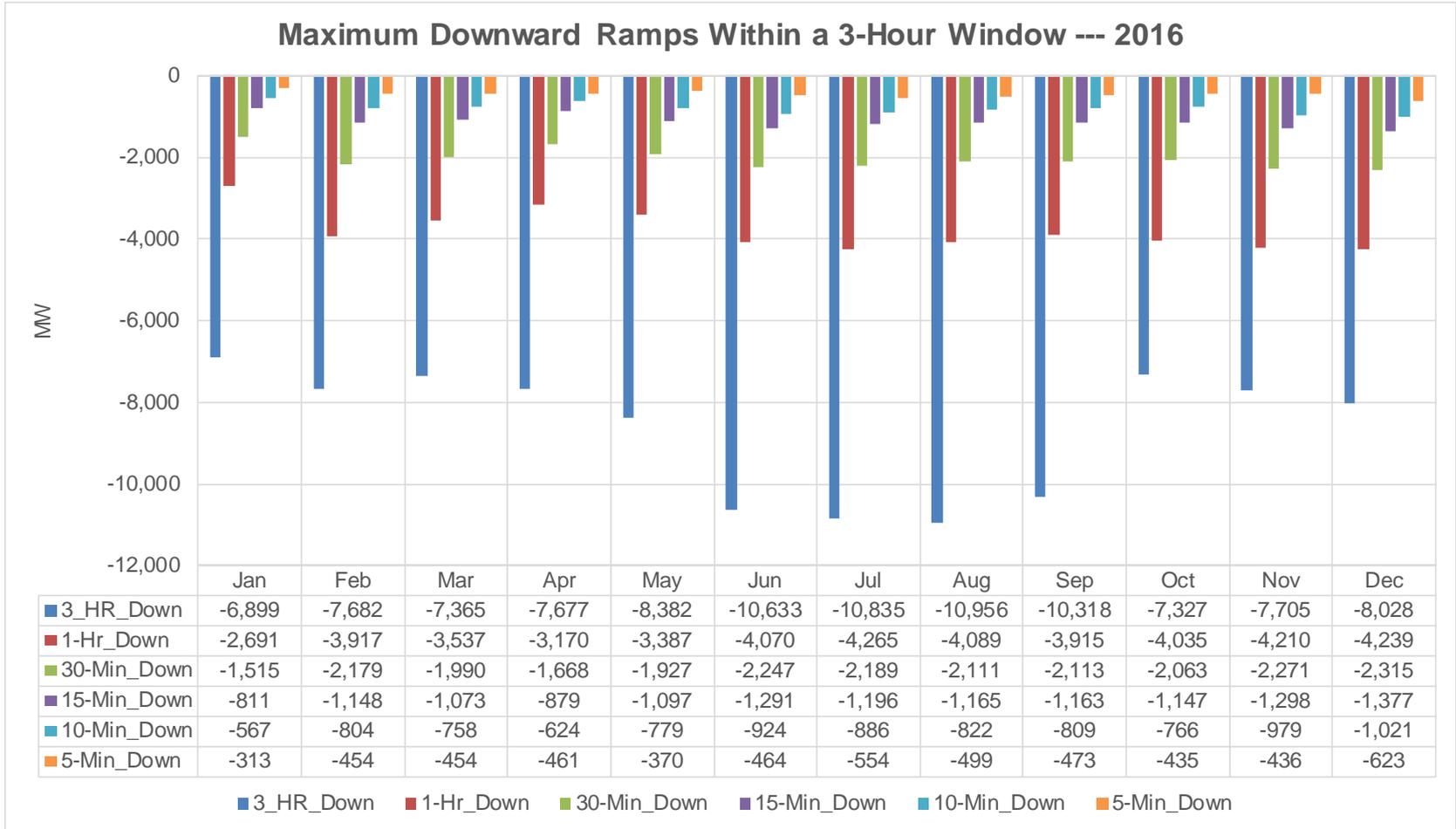
# Intra-hour downward ramping needs for 2016. Need to add regulation dispatched (~200 to 400 MW) to 10-minute and 5-minute ramps

Actual Intra-Hour Downward Monthly Ramps --- 2016

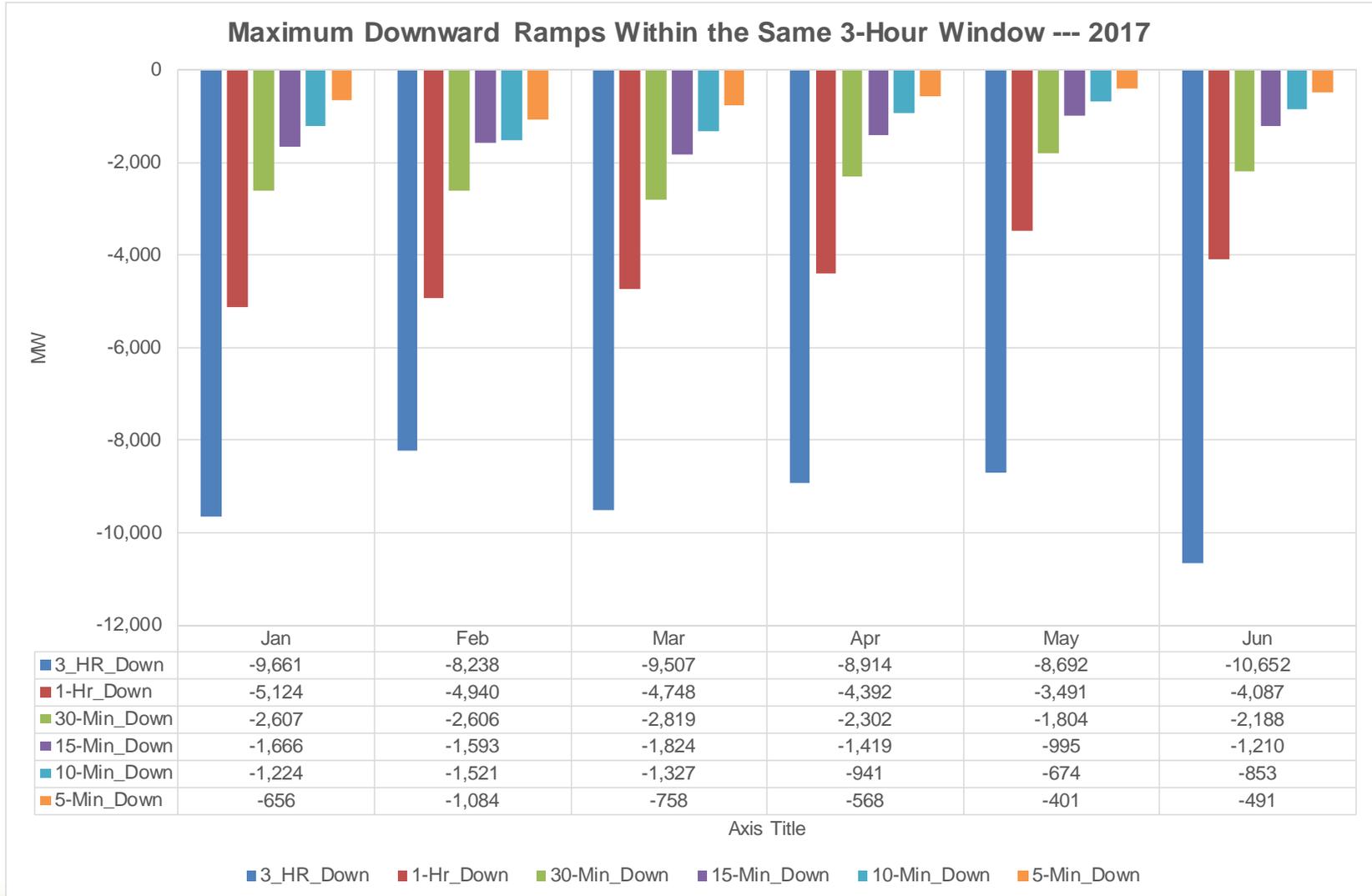


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Act 30min_Dn_Ramp	-1,724	-2,204	-2,087	-1,990	-1,927	-2,247	-2,189	-2,111	-2,113	-2,142	-2,177	-2,155
Act 10min_Dn_Ramp	-869	-1,023	-1,128	-1,097	-1,013	-924	-922	-822	-823	-954	-1,181	-1,202
Act 5min_Dn_Ramp	-843	-671	-895	-945	-798	-753	-598	-697	-560	-836	-890	-1,111

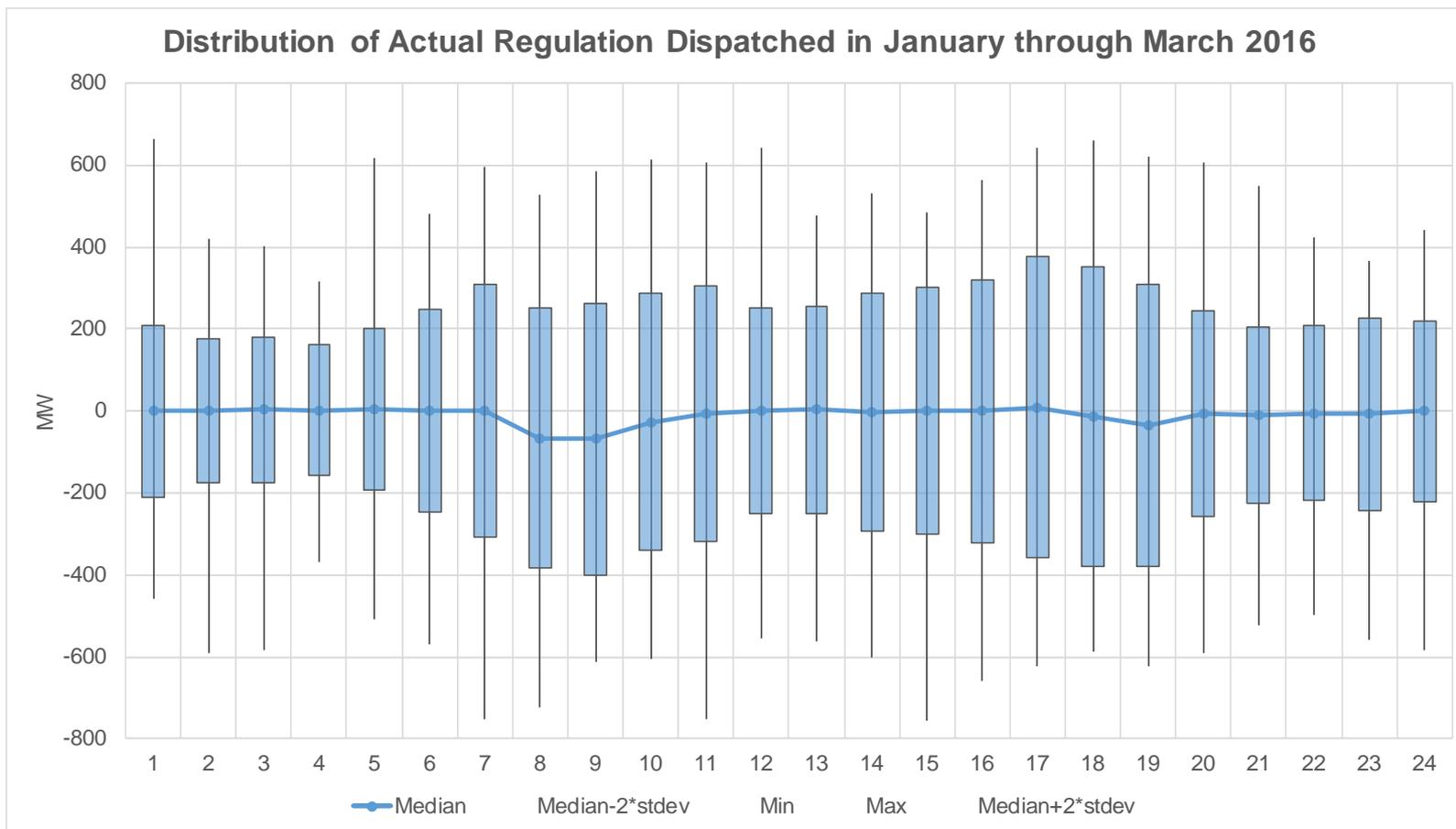
# Maximum downward ramps for different timeframes within the same three-hour window --- 2016



