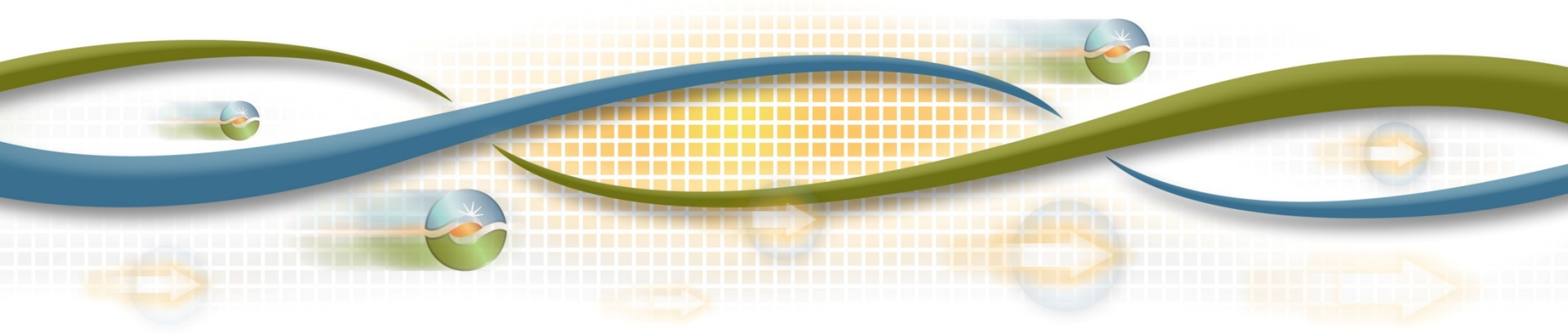
FRACMOO 2 Working Group

August 2, 2017



Agenda

Time	Item	Presenter
10:00-10:10	Introduction	Greg Cook
10:10-11:00	Operational Needs Assessment	Clyde Loutan and ISO Operations
11:00-11:30	Proposed Framework for CAISO Flexible Capacity Procurement	Hannes Pfeifenberger, The Brattle Group
11:30-11:55	Flexibility Metrics and Future Considerations	Karl Meeusen
11:55-12:00	Next Steps	Kim Perez

Introduction

Greg Cook – Director, Markets and Infrastructure Policy

Based on stakeholder feedback, the ISO is reframing the flexible capacity initiative.

- Broad opposition to previous ISO flexible capacity proposal, including
  - Concern about conflating three separate drivers
    - Renewable curtailments
    - Risk of retirements
    - Operational needs
  - Expressed need to take additional time to vet durable solution
  - Expressed need to include intertie resources
- CAISO is resetting the effort

Path forward

- Re-focus CAISO efforts on developing flexible capacity requirements aligned with operational needs
  - Develop an analytical approach to supporting proposed solutions
- Draft Final Proposal planned by end of the year
  - Provide proposal for CPUC consideration
  - Target implementation for 2020 RA compliance year
- Bring resulting policy to ISO Board summer 2018

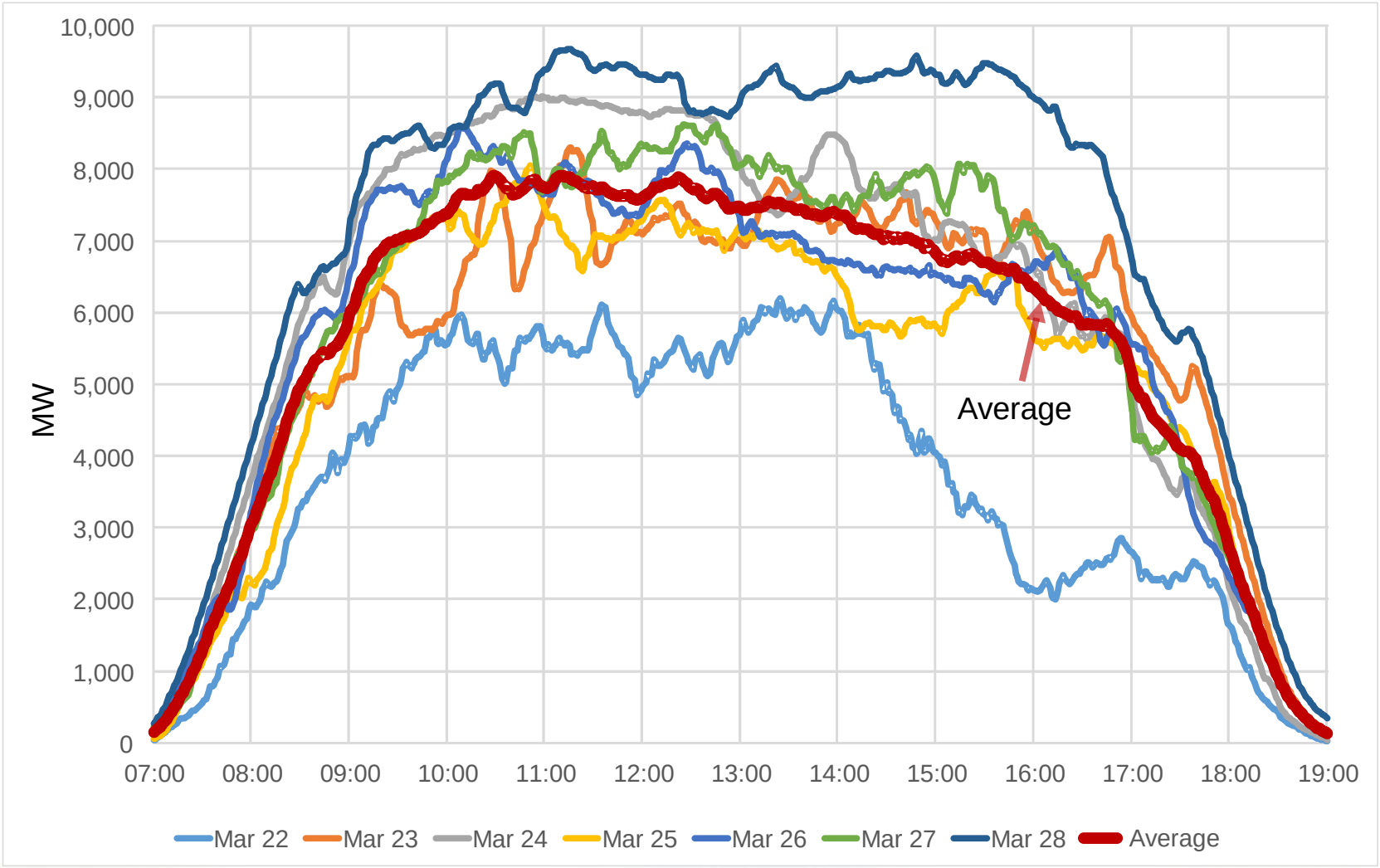
Today's focus

- What are the operational challenges facing the ISO?
- Where is the current 3-hour max net load ramp based requirement falling short?
- What changes are needed to the current flexible capacity product?
- What is the right framework for informing and assessing flexible capacity procurement needs?

