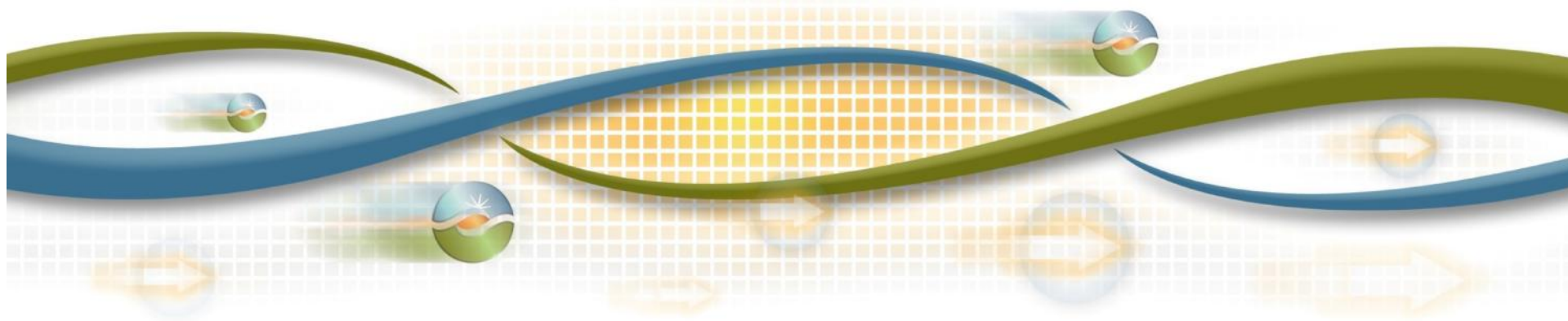




Presentation for CPUC Flexible Capacity Workshop

Ryan Kurlinski – Manager, Analysis and Mitigation Group
Department of Market Monitoring, California Independent System Operator