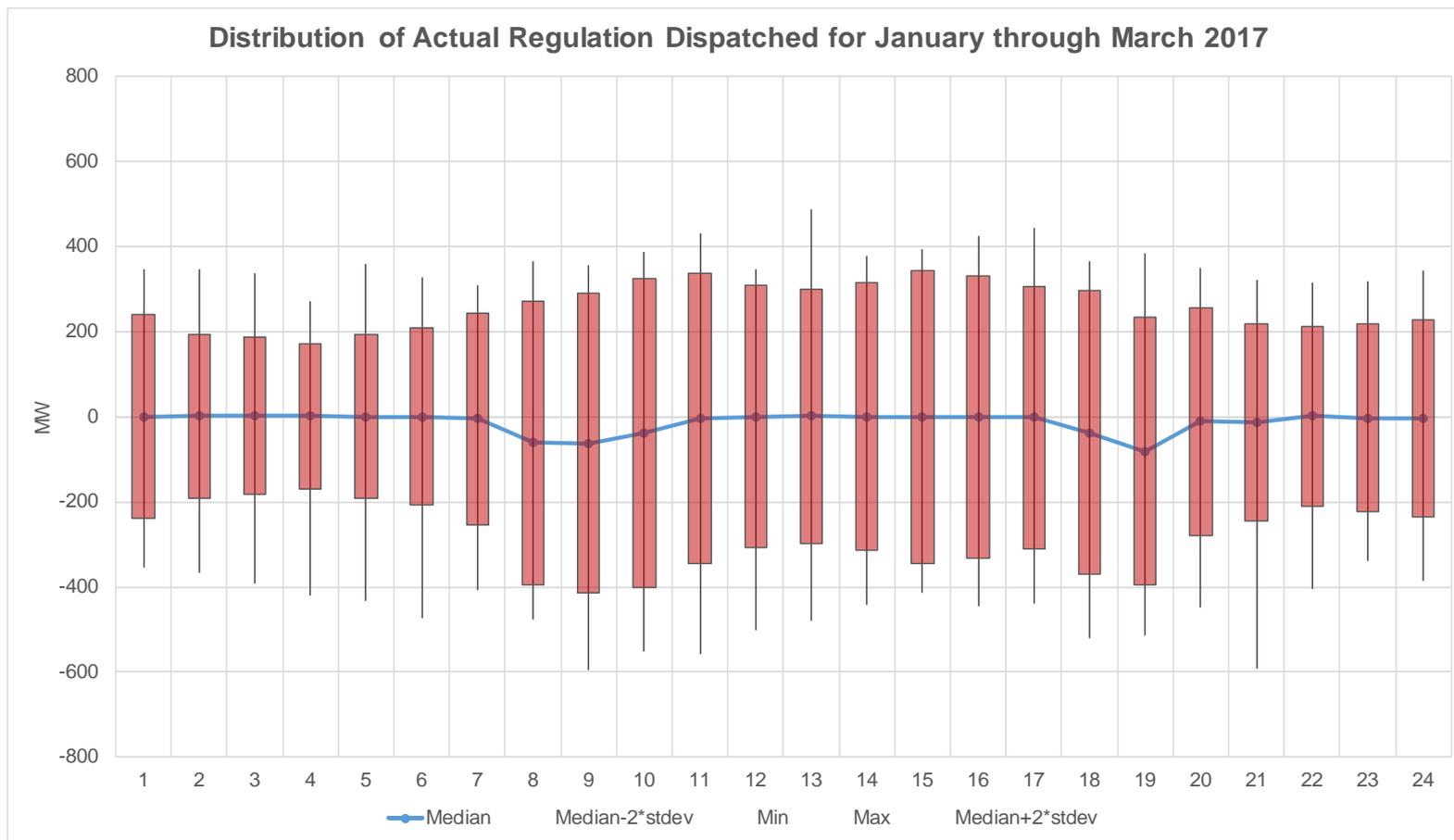
# Maximum downward ramps for different timeframes within the same three-hour window --- 2017



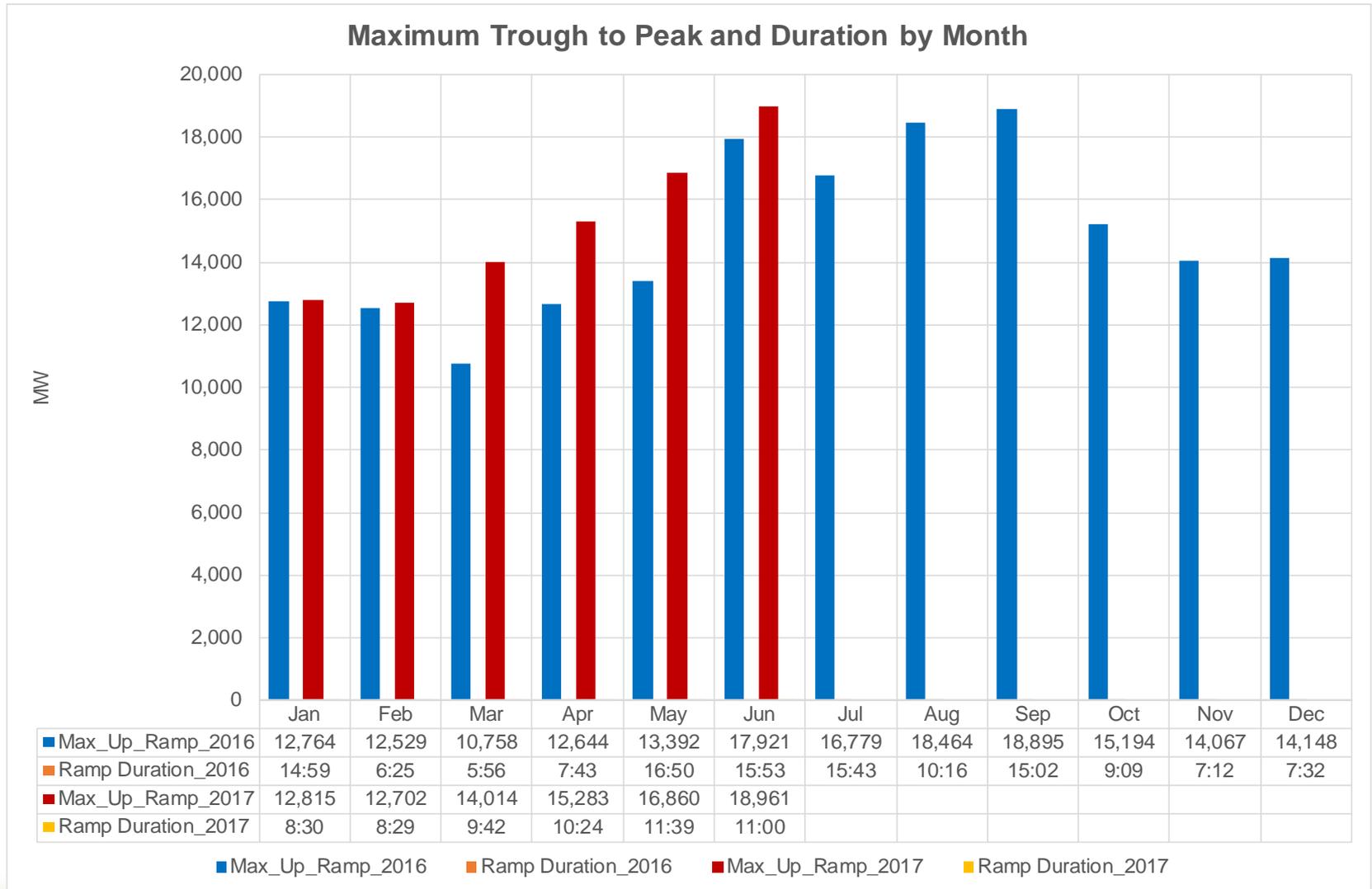
# Actual distribution of regulation dispatched for the first three months of 2016