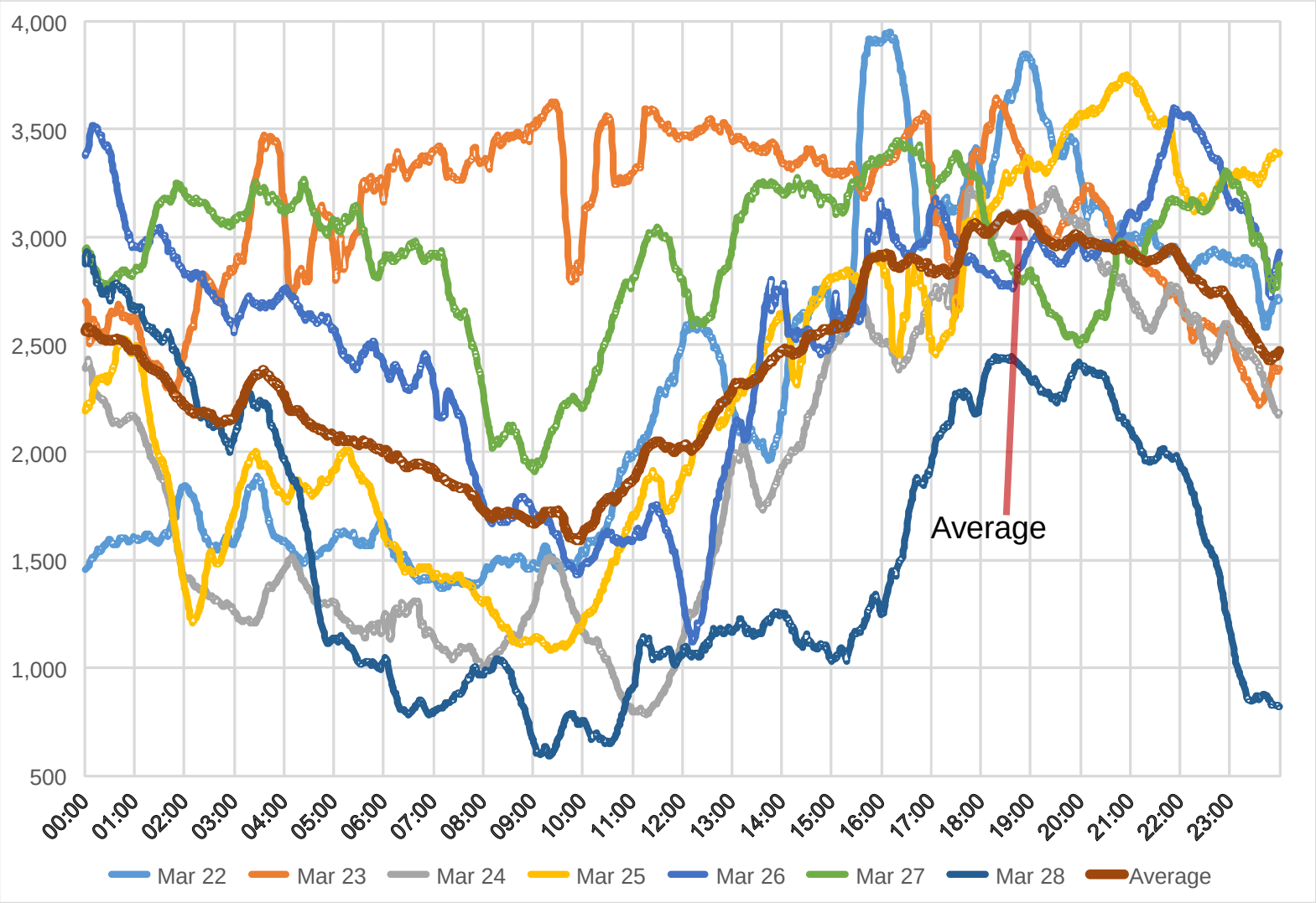
Operational Needs Assessment

Clyde Loutan – Principal, Renewable Energy Integration

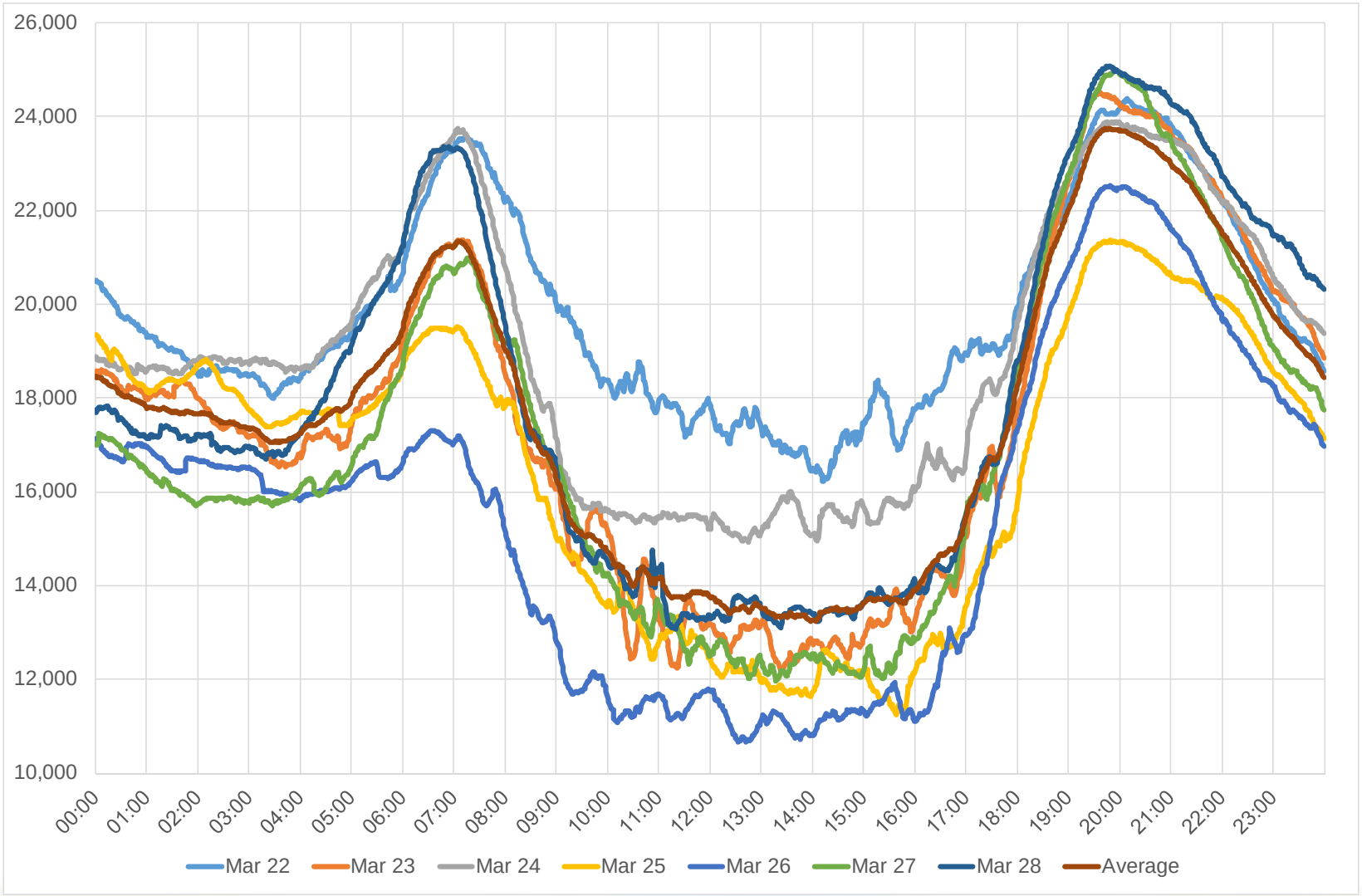
Solar production varies from one day to the next --- One week in March 2017



Wind production varies from one day to the next --- One week in March 2017



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



The assessment of a Balancing Authority control performance is based on the following components

- **Balancing Authority Ace Limit (BAAL) -** is a real-time measure of area control error and system frequency which cannot exceed predefined limits for more than 30-minutes

  $BAAL_{Limit} \leq 30$ minutes

- **Control Performance Standard (CPS1) -** measures how well a BA's ACE performs in conjunction with the frequency error of the Interconnection

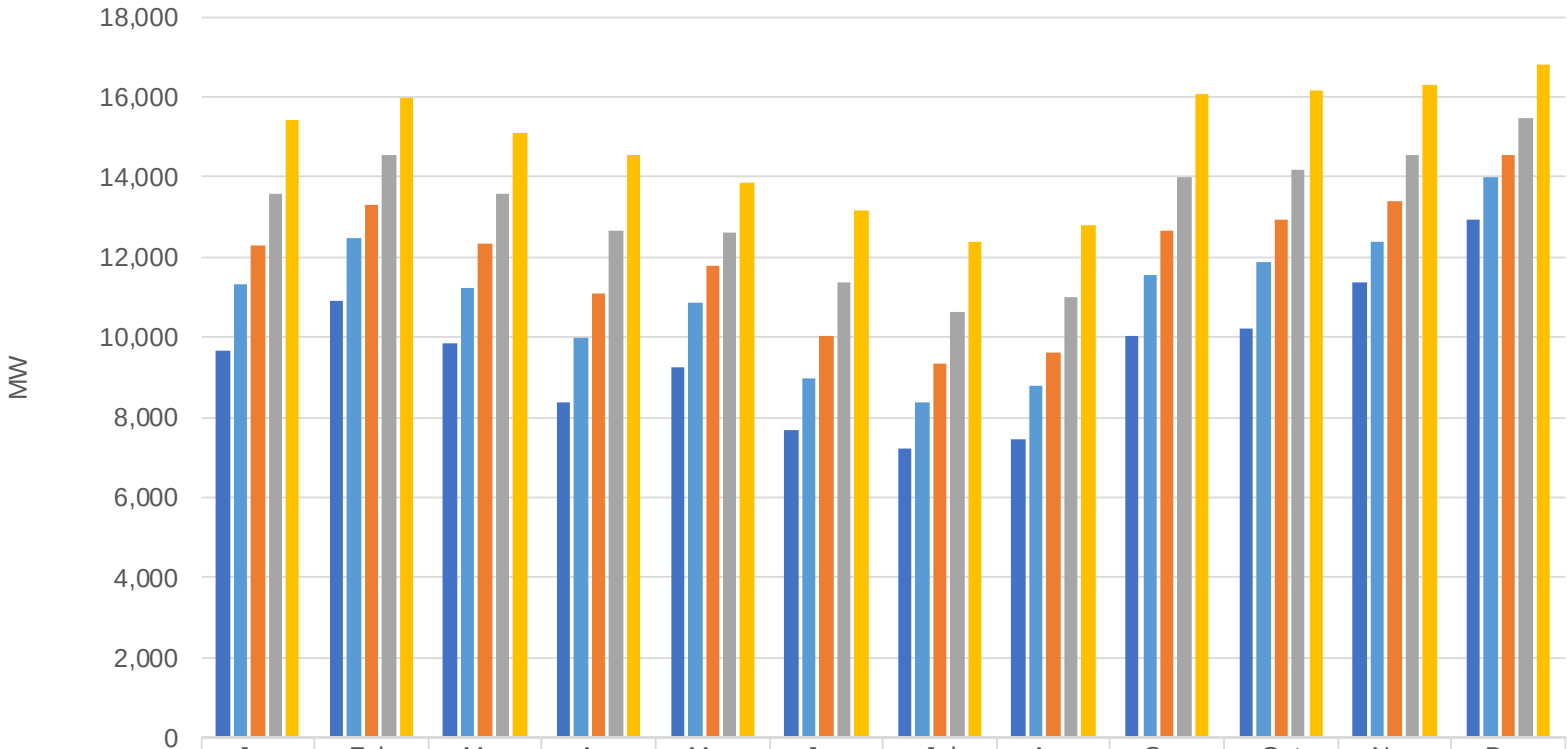
  CPS1 Pass ≥ 100% over rolling 12 months