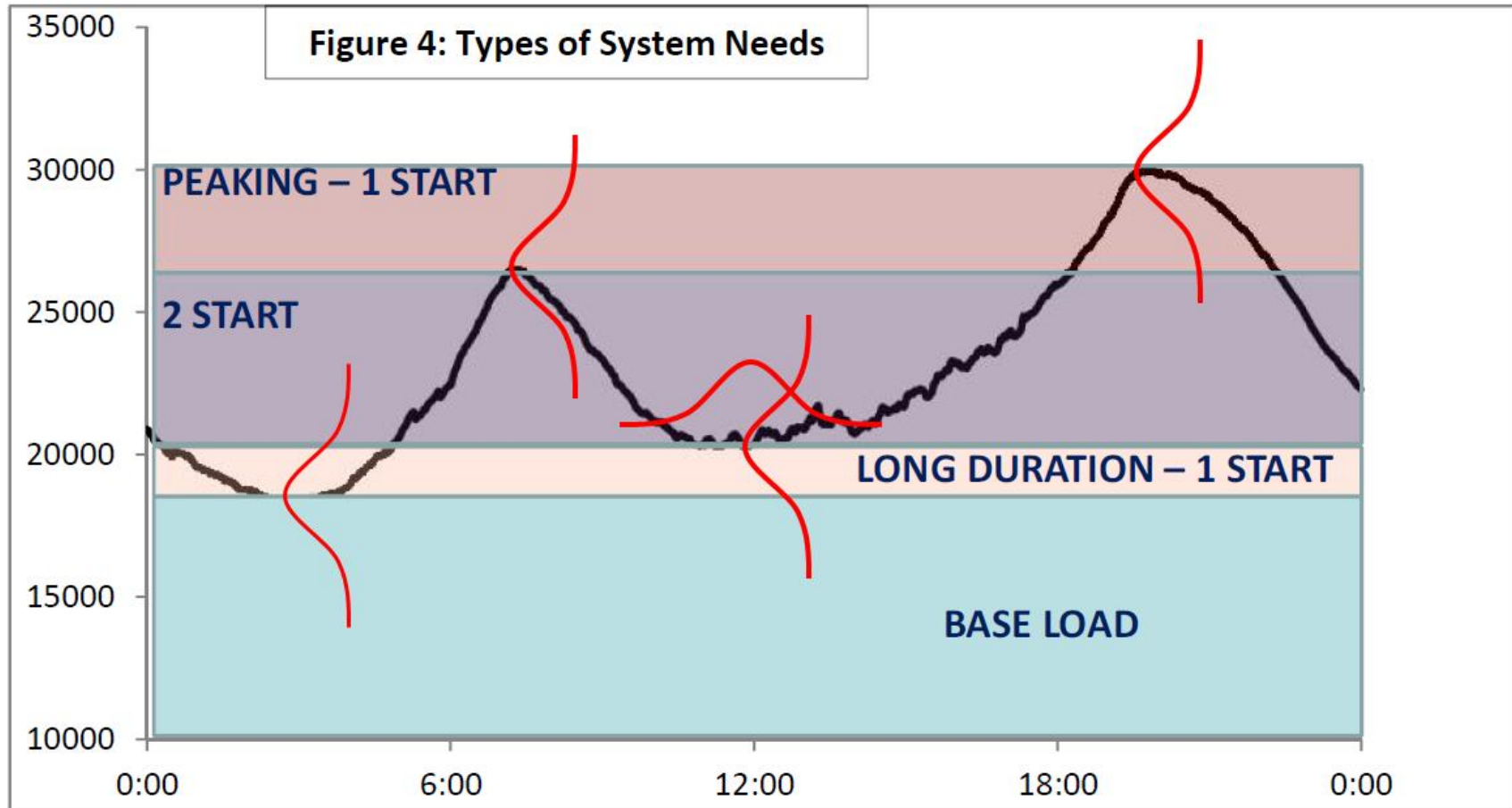
November 9, 2016



Overview

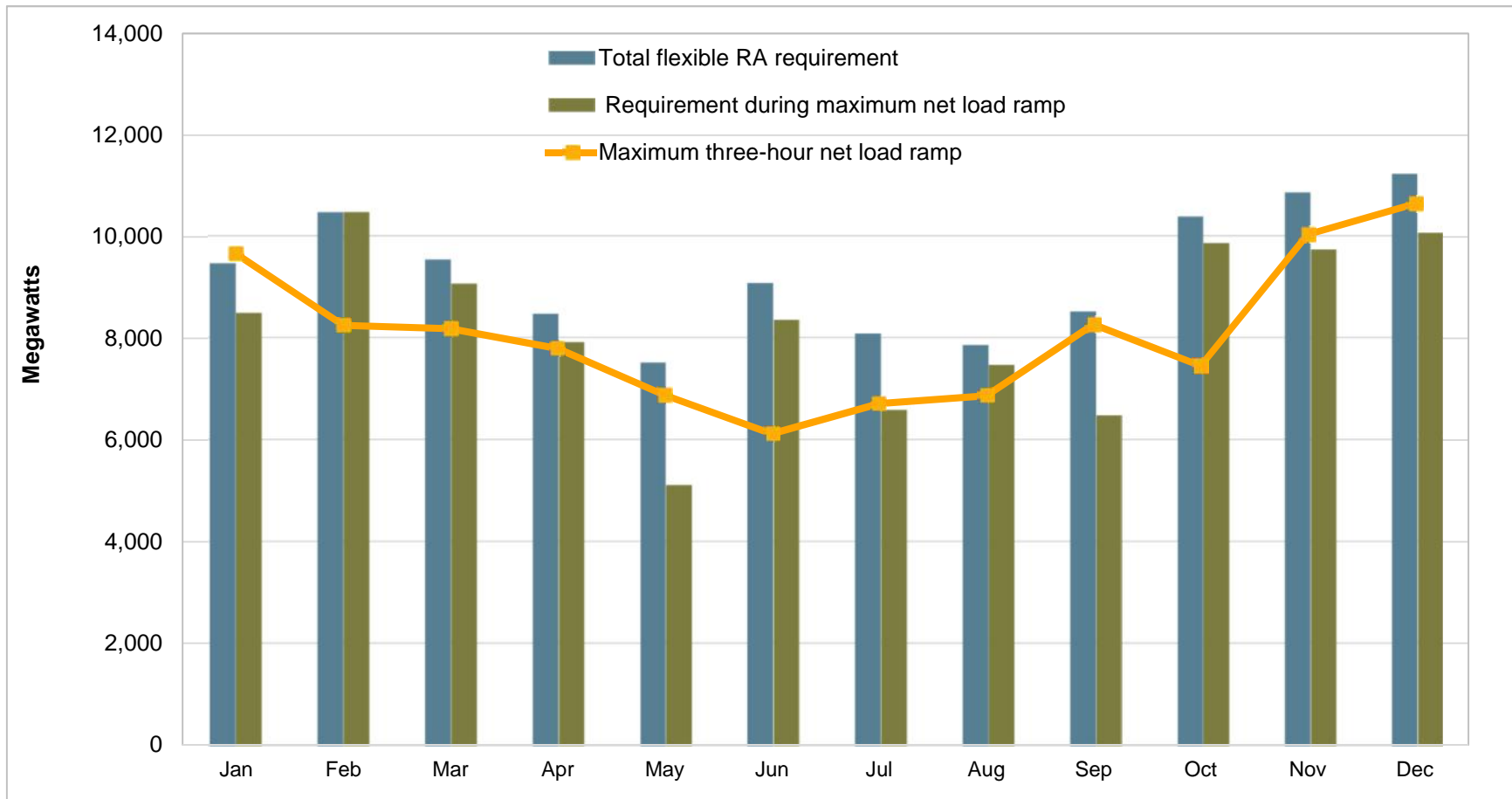
- Introduction
- Long-term flexibility
 - Expected variation
 - Uncertainty in expected variation
- Short-term flexibility
 - Uncertainty in day-ahead of real-time
 - Uncertainty in RT of net load in future RT intervals
 - Uncertainty in this RT interval of actual
- DMM analysis referenced as being relevant to these proceedings

Long-term flexibility: Expected variation and its uncertainty



Source of original graph: Energy Division – California Public Utilities Commission, *Flexible Resource Adequacy Workshop Report*, June 1, 2016, p. 6. (Edited for this presentation with red pdfs.)

Flexible resource adequacy requirements during the actual maximum net load ramp 2015



Source: 2015 Annual Report on Market Issues and Performance, Department of Market Monitoring, May 2016, p. 210:

<http://www.caiso.com/Documents/2015AnnualReportonMarketIssuesandPerformance.pdf>