# Actual distribution of regulation dispatched for the first three months of 2017

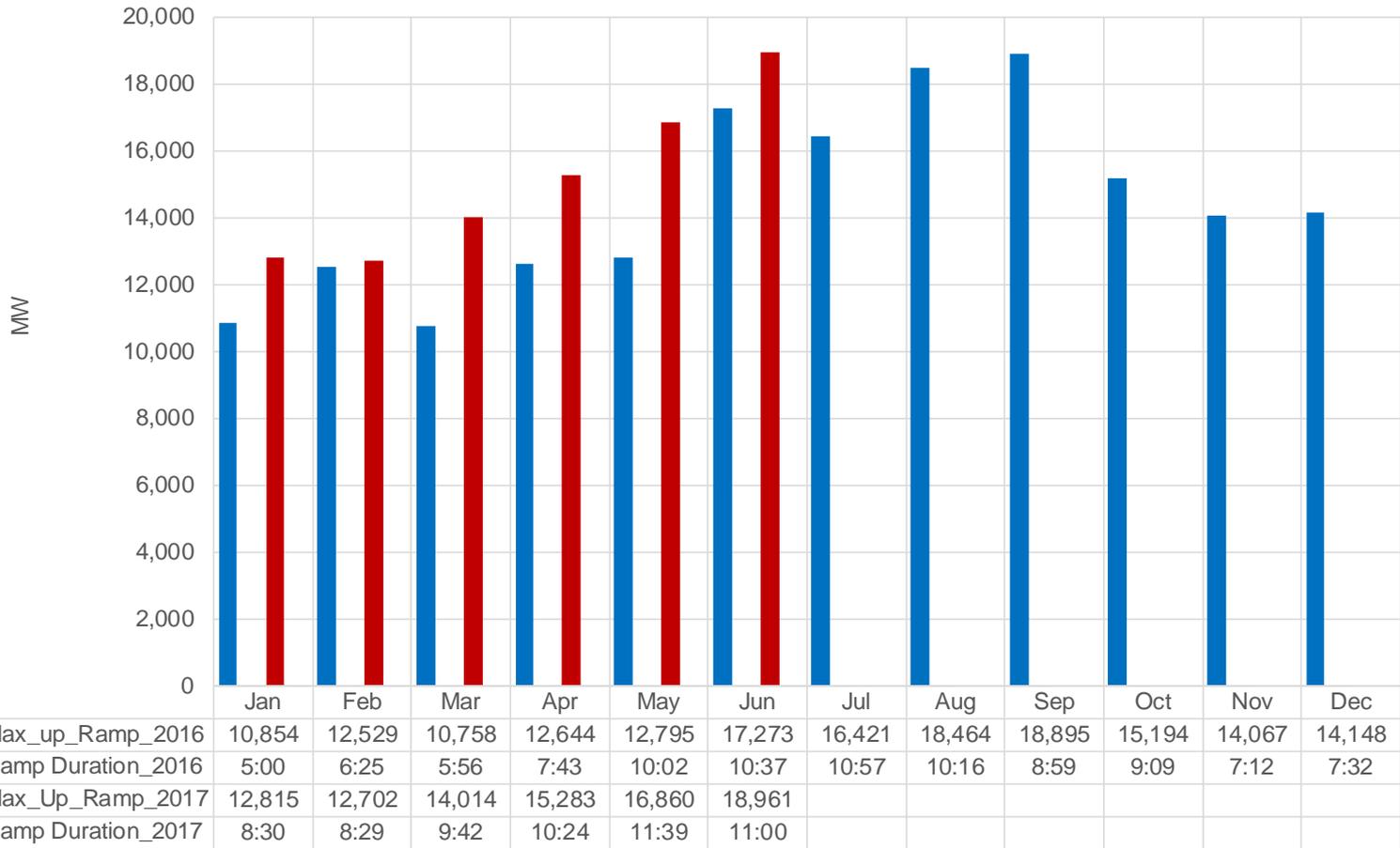


# Daily maximum trough to peak for a given month --- 2016 vs. 2017



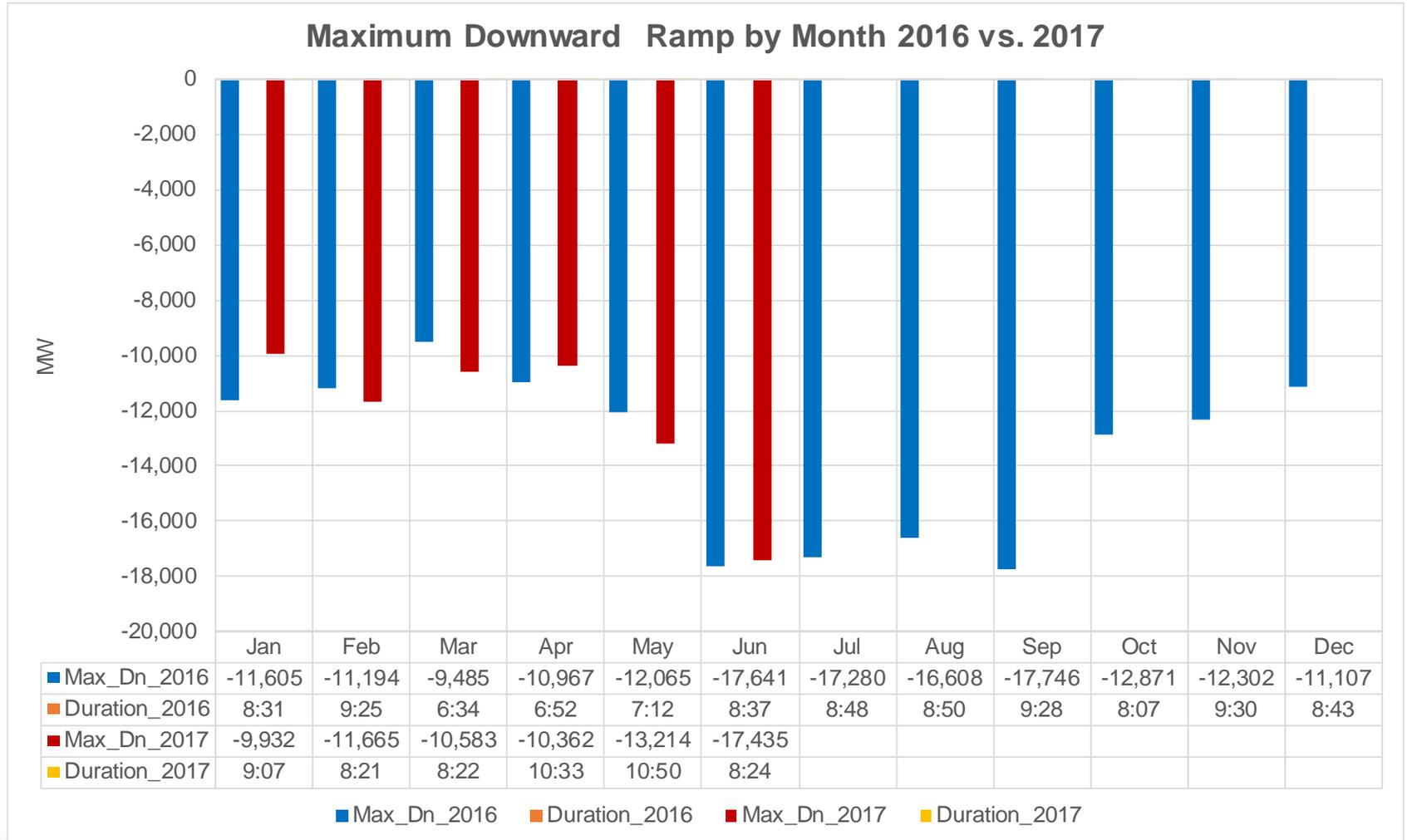
# Daily maximum trough to peak for a given month when the trough occurs after 7:00 a.m.

Maximum Trough to Peak after 7:00 a.m. by Month

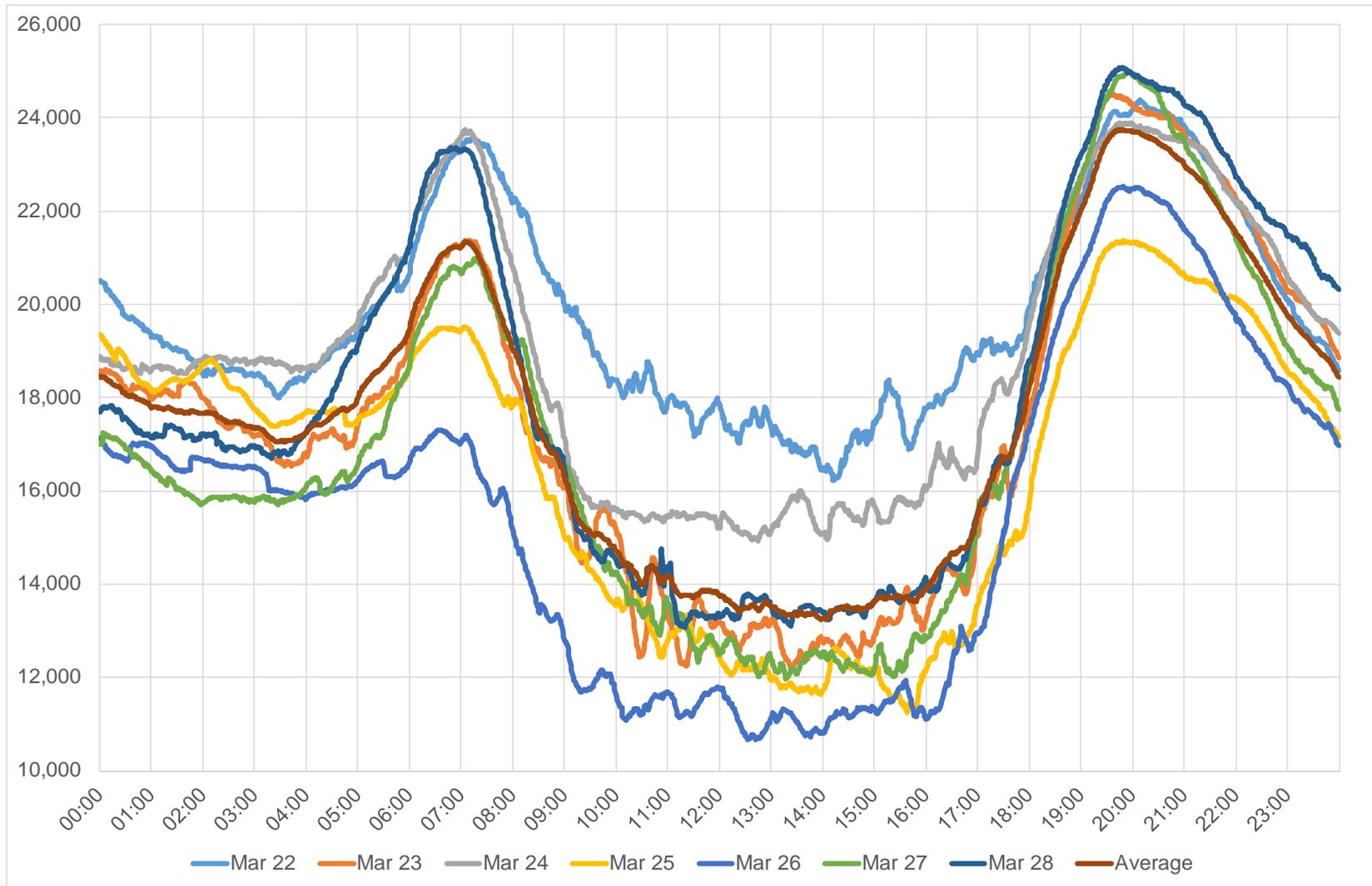


■ Max\_up\_Ramp\_2016   
 ■ Ramp Duration\_2016   
 ■ Max\_Up\_Ramp\_2017   
 ■ Ramp Duration\_2017