- **Disturbance Control Standard (DCS) -** is the responsibility of a BA to recover its ACE to zero if its ACE just prior to the disturbance was greater than zero or to its pre-disturbance level if ACE was less than zero within 15 minutes

  DCS = 100%

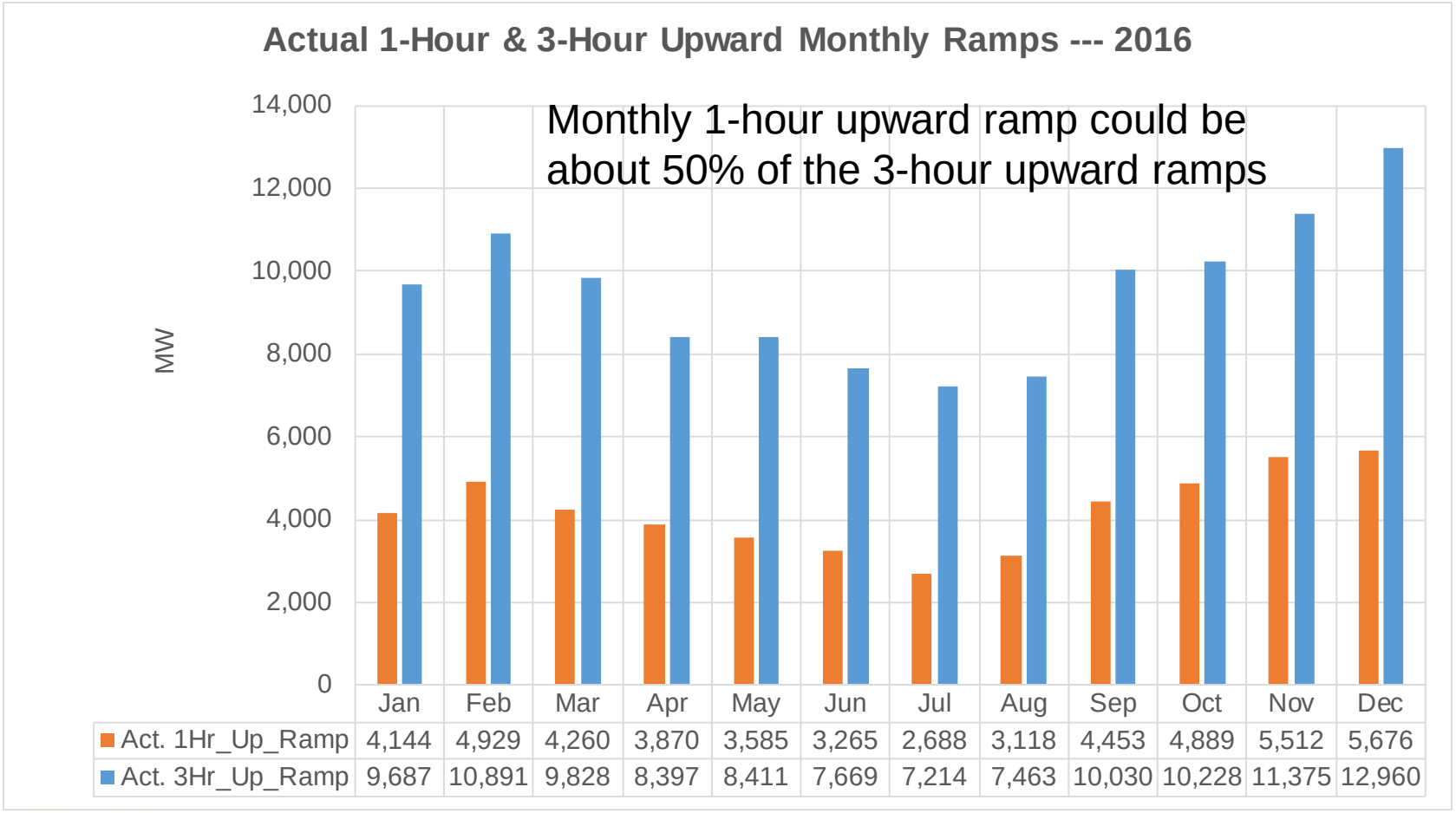
- ***Frequency Response***
  - All BAs to support the interconnection frequency within 52 seconds following a disturbance greater than 500 MW anywhere within the interconnection

3-hour ramps increase over time with build out of renewables and addition of behind-the-meter resources



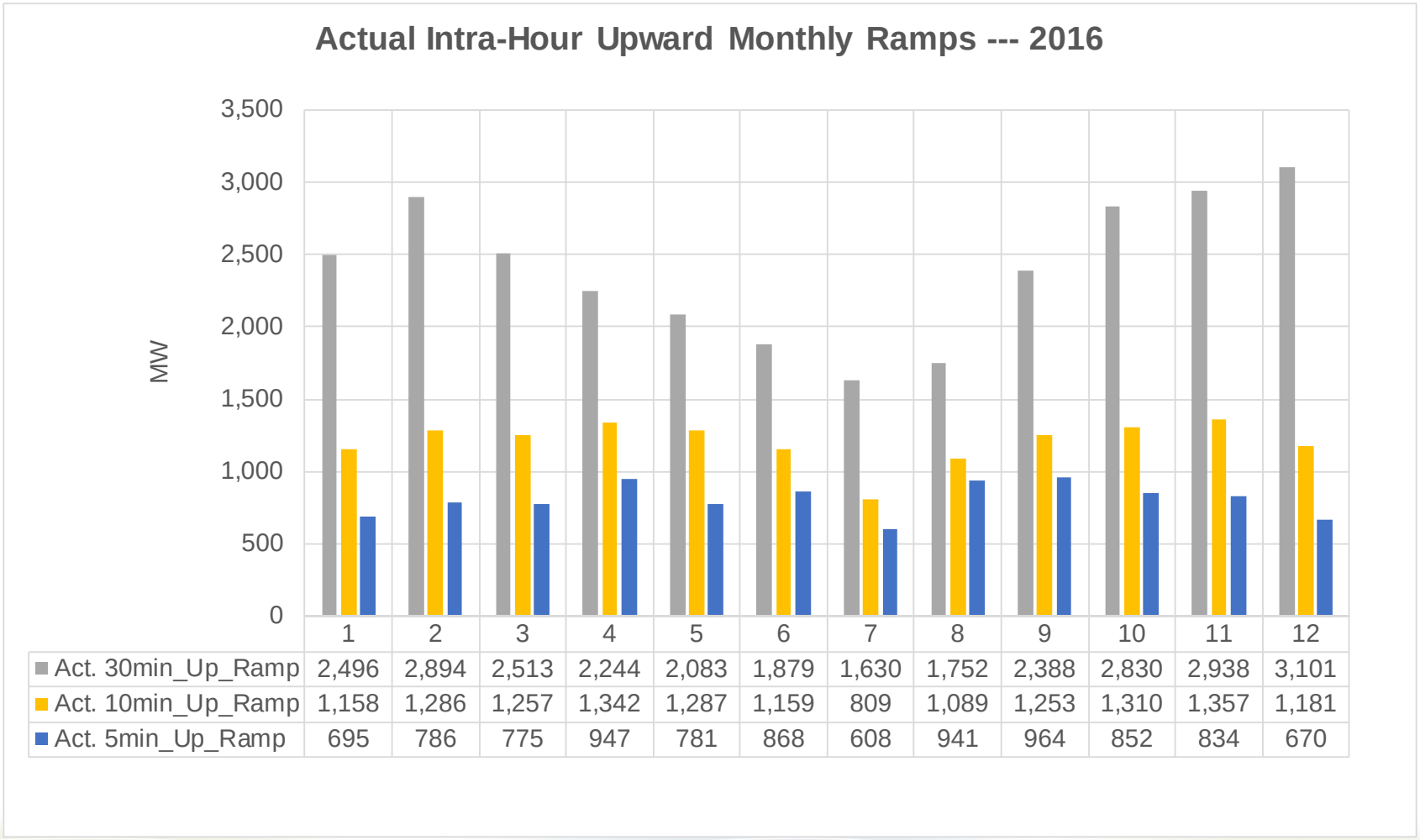
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016 (Actual)	9,687	10,891	9,828	8,397	9,263	7,669	7,214	7,463	10,030	10,228	11,375	12,960
2017	11,342	12,465	11,253	9,973	10,878	8,996	8,379	8,768	11,575	11,900	12,391	14,004
2018	12,282	13,313	12,352	11,111	11,803	10,039	9,326	9,617	12,660	12,954	13,376	14,567
2019	13,595	14,543	13,574	12,672	12,631	11,350	10,616	10,982	13,981	14,199	14,553	15,495
2020	15,439	15,984	15,089	14,572	13,859	13,181	12,391	12,821	16,061	16,169	16,293	16,817