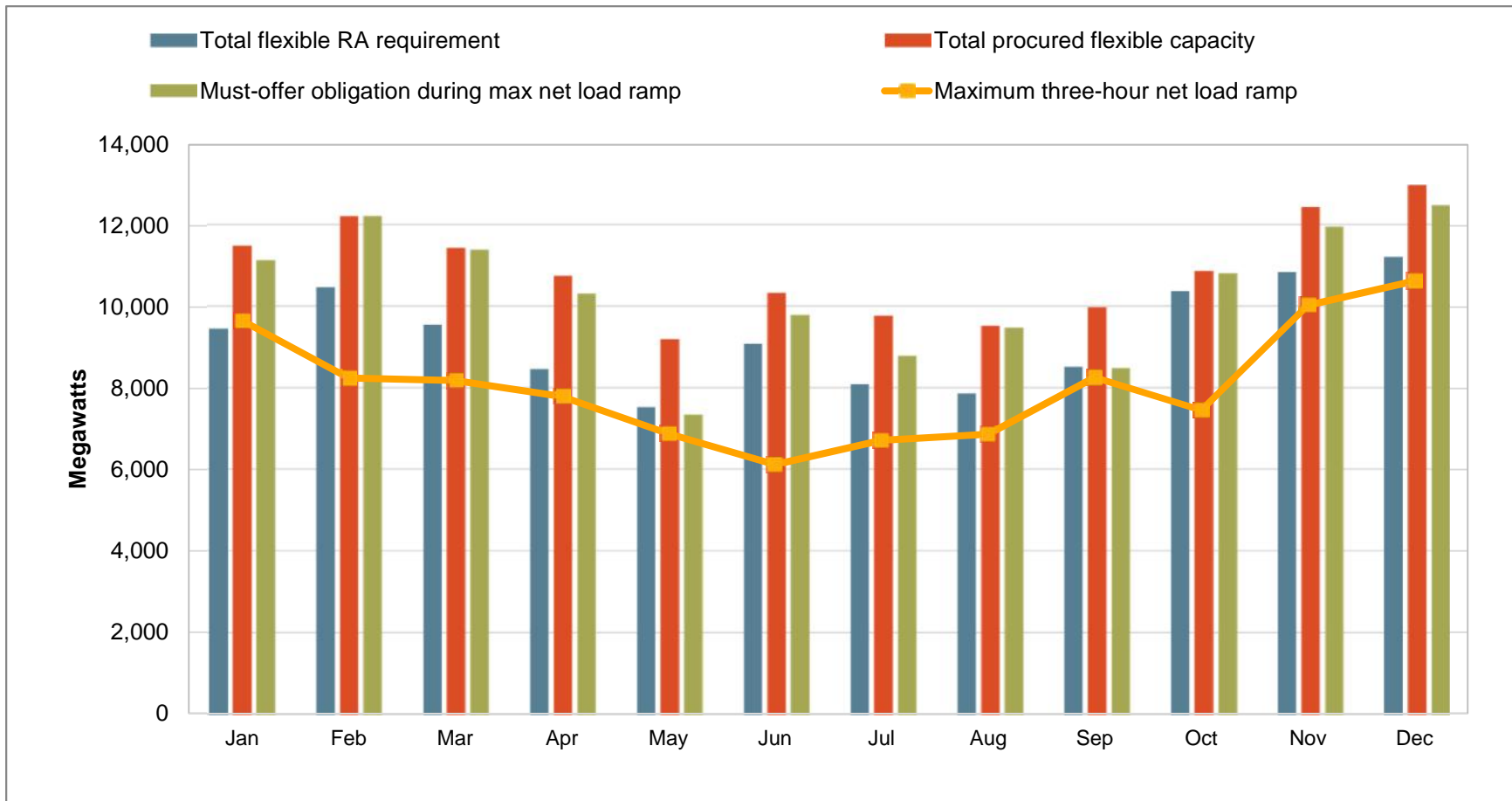
Maximum three-hour net load ramp and flexible resource adequacy requirements 2015

| Month | Maximum 3-hour net load ramp (MW) | Total flexible RA requirement (MW) | Average requirement during maximum net load ramp (MW) | Date of maximum net load ramp | Ramp start time | Average requirement met ramp? (Y/N) | Why average requirement during max net load ramp does not equal total requirement |
|-------|-----------------------------------|------------------------------------|---|-------------------------------|-----------------|-------------------------------------|---|
| Jan | 9,666 | 9,459 | 8,489 | 1/1/2015 | 14:35 | N | Ramp occurred on a holiday and one hour did not overlap with must offer hours |
| Feb | 8,255 | 10,465 | 10,465 | 2/11/2015 | 15:00 | Y | |
| Mar | 8,192 | 9,543 | 9,066 | 3/22/2015 | 16:30 | Y | Ramp occurred on a weekend |
| Apr | 7,799 | 8,468 | 7,917 | 4/8/2015 | 17:00 | Y | One hour of ramp did not overlap with must offer hours |
| May | 6,884 | 7,520 | 5,114 | 5/23/2015 | 17:20 | N | Ramp occurred on a weekend and entirely outside of must offer hours |
| Jun | 6,124 | 9,078 | 8,352 | 6/30/2015 | 10:25 | Y | One hour of ramp did not overlap with must offer hours |
| Jul | 6,720 | 8,083 | 6,587 | 7/19/2015 | 11:15 | N | Ramp occurred on a weekend and two hours did not overlap with must offer hours |
| Aug | 6,874 | 7,861 | 7,467 | 8/16/2015 | 9:55 | Y | Ramp occurred on a weekend |
| Sep | 8,272 | 8,523 | 6,478 | 9/8/2015 | 12:20 | N | Three hours of ramp did not overlap with must offer hours |
| Oct | 7,461 | 10,381 | 9,862 | 10/4/2015 | 16:05 | Y | Ramp occurred on a weekend |
| Nov | 10,042 | 10,848 | 9,737 | 11/29/2015 | 14:30 | N | Ramp occurred on a weekend and one hour did not overlap with must offer hours |
| Dec | 10,675 | 11,212 | 10,063 | 12/26/2015 | 14:30 | N | Ramp occurred on a weekend and one hour did not overlap with must offer hours |

Source: 2015 Annual Report on Market Issues and Performance, Department of Market Monitoring, May 2016, p. 212:

<http://www.caiso.com/Documents/2015AnnualReportonMarketIssuesandPerformance.pdf>