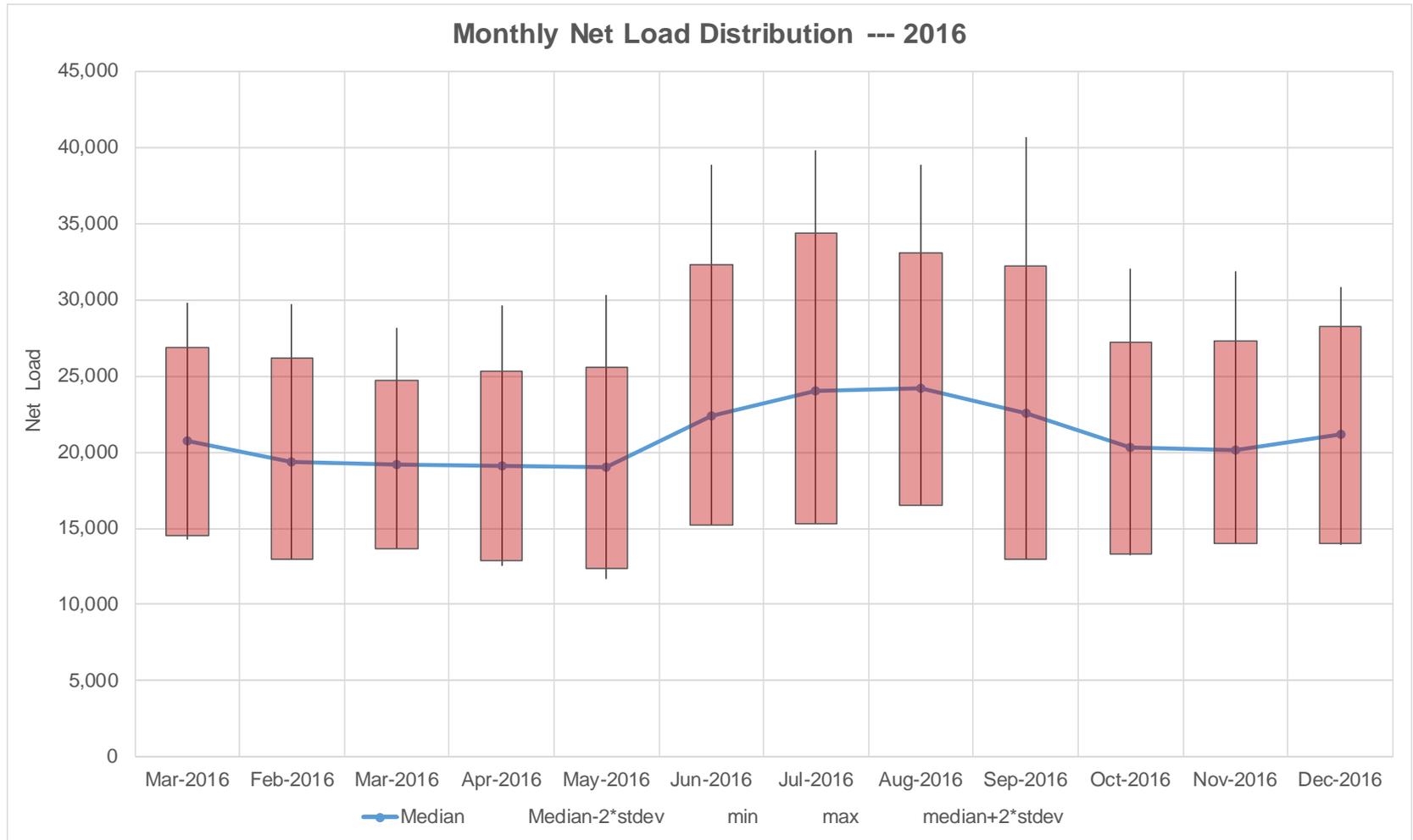
# Daily maximum downward ramp for a given month - -- 2016 vs. 2017



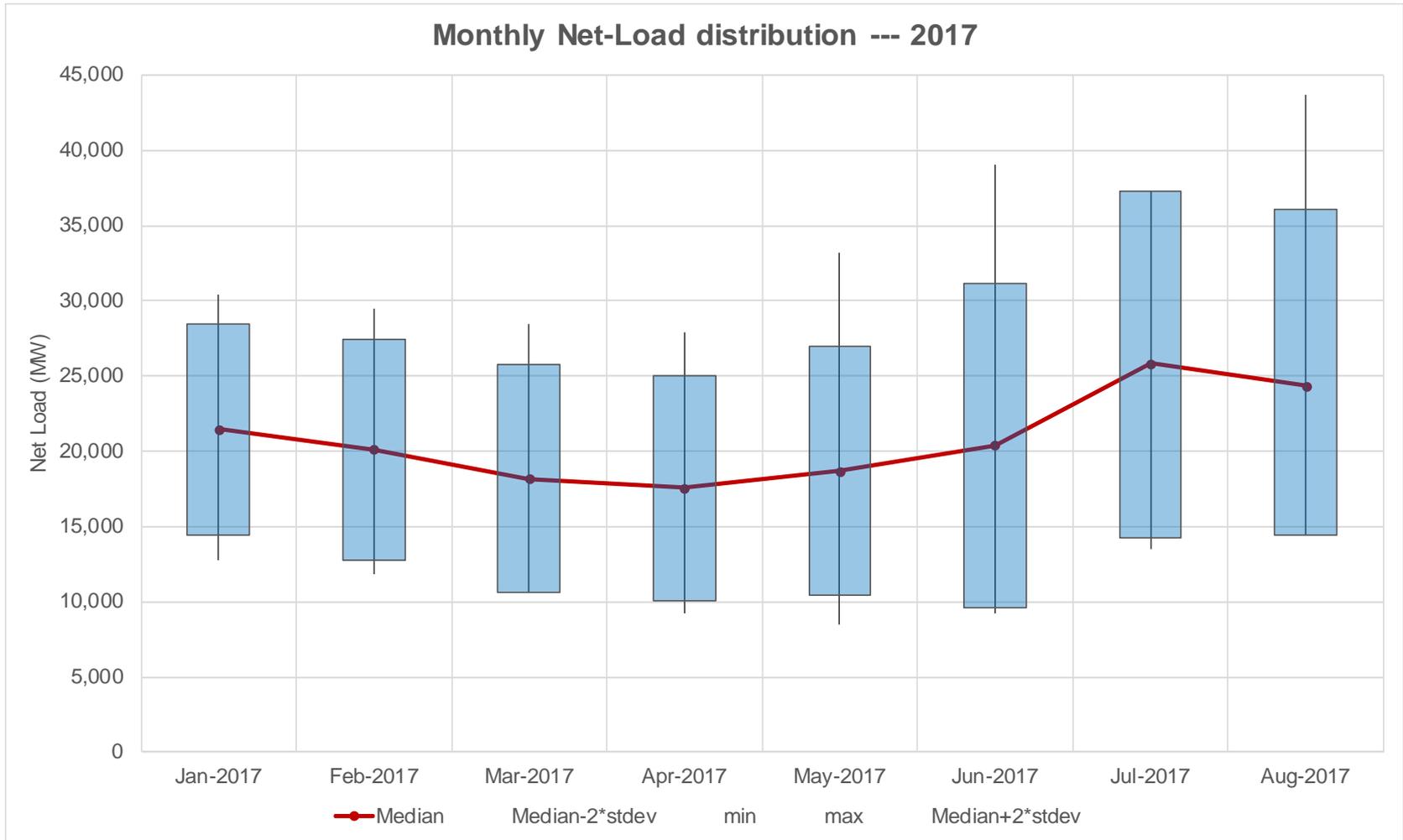
# Net Load varies from one day to the next --- One week in March 2017



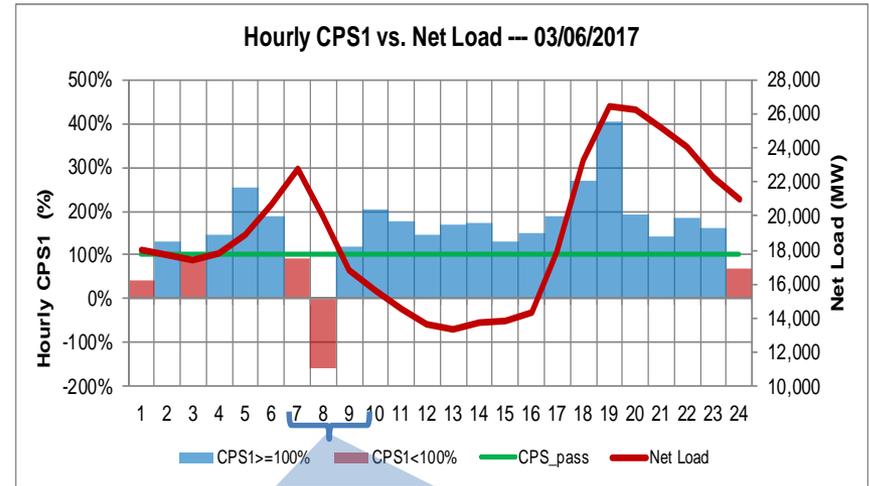
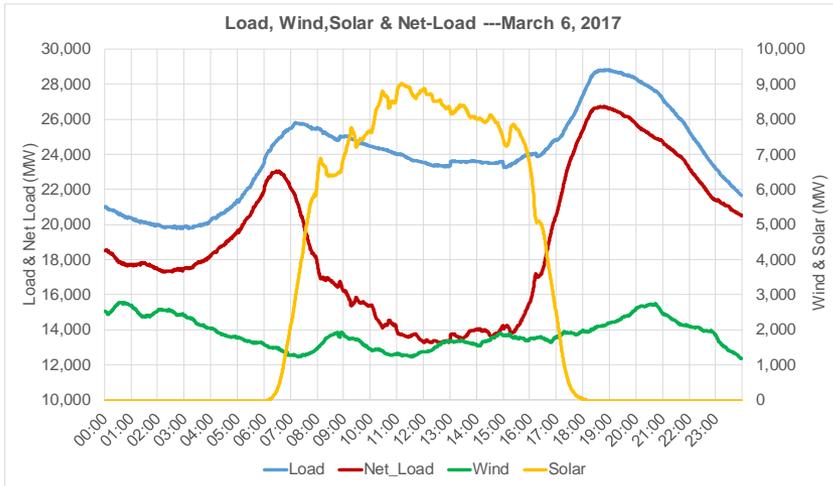
# Monthly net load distribution for 2016