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



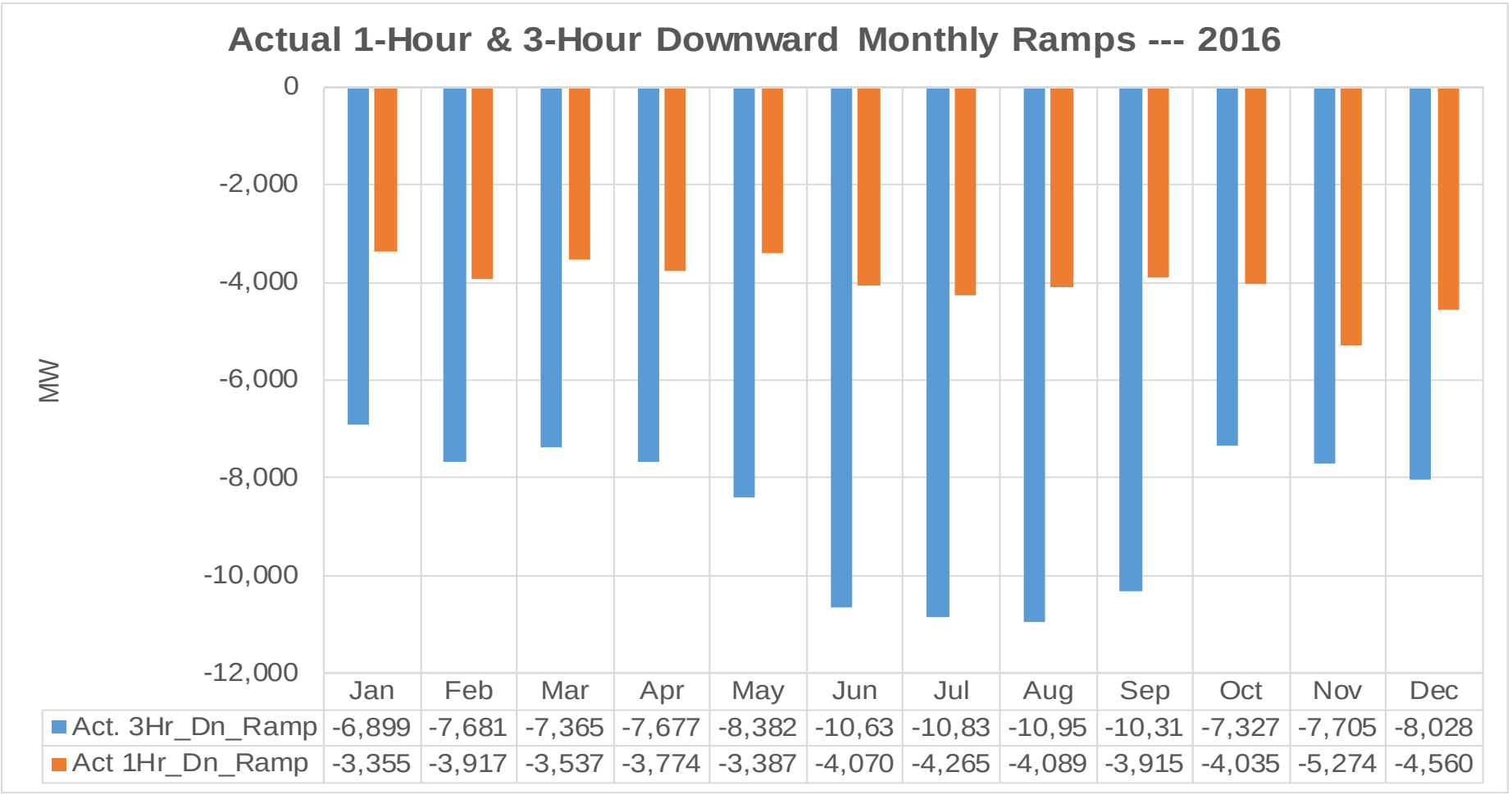
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Act. 1Hr_Up_Ramp	4,144	4,929	4,260	3,870	3,585	3,265	2,688	3,118	4,453	4,889	5,512	5,676
Act. 3Hr_Up_Ramp	9,687	10,891	9,828	8,397	8,411	7,669	7,214	7,463	10,030	10,228	11,375	12,960

Intra-hour upward ramping needs for 2016



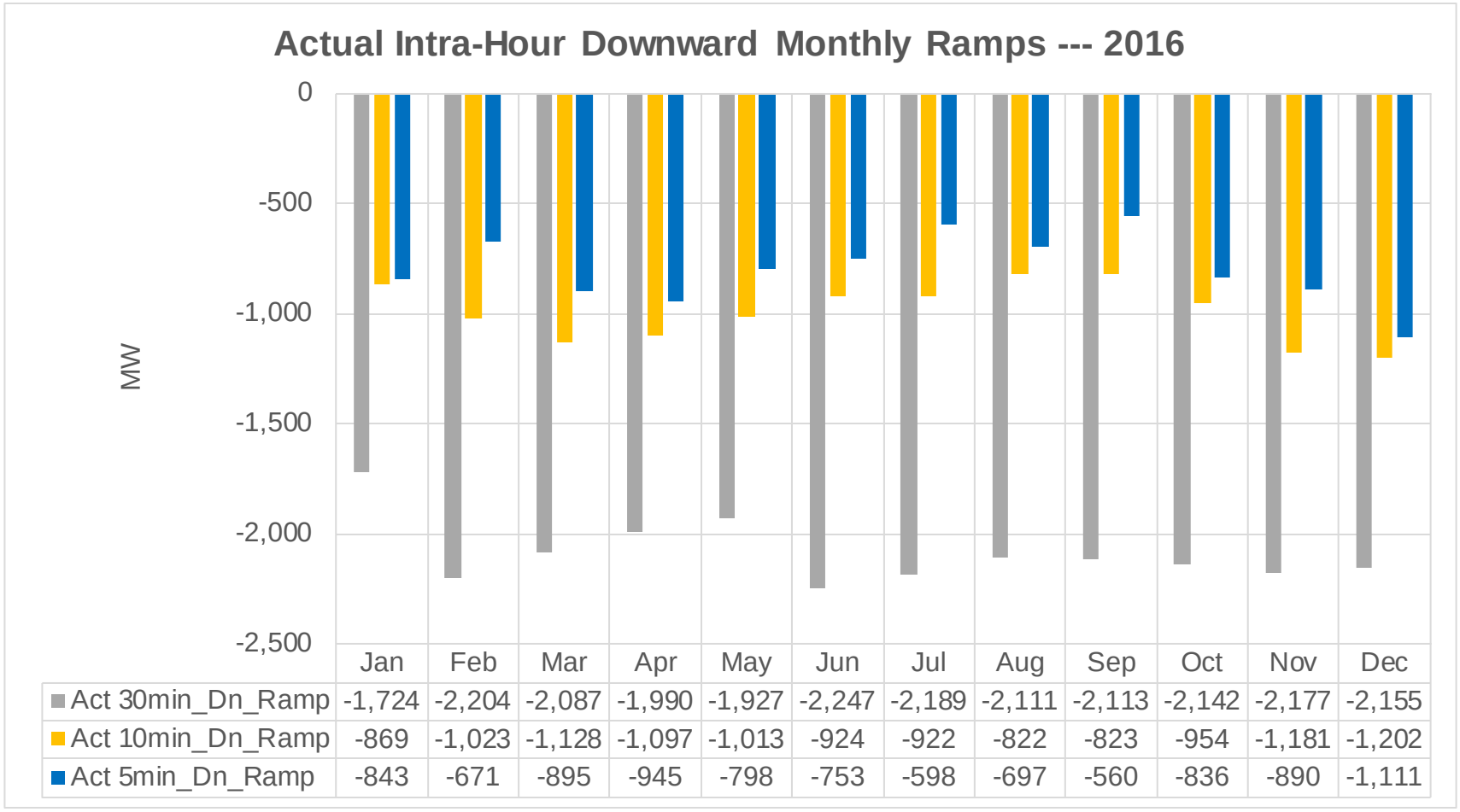
	1	2	3	4	5	6	7	8	9	10	11	12
Act. 30min_Up_Ramp	2,496	2,894	2,513	2,244	2,083	1,879	1,630	1,752	2,388	2,830	2,938	3,101
Act. 10min_Up_Ramp	1,158	1,286	1,257	1,342	1,287	1,159	809	1,089	1,253	1,310	1,357	1,181
Act. 5min_Up_Ramp	695	786	775	947	781	868	608	941	964	852	834	670