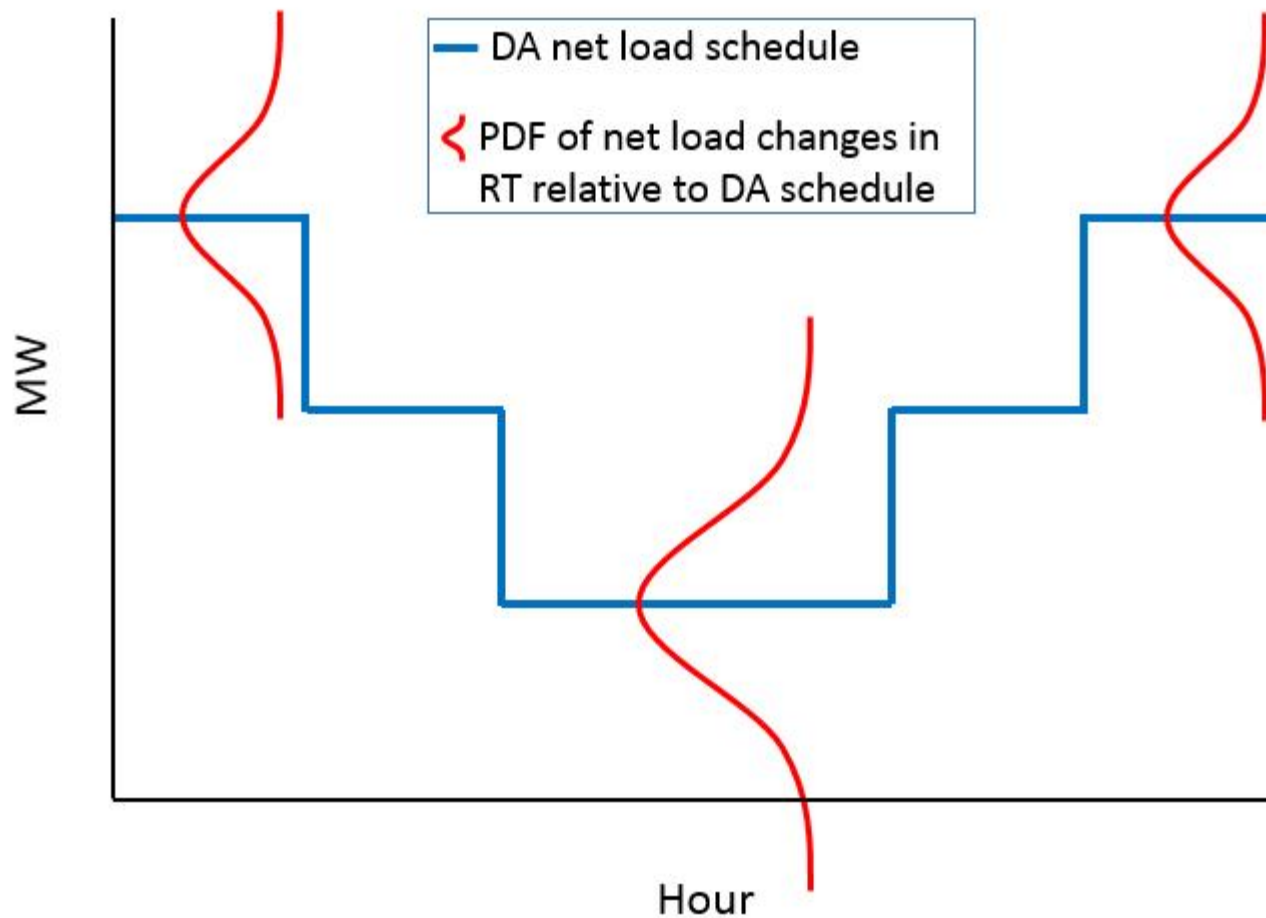
Flexible resource adequacy procurement during the maximum net load ramp 2015



Source: 2015 Annual Report on Market Issues and Performance, Department of Market Monitoring, May 2016, p. 214:

<http://www.caiso.com/Documents/2015AnnualReportonMarketIssuesandPerformance.pdf>

Short-term flexibility: Uncertainty in day-ahead of real-time (i.e., self-scheduled changes in real-time relative to day-ahead schedules)



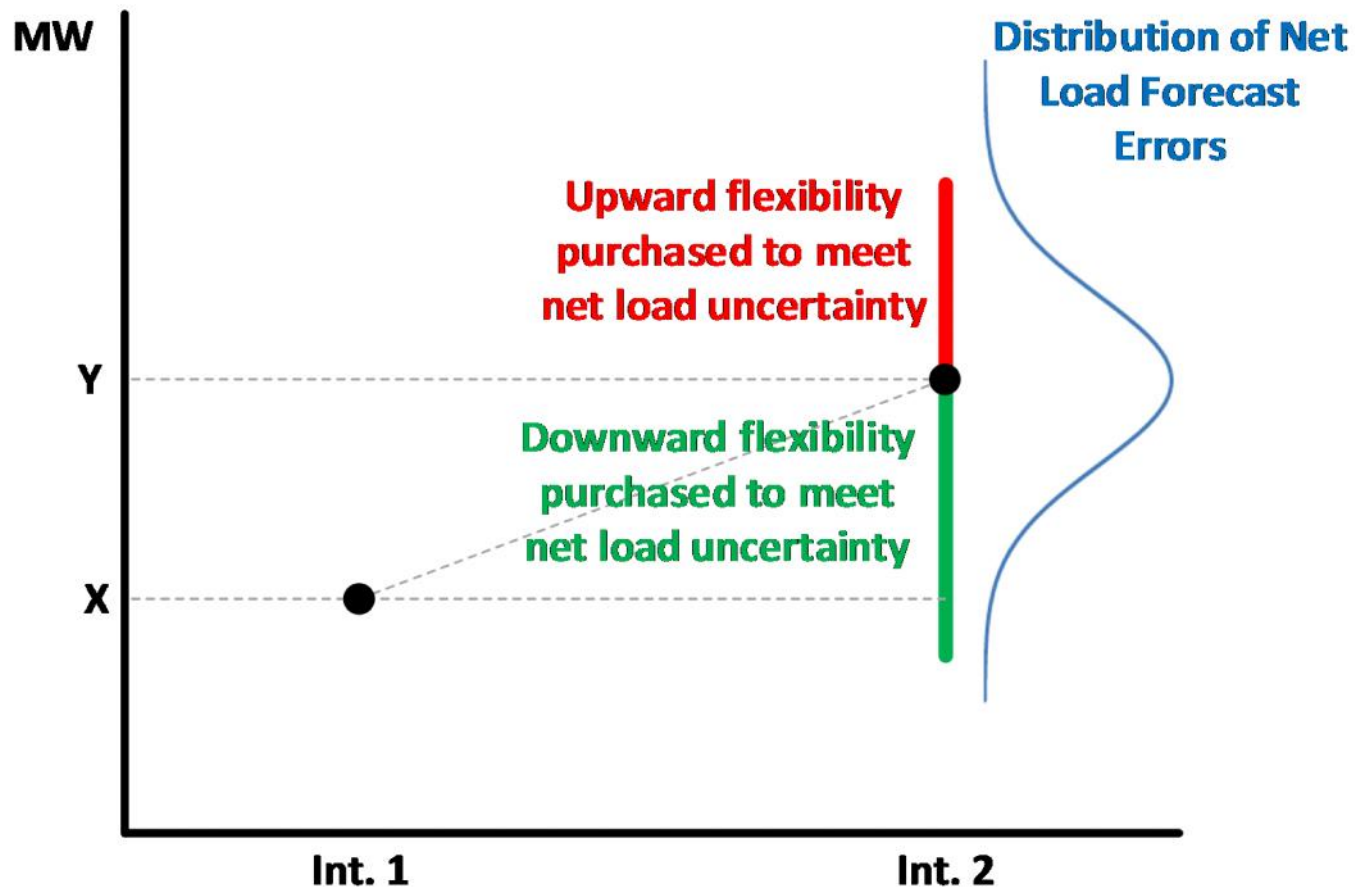
Average flexible resource adequacy capacity and availability