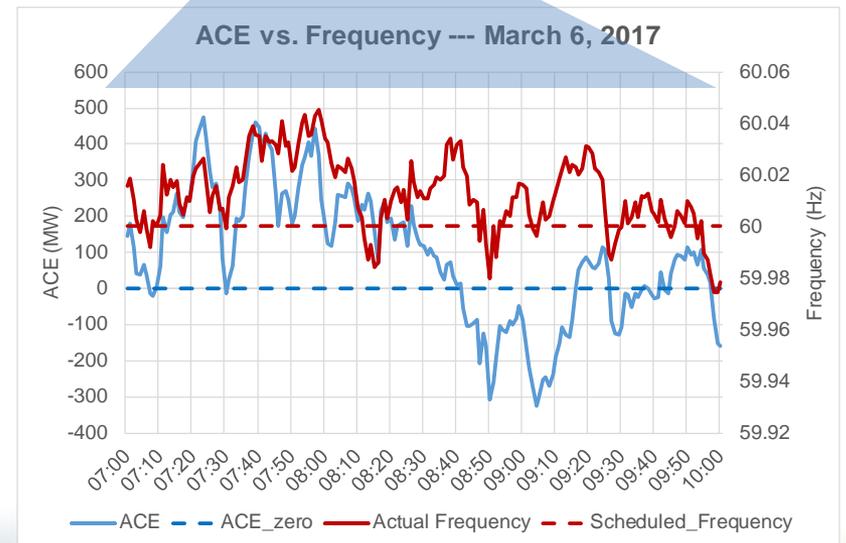
# Monthly net load distribution through August 2017



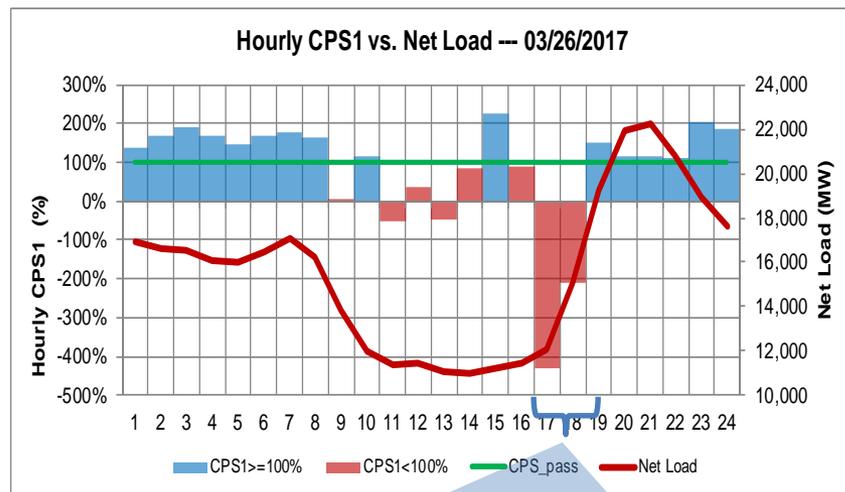
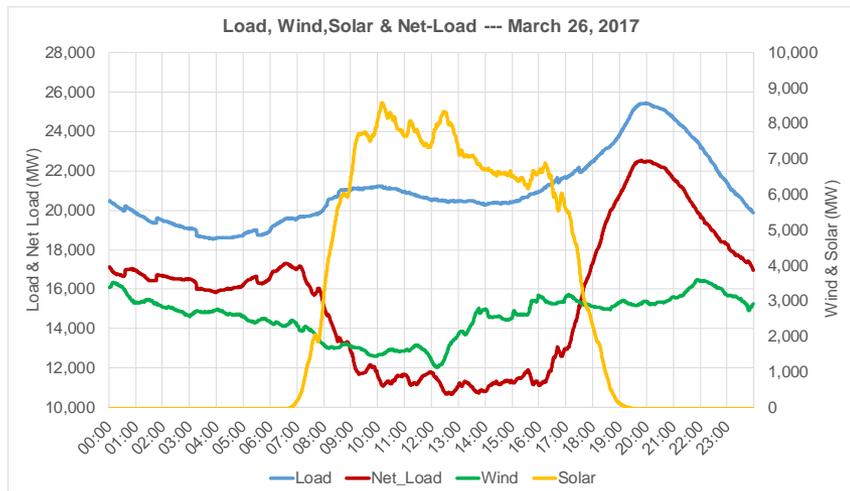
# Interplay between supply and demand impacts ability of the fleet to meet ramps-- March 6, 2017 (Weekday)



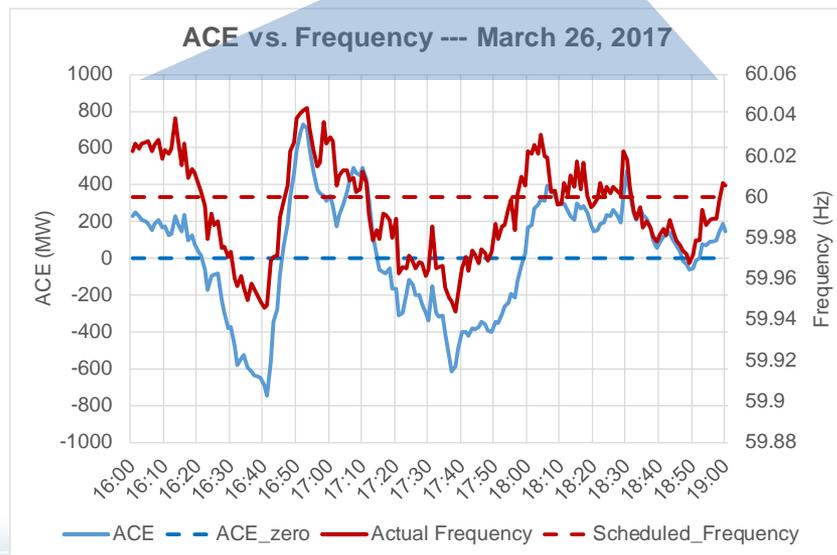
	Load	Solar	Net Load
Sunrise Ramp Rate (MW/Min) 7:00 – 10:00	-6	31	-37
MW Change	-1,023	5,529	-6,724
Sunset Ramp Rate (MW/Min) 16:00 – 19:00	27	-37	61
MW Change	4,801	-6,703	11,049



# Interplay between supply and demand impacts ability of the fleet to meet ramps-- March 26, 2017 (Weekend)



	Load	Solar	Net Load
Sunrise Ramp Rate (MW/Min) 7:00 – 10:00	9	44	-30
MW Change	1,612	7,947	-5,489
Sunset Ramp Rate (MW/Min) 16:00 – 19:00	16	-37	54
MW Change	2,908	-6,575	9,663