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



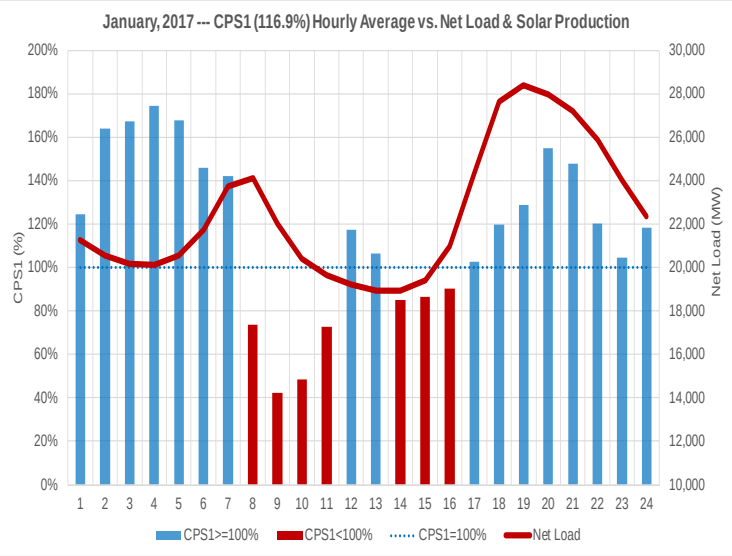
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Act. 3Hr_Dn_Ramp	-6,899	-7,681	-7,365	-7,677	-8,382	-10,63	-10,83	-10,95	-10,31	-7,327	-7,705	-8,028
Act 1Hr_Dn_Ramp	-3,355	-3,917	-3,537	-3,774	-3,387	-4,070	-4,265	-4,089	-3,915	-4,035	-5,274	-4,560

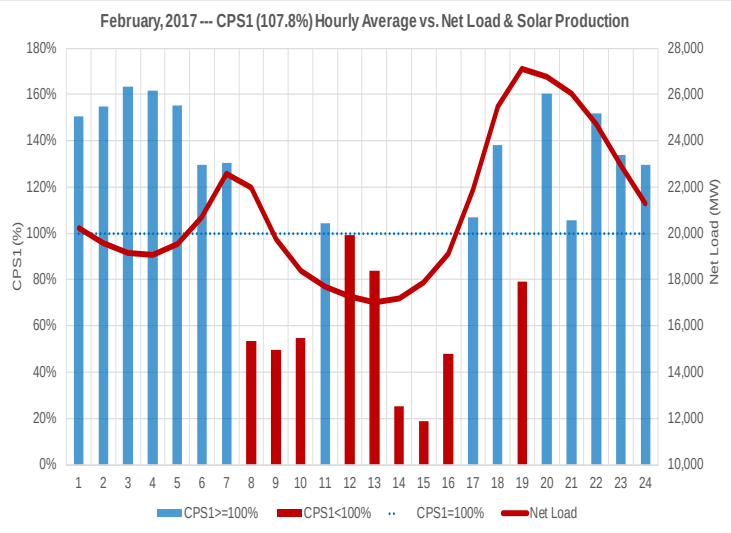
Intra-hour downward ramping needs for 2016

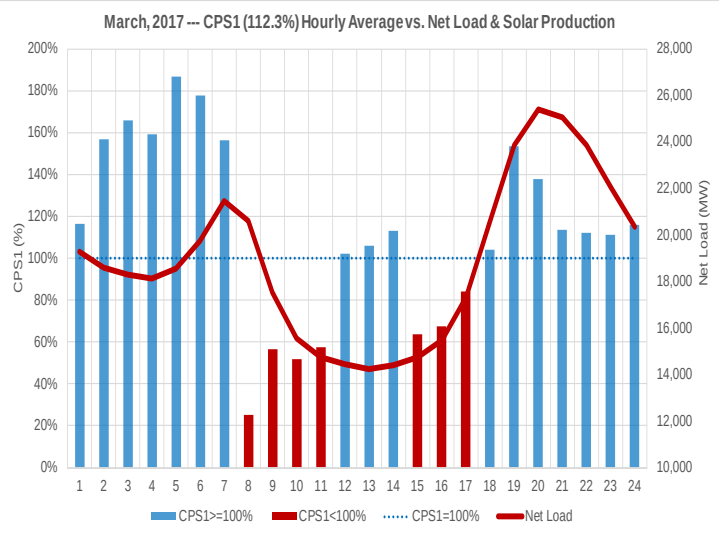


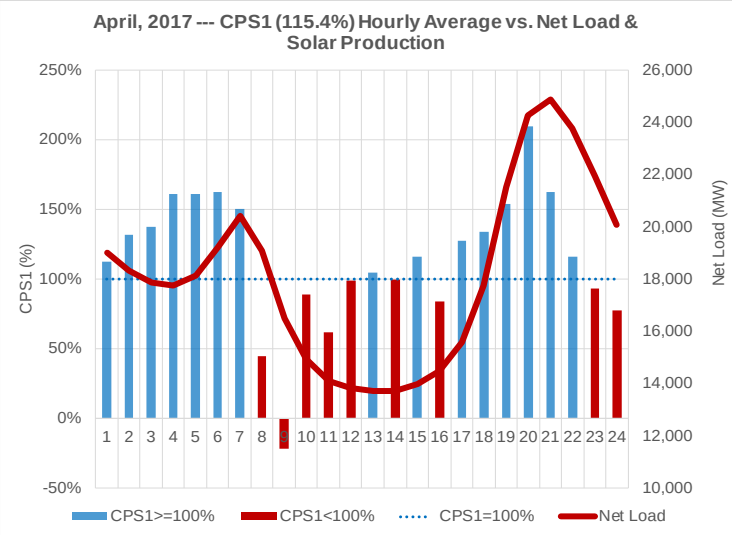
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Act 30min_Dn_Ramp	-1,724	-2,204	-2,087	-1,990	-1,927	-2,247	-2,189	-2,111	-2,113	-2,142	-2,177	-2,155
Act 10min_Dn_Ramp	-869	-1,023	-1,128	-1,097	-1,013	-924	-922	-822	-823	-954	-1,181	-1,202
Act 5min_Dn_Ramp	-843	-671	-895	-945	-798	-753	-598	-697	-560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

Controlling CPS1 scores has been a recurring operational challenge – data from Jan to April 2017