| Month | Average DA flexible capacity (MW) | Average DA Availability | | Average RT flexible capacity (MW) | Average RT Availability | |
|-----------|-----------------------------------|-------------------------|------------------|-----------------------------------|-------------------------|------------------|
| | | MW | % of RA Capacity | | MW | % of RA Capacity |
| January | 10,565 | 9,402 | 89% | 6,154 | 5,524 | 90% |
| February | 10,750 | 8,549 | 80% | 5,755 | 4,905 | 85% |
| March | 10,360 | 8,982 | 87% | 5,929 | 5,013 | 85% |
| April | 9,489 | 7,717 | 81% | 4,846 | 4,315 | 89% |
| May | 7,961 | 6,672 | 84% | 3,598 | 3,218 | 89% |
| June | 8,876 | 8,091 | 91% | 5,398 | 4,979 | 92% |
| July | 8,486 | 8,006 | 94% | 5,593 | 5,146 | 92% |
| August | 8,315 | 7,726 | 93% | 5,423 | 4,858 | 90% |
| September | 8,655 | 8,009 | 93% | 5,681 | 5,163 | 91% |
| October | 9,751 | 8,616 | 88% | 6,505 | 5,438 | 84% |
| November | 11,139 | 9,834 | 88% | 6,114 | 5,373 | 88% |
| December | 11,645 | 10,588 | 91% | 7,114 | 6,251 | 88% |

Source: 2015 Annual Report on Market Issues and Performance, Department of Market Monitoring, May 2016, p. 221:

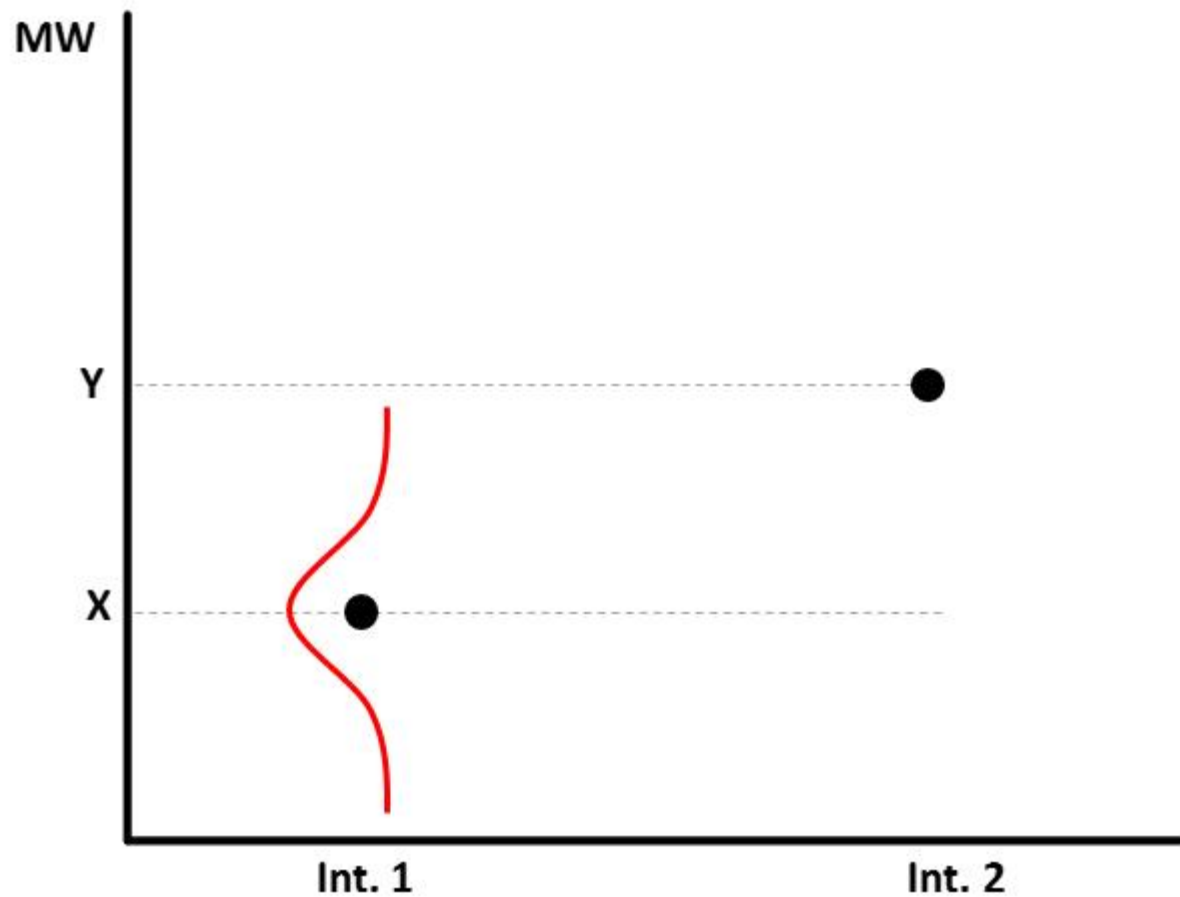
<http://www.caiso.com/Documents/2015AnnualReportonMarketIssuesandPerformance.pdf>