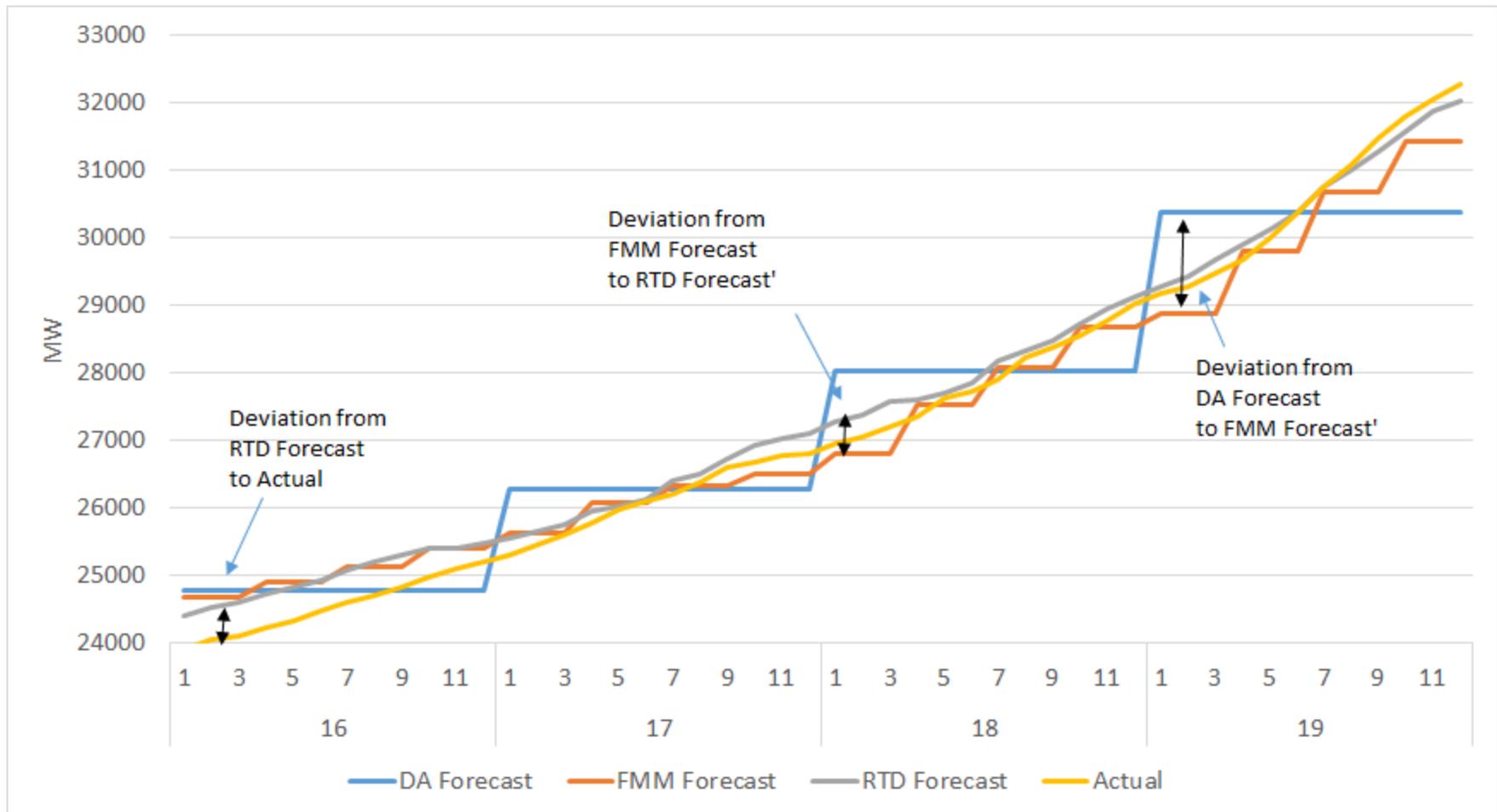


# Results of preliminary uncertainty and load-following needs

Abhishek Hundiwale  
Lead Engineering Specialist

Karl Meeusen, Ph.D.  
Senior Advisor – Regulatory and Infrastructure Policy

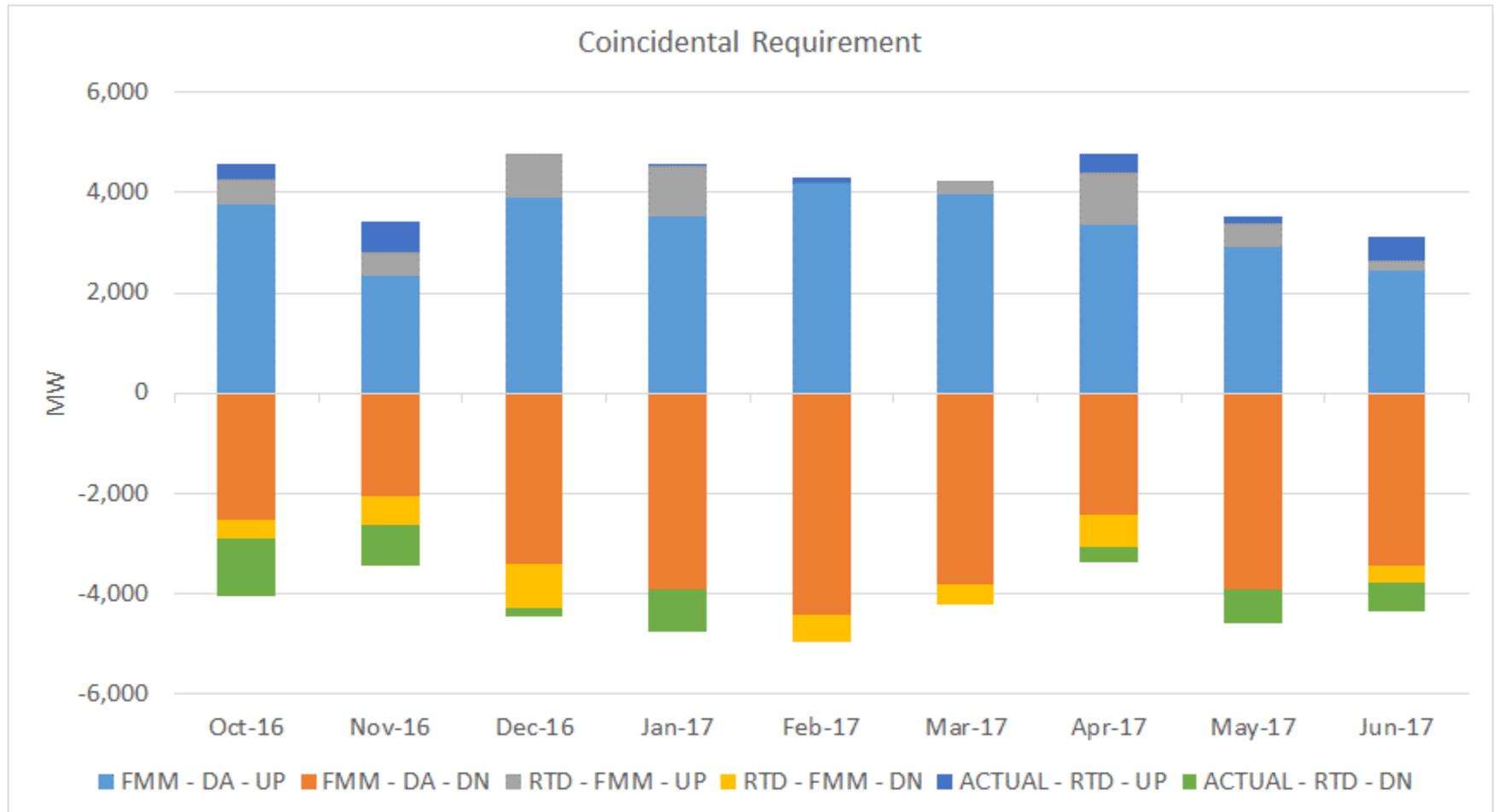
# Methodology to calculate the maximum uncertainty from DA forecast to Actual



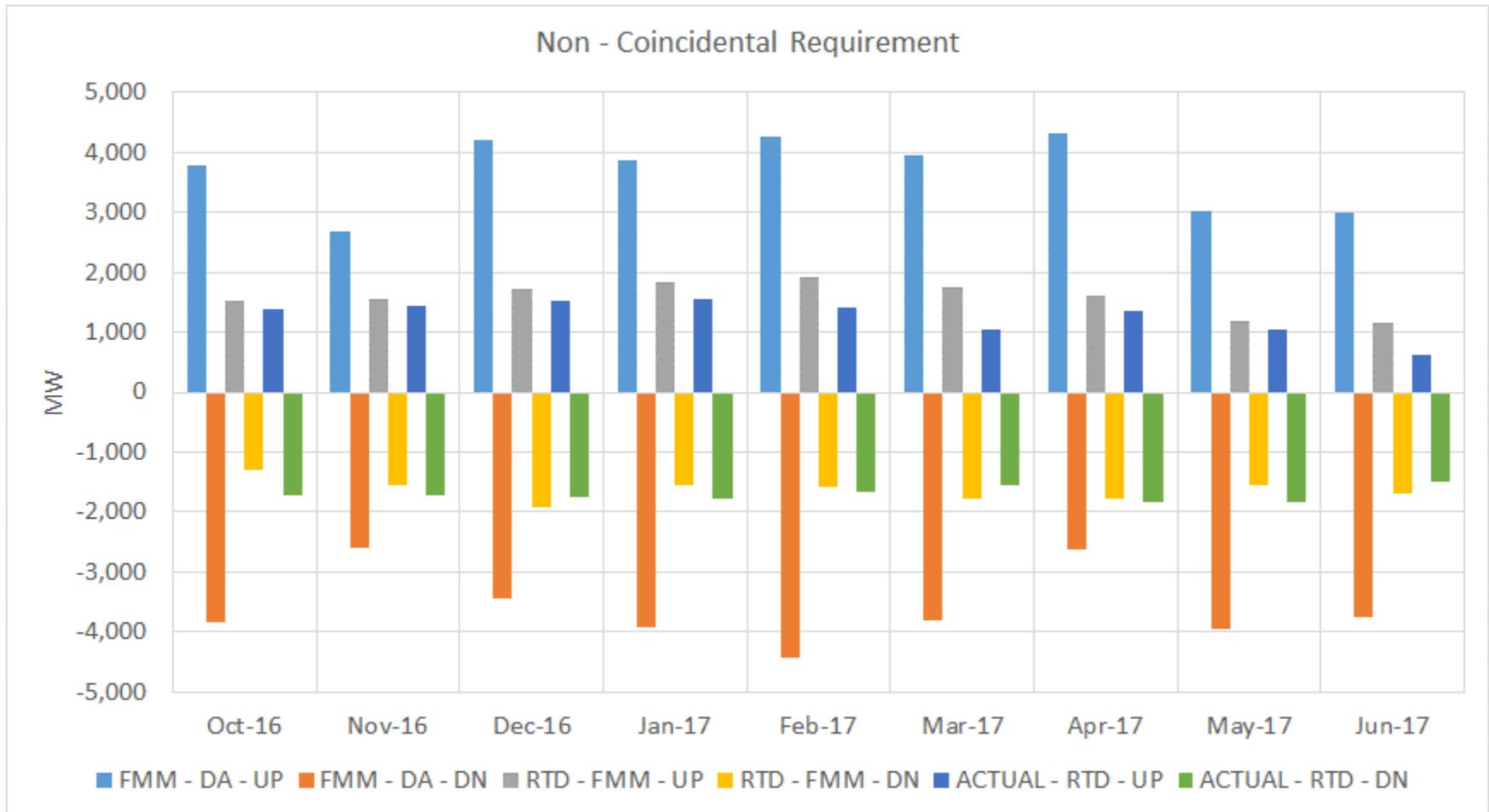
## Uncertainty Deviations-

- Deviations of Net Load forecast from IFM to FMM either in up or down direction – FMM\_DA
- Deviations of Net Load forecast from FMM to RTD in up or down direction – RTD\_FMM
- Deviations of Actual Net Load to RTD Net Load forecast in up or down direction – ACT\_RT D
- Compute the maximum deviations for each month

# Coincidental Deviations – Deviations for the same interval (DA to FMM, FMM to RTD and RTD to Actual)



# Non – Coincidental Deviations – Deviations are for different days, hours and intervals



# Summary and Recommendations from Initial CAISO Analysis

Karl Meeusen, Ph.D.

## Key findings

- Need for speed: maximum monthly one hour net load ramps can be greater than 50 percent of the maximum three hour net load
  - Consistently over 40 percent within the monthly maximum three hour net load ramp (over 5,000 MW, or 83 MW/min)
    - Expected to increase over time
- More regulation is needed more often
- Downward ramps are comparable to upward ramps in terms of speed and magnitude
- The time between minimum and maximum net load and MWs ramped are increasing

## Key findings

- Forecast error (load and VERs) and load following needs are greatest between IFM and FMM market
  - For both upward and downward needs
- Forecast error between post-IFM must be addressed by resources that are flexible in real-time
  - The need is demonstrated by non-coincident quantities in forecast errors
- The cumulative non-coincident forecast error and load following needs are about 3,000 MW greater than the coincident error

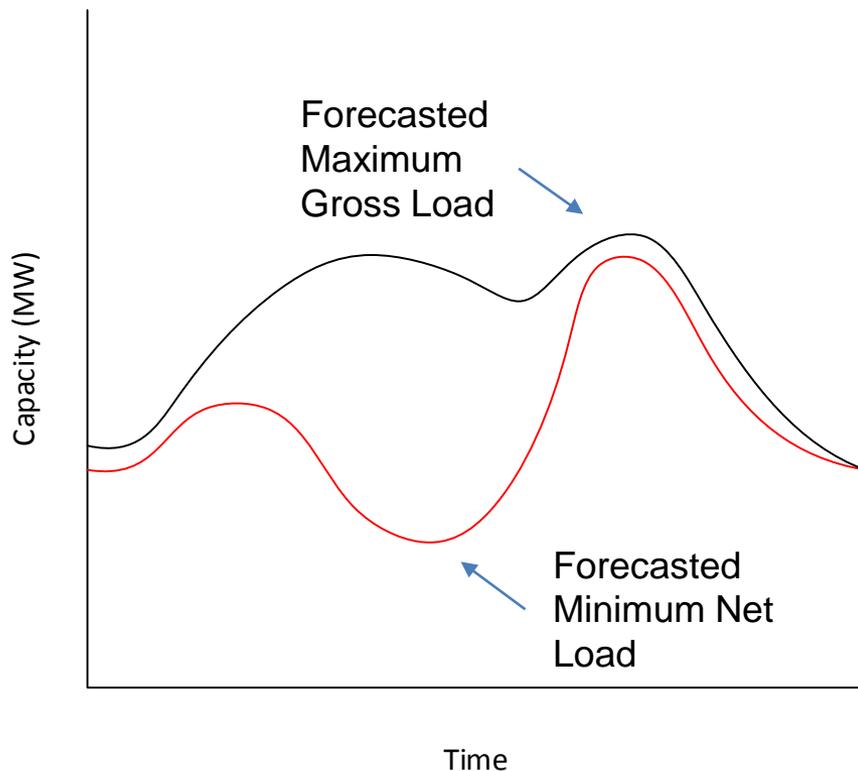
# Recommendations

- Flexible RA should be sufficient to cover:
  - The entire ramping range over the course of a month
  - Sufficient economic bids to clear the day-ahead market with a market based solution
  - Faster ramp rates with potentially shorter notice in real-time
  - An increased regulation quantity and frequency of use
- A new flexible RA framework should be developed based on a quantification of total ramping range and expected levels of uncertainty possible between market runs