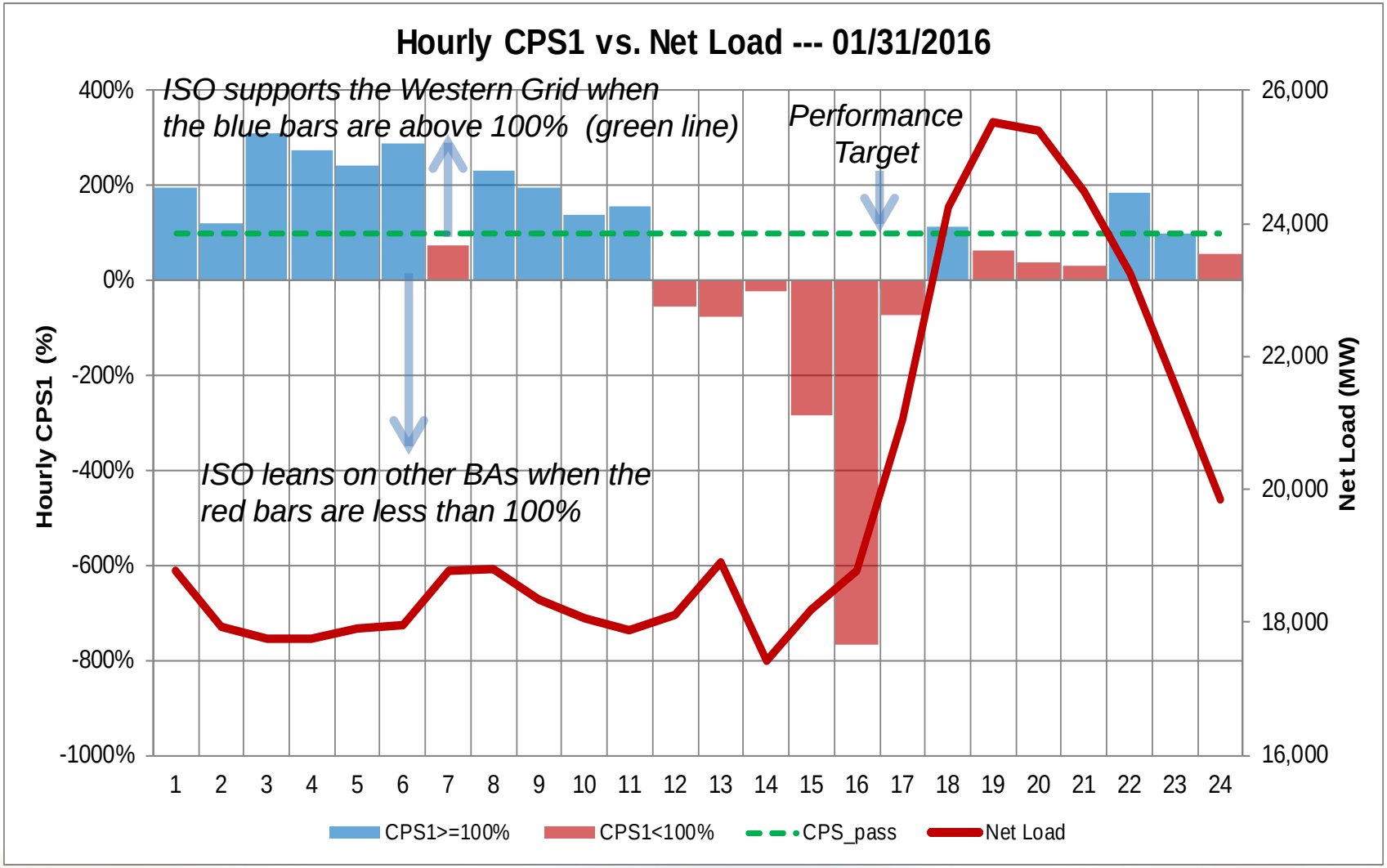




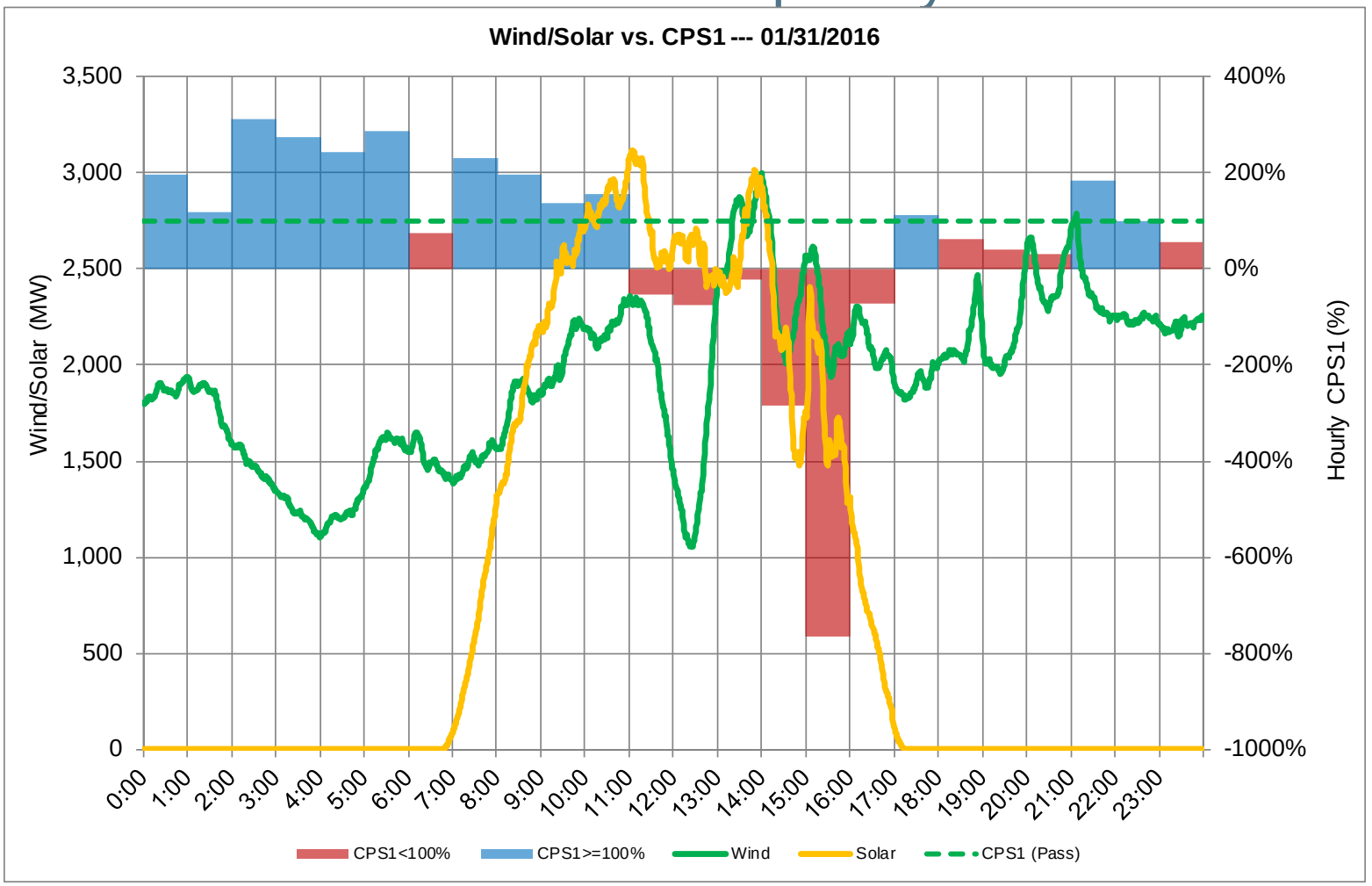




At certain times, ISO has persistent challenge balancing real-time supply and demand

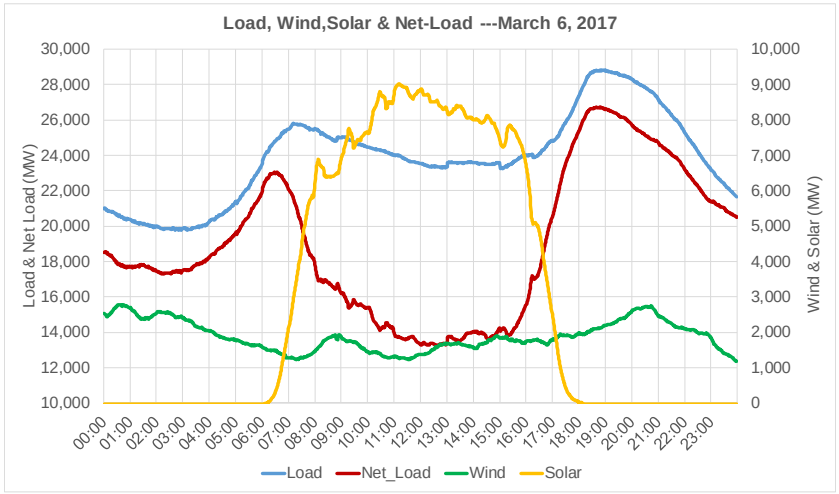


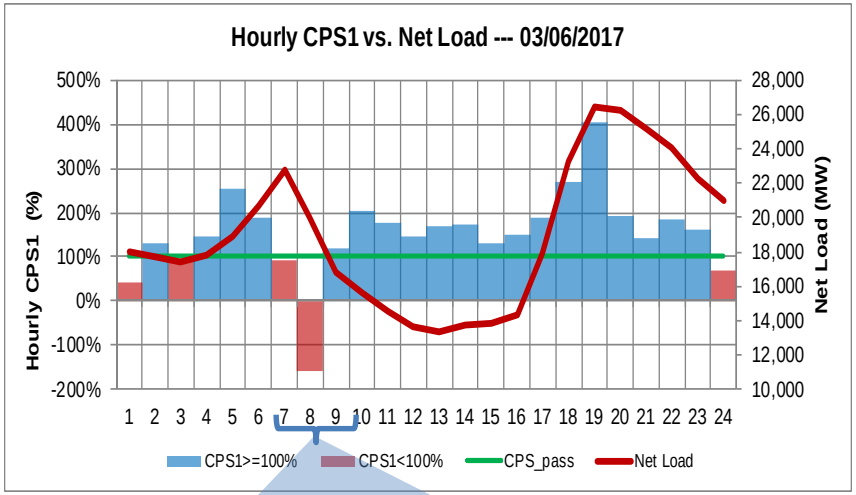
Intra-hour variability and uncertainty can result in inability to control the interconnection frequency in real-time



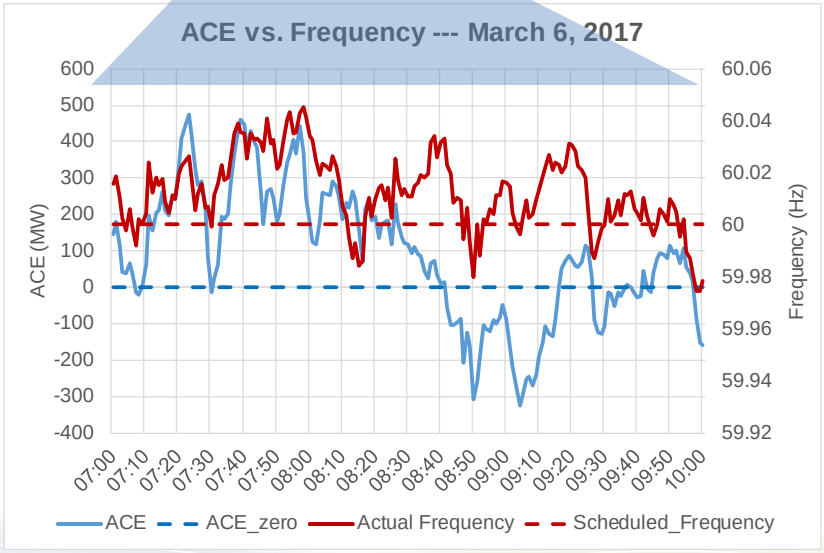
CPS1 is evaluated on a rolling 12-month average. Over the past few years, the rolling average has been declining as a result of some poor daily performances. Thus, the CAISO needs to take measures to improve daily performance on days with higher variability.