Short-term flexibility: Uncertainty in real-time of net load in future real-time intervals

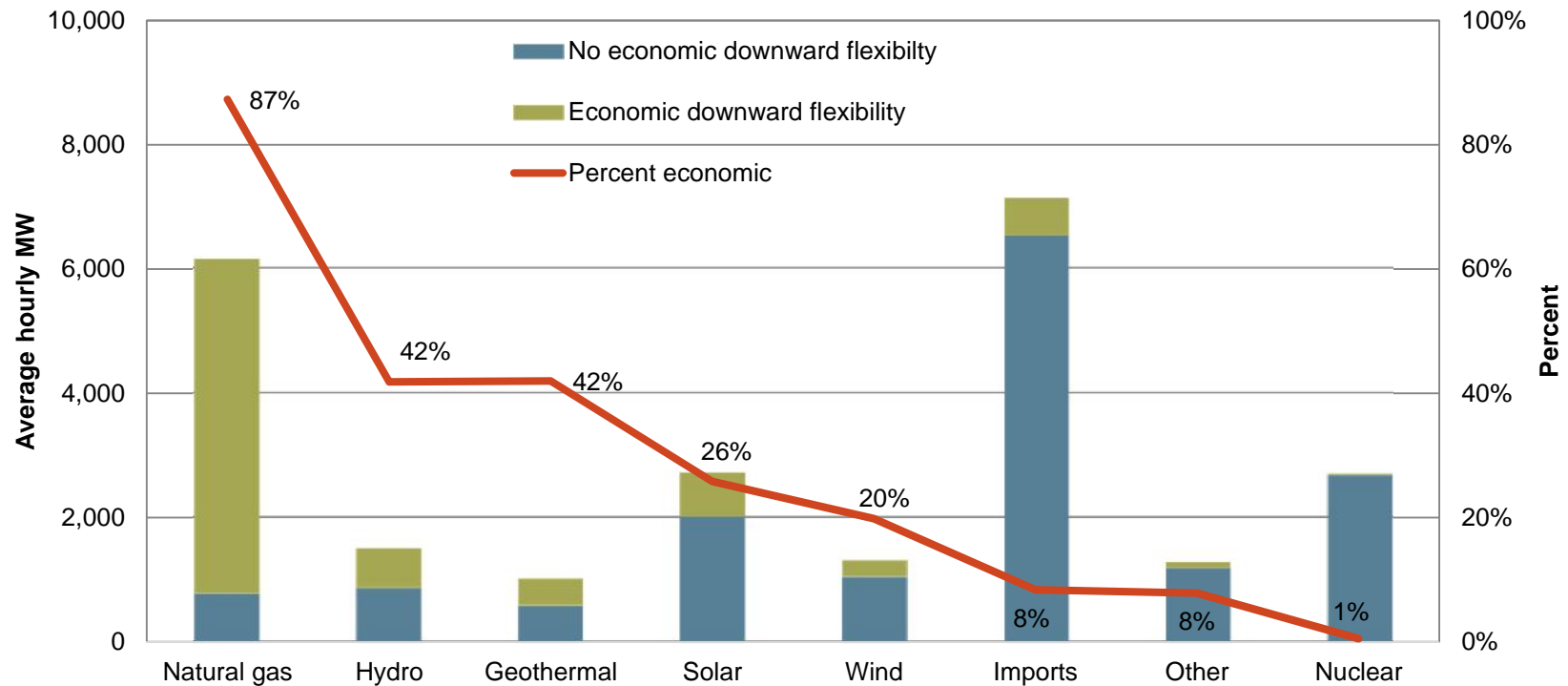


Source: *Comments on Final Flexible Ramping Product Proposal*, Department of Market Monitoring, June 24, 2016, Attachment H, p. 7: http://www.caiso.com/Documents/Jun242016_TariffAmendment-FlexibleRampingProduct_ER16-2023.pdf