# Overview of conceptual Flexible RA Framework

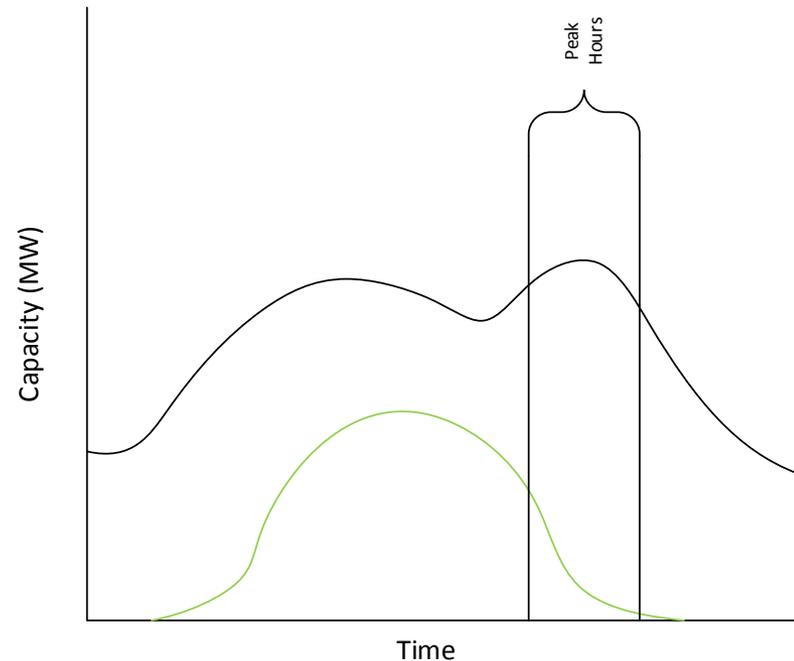
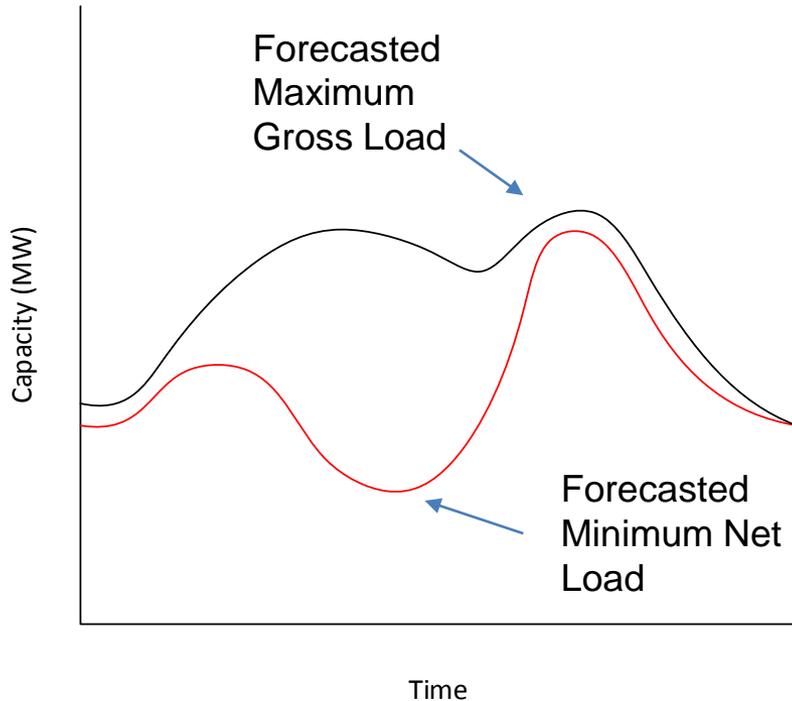
Karl Meeusen, Ph.D.

Need to rethink flexible vs. inflexible capacity while focusing on the core principles of operational needs, economic bidding, and environmental objectives.



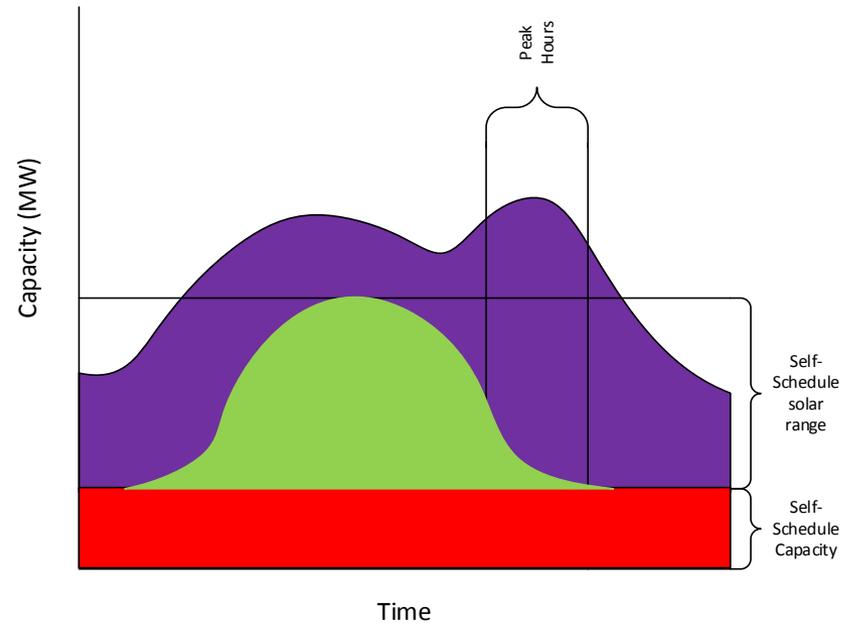
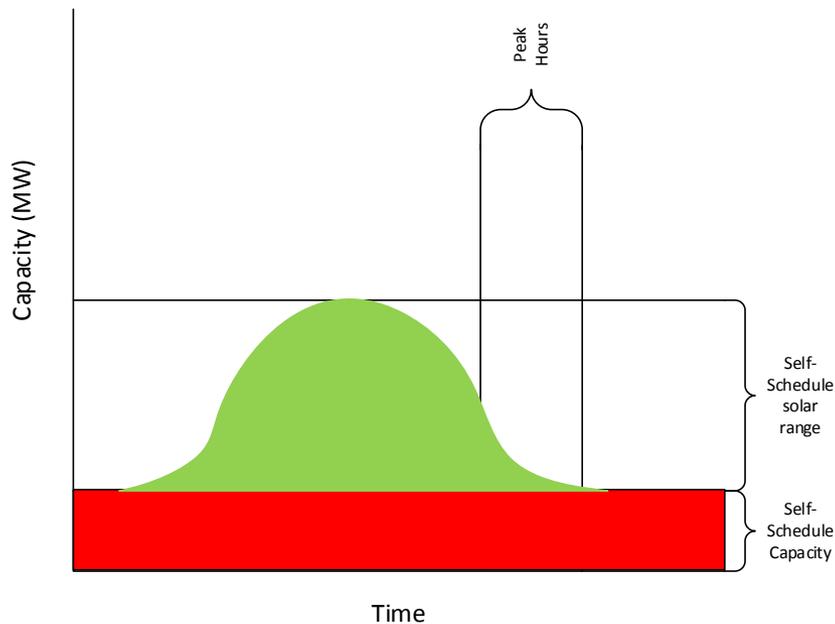
- Inflexible - resources that elect to not provide economic bids
- Flexible – resources that submit economic bids
- Redefine net load as load minus inflexible capacity
- Develop forecasted load and net load curves
- Flexible capacity covers the difference between gross load and inflexible capacity
  - Also covers any additional capacity required for reserves

# The amount of flexible capacity needed is affected by the amount of non-dispatchable resources utilized

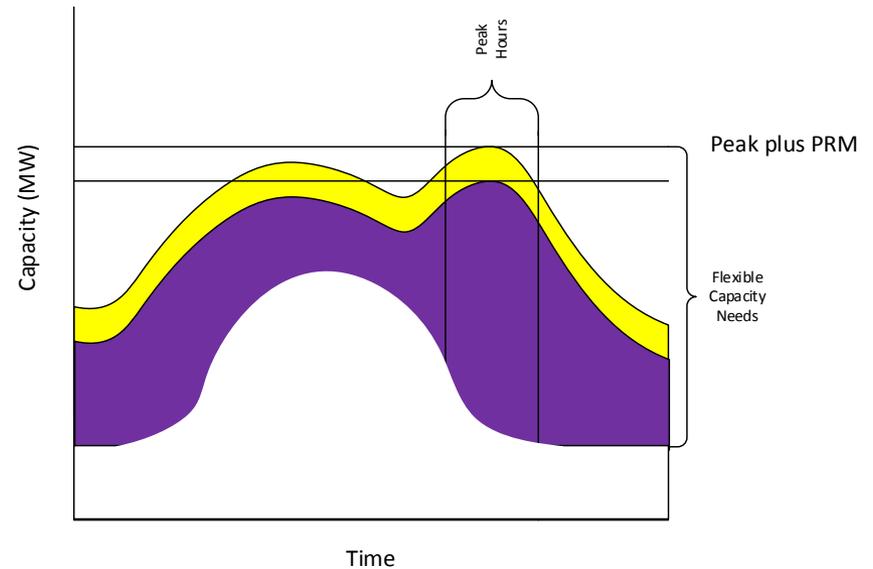
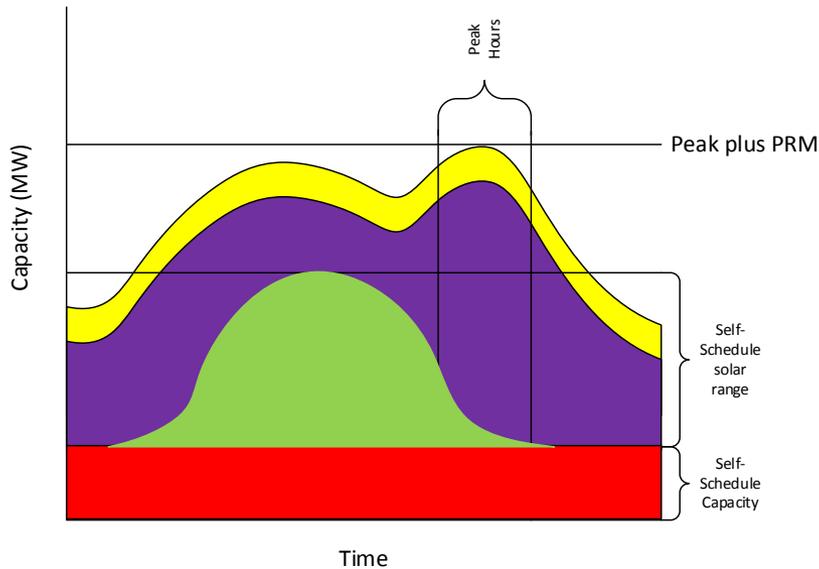