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

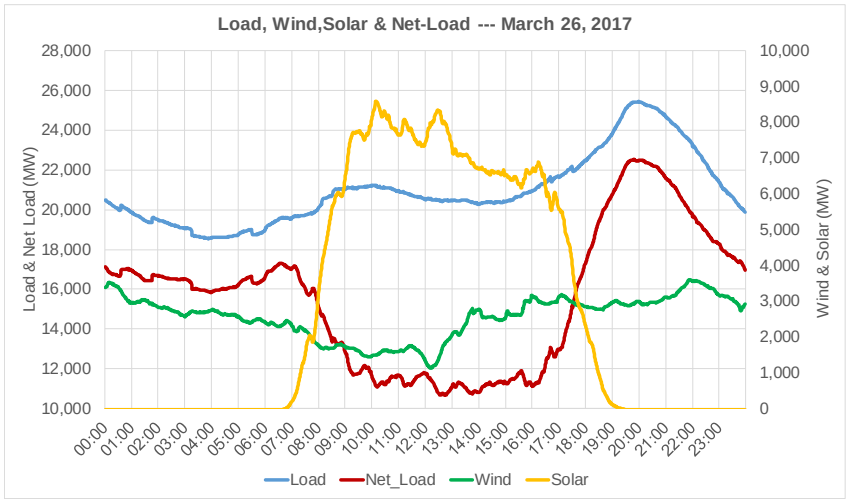


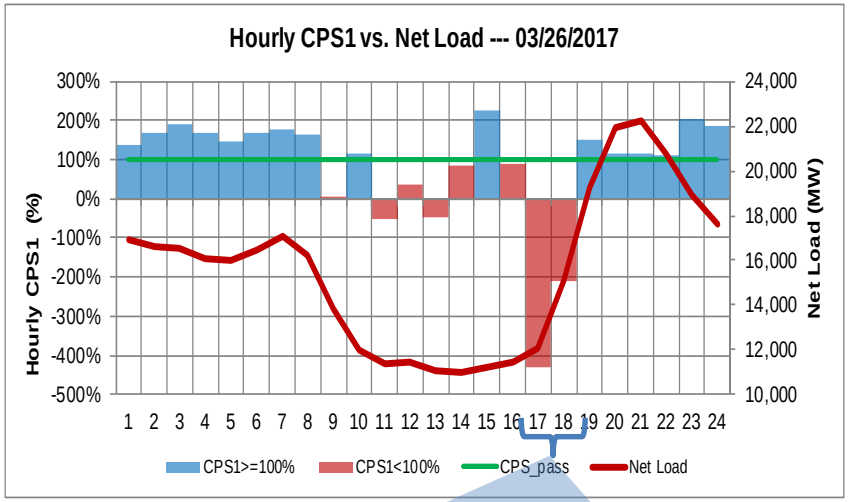


	Load	Solar	Net Load
Sunrise Ramp Rate (MW/Min) 7:00 – 10:00	-6	31	-37
MW Change	-1,023	5,529	-6,724
Sunset Ramp Rate (MW/Min) 16:00 – 19:00	27	-37	61
MW Change	4,801	-6,703	11,049

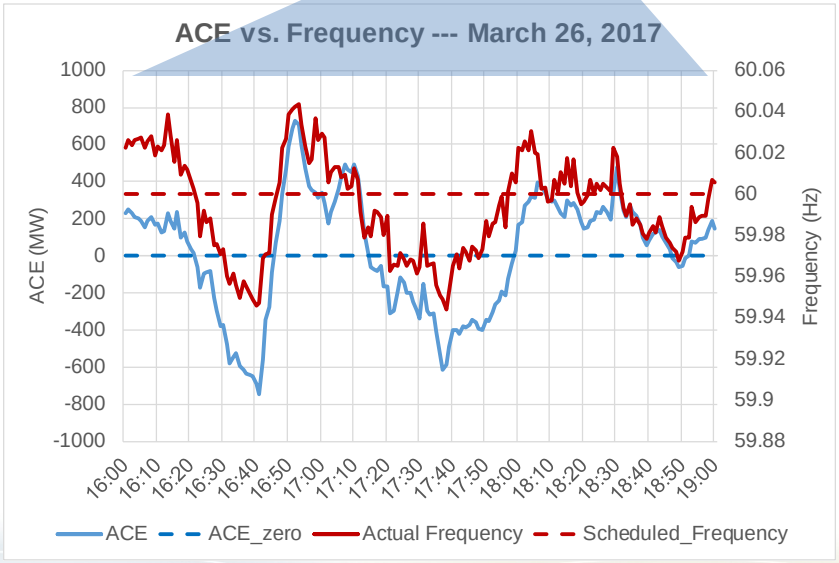


Interplay between supply and demand impacts ability of the fleet to meet ramps - March 26, 2017 (Weekend)



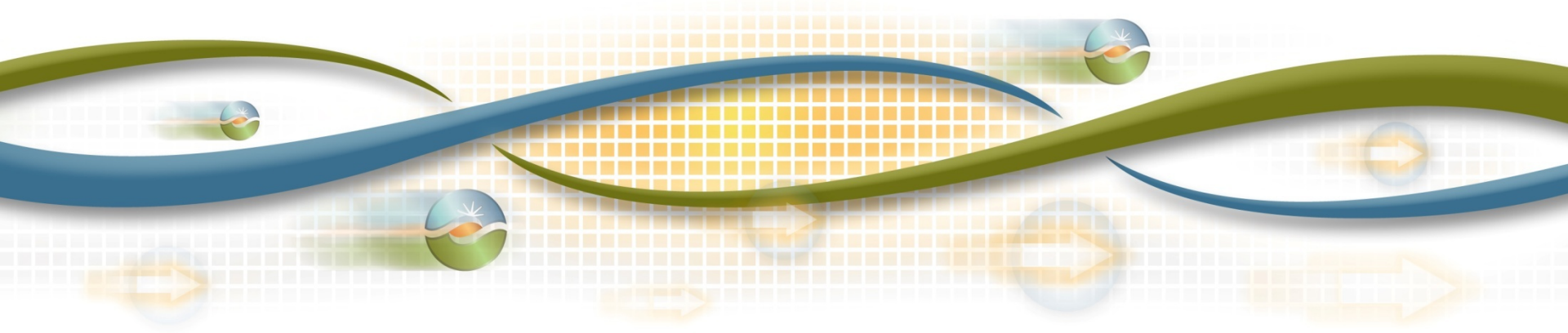


	Load	Solar	Net Load
Sunrise Ramp Rate (MW/Min) 7:00 – 10:00	9	44	-30
MW Change	1,612	7,947	-5,489
Sunset Ramp Rate (MW/Min) 16:00 – 19:00	16	-37	54
MW Change	2,908	-6,575	9,663



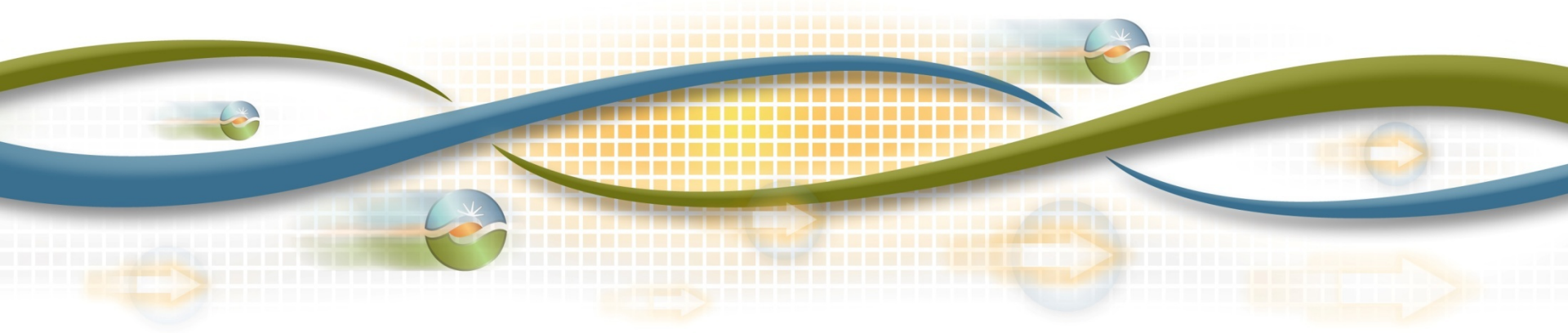
Proposed Framework for CAISO Flexible Capacity Procurement