Short-term flexibility: Uncertainty in this real-time interval of actual



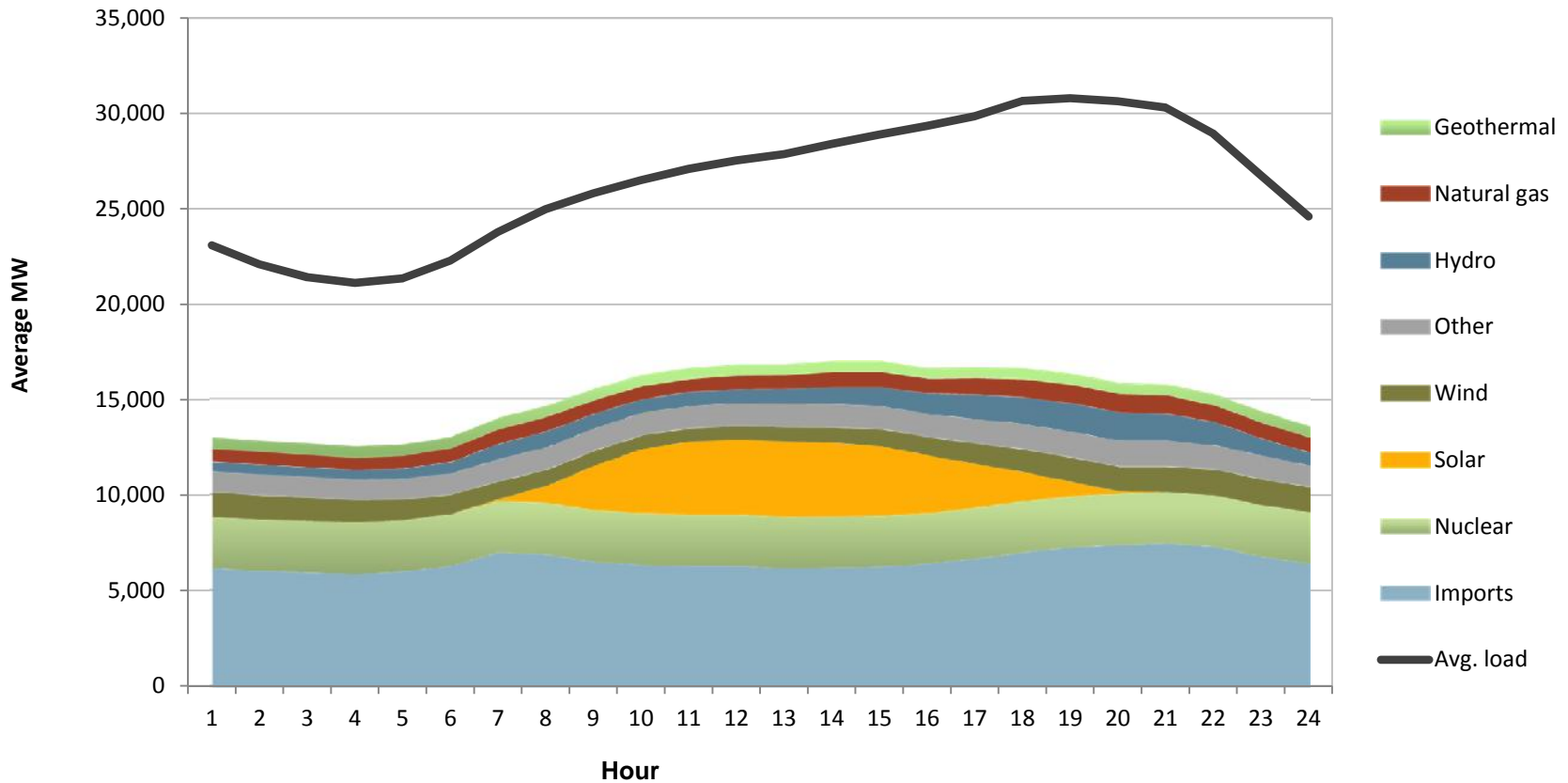
Average hourly real-time economic bids by generation type (2015)



Source: 2015 Annual Report on Market Issues and Performance, Department of Market Monitoring, May 2016, p. 92:

<http://www.caiso.com/Documents/2015AnnualReportonMarketIssuesandPerformance.pdf>

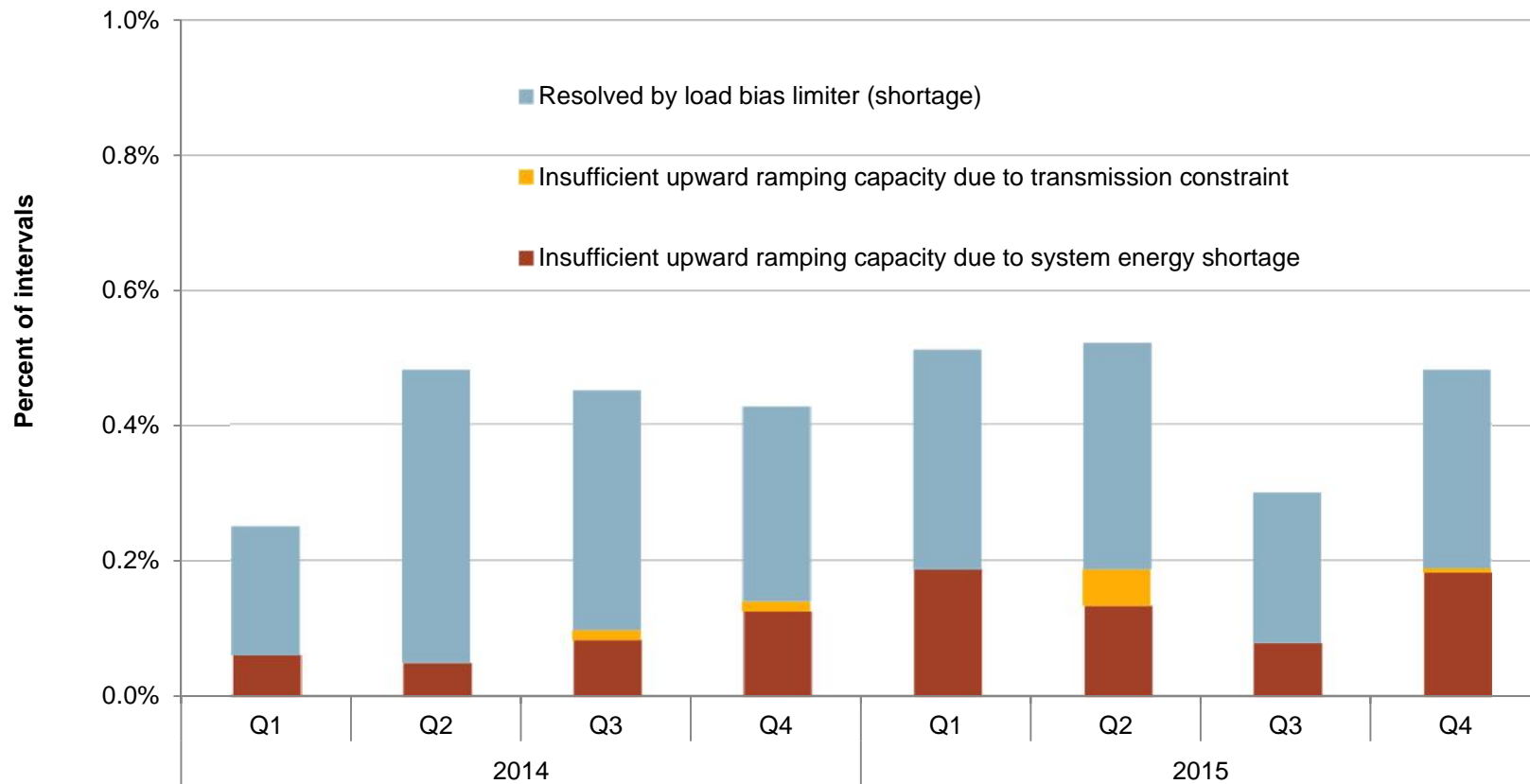
Average hourly self-scheduled generation compared to load (2015)