- The Duck curve was based on self-scheduled wind and solar

# Flexibility capacity should provide sufficient economic bid range for the ISO to dispatch around inflexible capacity



# Flexibility capacity should provide sufficient economic bid range for the ISO to dispatch around inflexible capacity



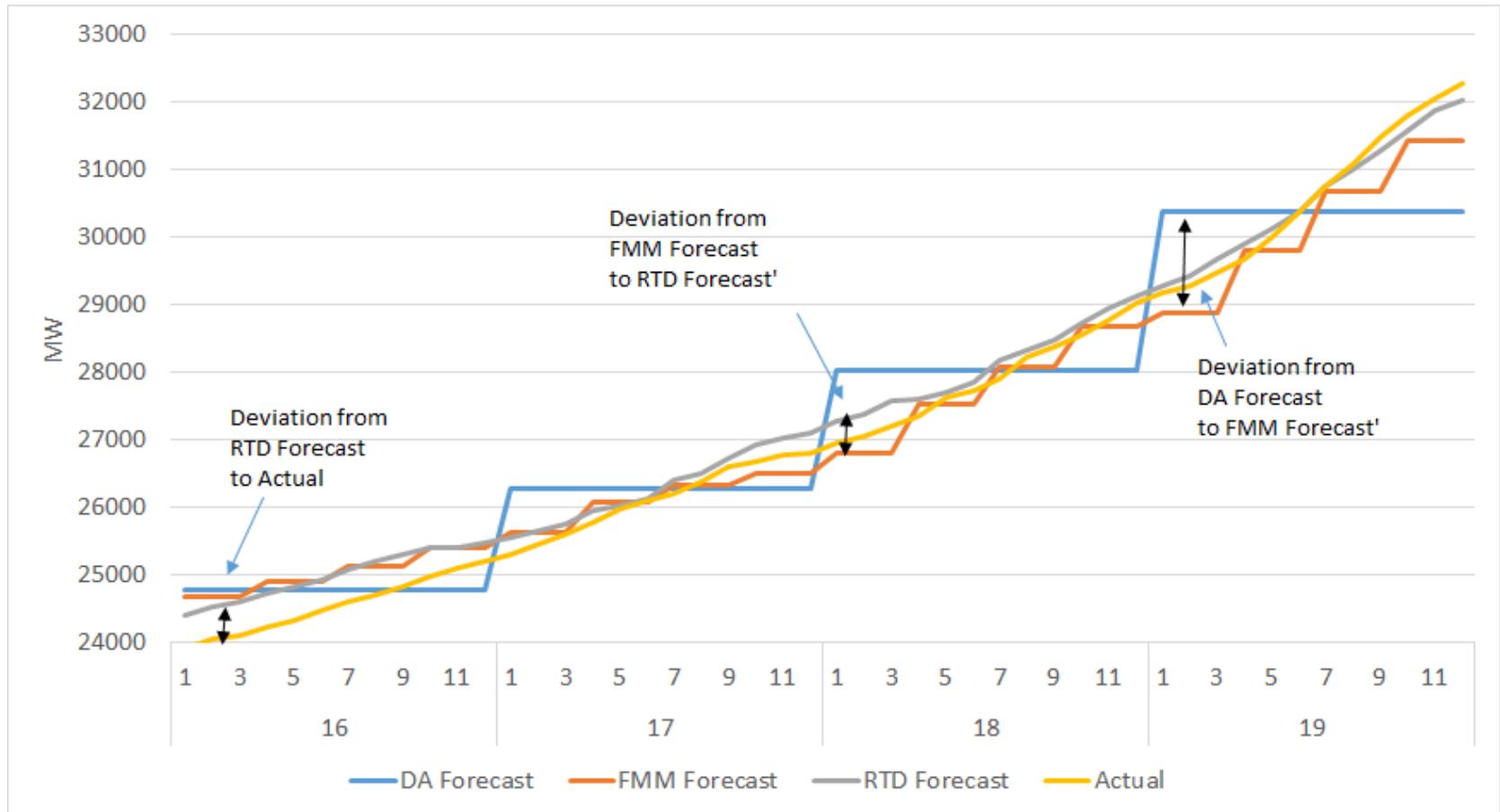
# The quantity of flexible capacity needed depends on inflexible capacity and forecast uncertainty between dispatch intervals

- Flexible capacity should be sufficient to cover forecasted load minus non-dispatchable generation
- Flexible RA products should address one-hour and intra-hour ramps
- Products to address ramping, uncertainty, and variability:
  - Day-ahead to real-time one-hour uncertainty
  - 15-minute
  - 5-minute

# Fundamental principles

- Resource counting rules and must offer-obligations must fit operational needs
  - e.g. provide the needed ramp capability (quantity and speed) over a given time interval
- Provide opportunities for both internal and external resources to meet flexibility needs of the grid through markets without the need for out of market actions

# Forecast error exists between each level of the ISO's dispatch



# Conceptual framework

- Four products
  - Day-ahead ramping range capacity
  - 15 minute dispatchable flexible capacity
  - 5 minute dispatchable flexible capacity
  - Regulation certified capacity

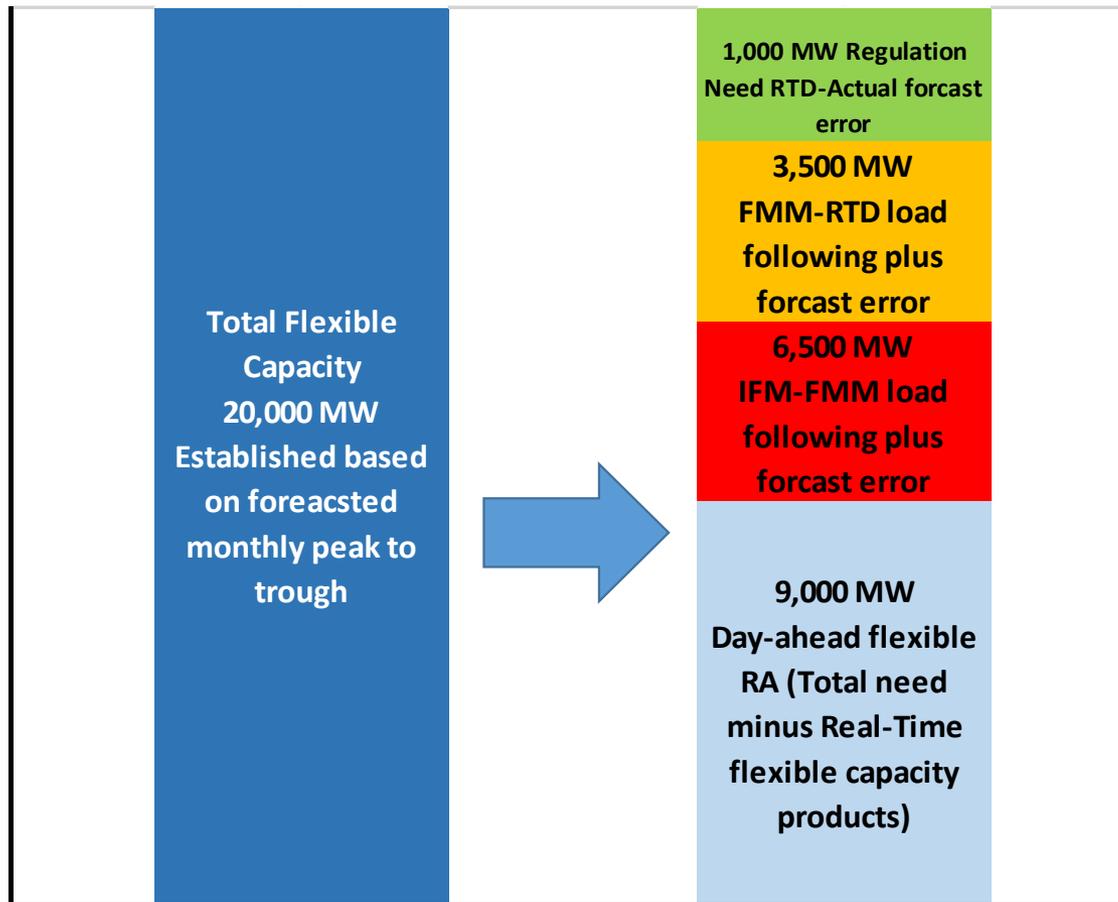
# Conceptual needs determination

- Overall flexible capacity need determined by forecasted maximum gross load plus PRM minus forecasted minimum net load
- Forecast error
  - Coincident vs non-coincident

## Conceptual needs determination for each product

- 5 minute dispatchable flexible capacity
  - Sum of maximum historic upward and downward load following and forecast error between FMM and RTD scaled by estimated growth in VER output
- 15 minute dispatchable flexible capacity
  - Maximum historic upward and downward load following and forecast error between IFM and FMM scaled by estimated growth in VER output
- Day-ahead flexible capacity
  - Maximum gross load plus PRM – minimum net load – 15 minute product – 5 minute product

# Example of conceptual needs determination



# Conceptual eligibility criteria

- Internal vs external
  - Day-ahead: internal and external resources could be eligible
  - 15 minute dispatchable: internal resources and interties willing to provide 15 minute bids
  - 5 minute dispatchable: internal resources only
- Use-limited resources could be eligible

# Conceptual eligibility criteria

- Start-up time/notification
  - Day-ahead: short, medium, and long start resources
  - 15 minute dispatchable: TBD
  - 5 minute dispatchable: TBD
- Duration
  - Resources must be able to sustain output for multiple hours
    - Three hours is current standard

# Counting rules should reflect ramping capability over a given time interval

- Ensures ability to address specific operational need
- Flexible capacity value does not necessarily need to reflect NQC
  - Creates an incentive for VERs to provide additional flexibility to address operational needs
  - ISO would determine if additional reliability studies are needed

# Must-offer obligations should reflect the timing of the ramp the resource is procured to address

Product	Conceptual must offer obligation
<b>Day Ahead Product</b>	<ul style="list-style-type: none"><li>• Must economically bid into DAM,</li><li>• Must economically bid into RTM for quantity not cleared in DAM,</li><li>• May self schedule all IFM awards</li><li>• If long-start and not committed in IFM or RUC, no additional obligations</li></ul>
<b>Fifteen Minute Product</b>	<ul style="list-style-type: none"><li>• Must economically bid into DAM,</li><li>• Must economically bid full flexible RA value into RTM,</li><li>• Must be dispatchable in at least FMM</li></ul>
<b>Five Minute Product</b>	<ul style="list-style-type: none"><li>• Must economically bid into DAM,</li><li>• Must economically bid full flexible RA value into RTM,</li><li>• Must be dispatchable in at least RTD</li></ul>

# Next Steps

- Stakeholder comments due:
  - October 10, 2017
- Second Revised Straw Proposal
  - Early November 2017