Johannes Pfeifenberger - Principal
The Brattle Group



Future Direction of FRACMOO 2

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



Recap of our data analysis

1. The origin of several operational challenges

2. The three hour ramp is still important but it is not capable of serving our full operational needs

3. Implications of not having sufficient flexibility is leading to operational challenges

Flexible capacity needs are a function of both predictable and unpredictable factors

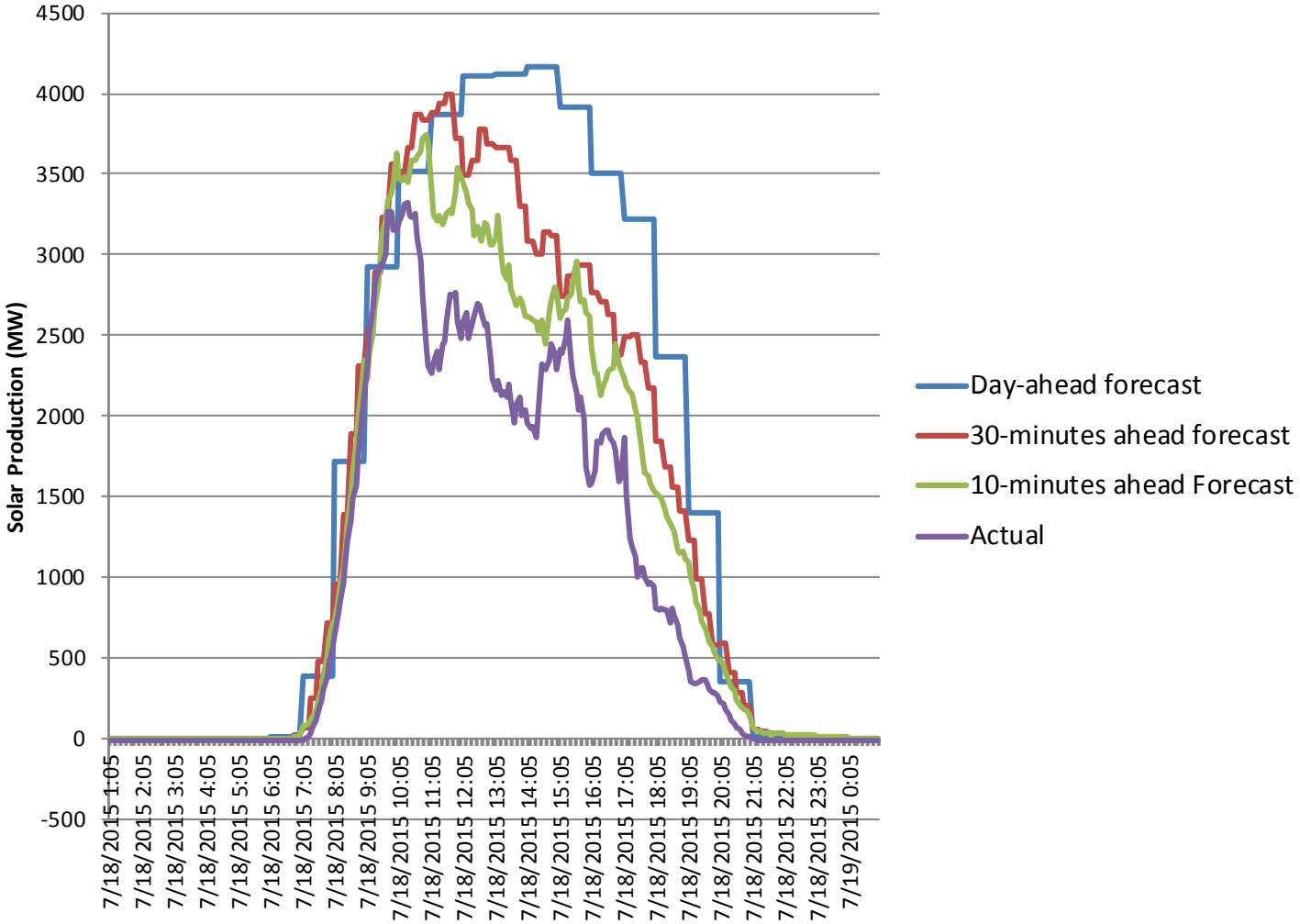
Uncertainty and Variability

- Day-Ahead to Real-Time markets
- Hourly to Fifteen Minute Market
- FMM to five minute dispatch
- Regulation

Ramping Needs

- Three hour
- One hour
- Intra-hour
- Fifteen minute

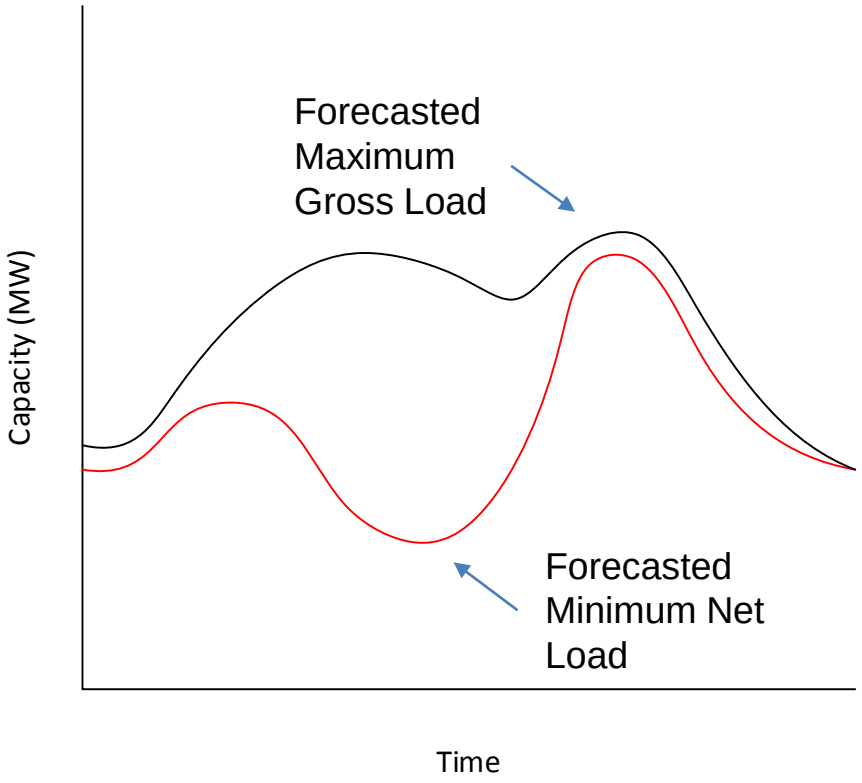
Example of day-ahead versus real-time uncertainty



Suggestions we've heard from stakeholders

- Total bids and self-schedules by hour
  - Categorized by resource type
  - Categorized by RA and non-RA resources
  - Categorized by flexible RA and system RA resources
- Total bids and self-schedules of renewable resources by hour, categorized by resource online date
- In actual operations, is the CAISO exhausting resources capable of addressing intra-hour variability?
- To what extent does the CAISO rely on regulation to address intra-hour variability?
- Are resources that provide regulation typically procured and shown as generic or flexible RA?

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

CAISO is looking to develop shorter duration products to address operational needs created by uncertainty

- In addition to the existing three hour product, Flexible RA products should address one-hour and intra-hour net load ramps
- Products to address uncertainty and variability:
  - Day-ahead to real-time
  - One-hour uncertainty
  - 15-minute
  - 5-minute
- Resource counting rules and must offer-obligations must fit operational needs, e.g. provide the needed ramp capability.
- Provide opportunities for both internal and external resources to support flexible needs of the grid

A new RA assessment methodology is needed to evaluate the interaction of the fleet to meet the needs of the transforming grid

- Ensure there is sufficient capacity & energy 8760 hrs/yr
- Satisfy all operational needs all hours of the year
- Consider the interactions of the RA fleet and its attributes across the year
- Properly account for resource use-limitations in the context of the transforming grid

The ISO is taking a holistic, operationally-focused approach to address its flexibility needs, including what ISO market enhancements are needed

- RA enhancements and market design/process enhancements are needed to help the CAISO manage ramping needs, variability, and uncertainty
  - IFM-RUC integration
  - 15-minute IFM schedules
  - Expanding STUC outlook horizon

ISO is targeting the end of 2017 to complete its policy development, but additional coordination is needed.

- Stakeholder comments on proposed metrics by mid-August
- Stakeholder meeting on findings of proposed metrics in September
- Revised FRACMOO2 proposal targeted for mid-October
- Draft final proposal targeted for December
- Collaborate with LRA's for target implementation for 2020 RA year
- CAISO Board approval summer 2018

Next steps

- Stakeholder comments due:
  - August 16, 2017
- Stakeholder meeting:
  - September
- Complete stakeholder process by end of 2018