Source: 2015 Annual Report on Market Issues and Performance, Department of Market Monitoring, May 2016, p. 93:

<http://www.caiso.com/Documents/2015AnnualReportonMarketIssuesandPerformance.pdf>

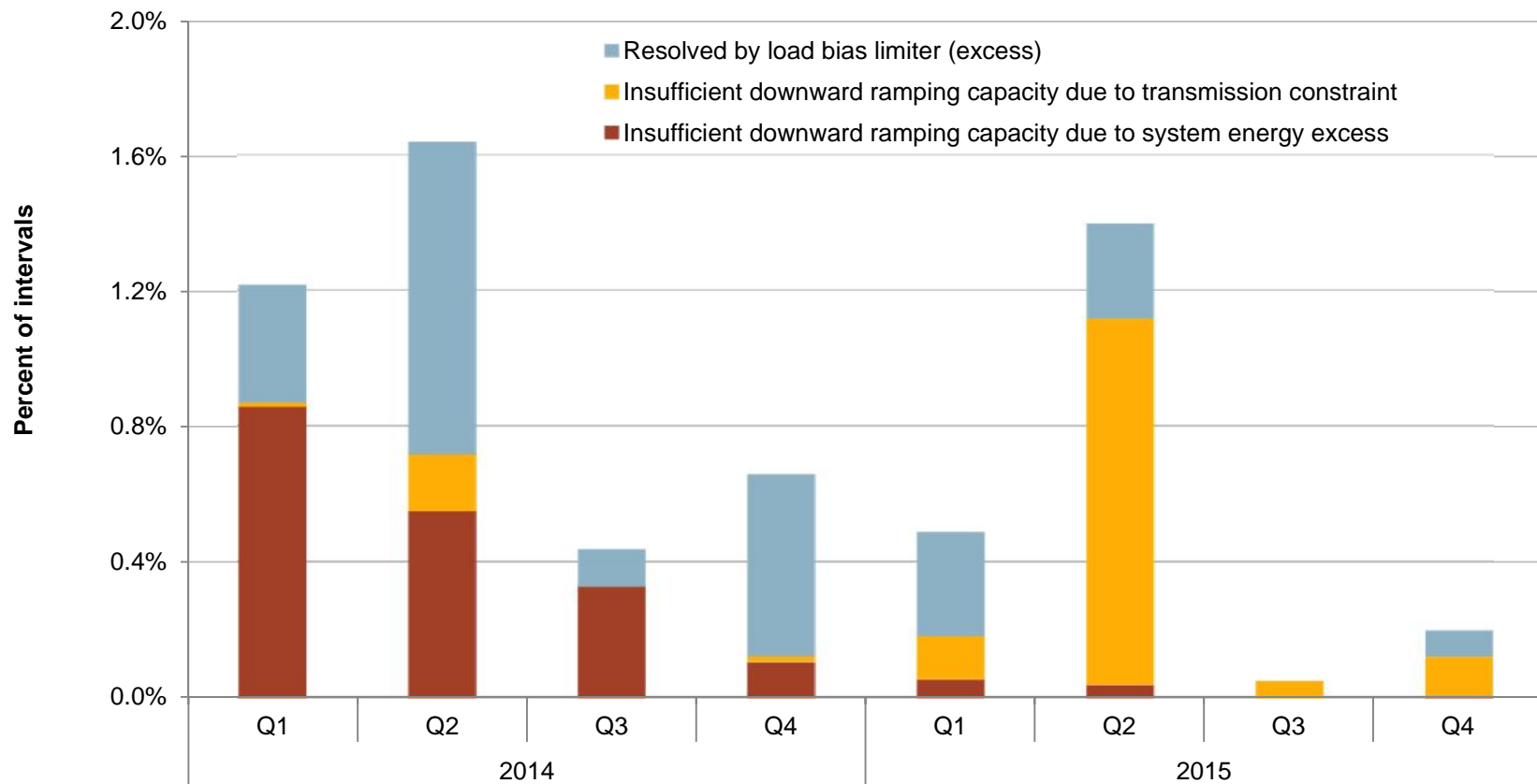
Relaxation of power balance due to insufficient upward ramping capacity



Source: 2015 Annual Report on Market Issues and Performance, Department of Market Monitoring, May 2016, p. 81:

<http://www.aiso.com/Documents/2015AnnualReportonMarketIssuesandPerformance.pdf>

Relaxation of power balance due to insufficient downward ramping capacity



Source: 2015 Annual Report on Market Issues and Performance, Department of Market Monitoring, May 2016, p. 81:

<http://www.caiso.com/Documents/2015AnnualReportonMarketIssuesandPerformance.pdf>