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Shaping a Renewed Future

# 2014 ISO Flexible Capacity Needs Assessment: Study Methodology, Assumptions, and Preliminary Results

Presented at the CPUC RA Workshop
April 9, 2014

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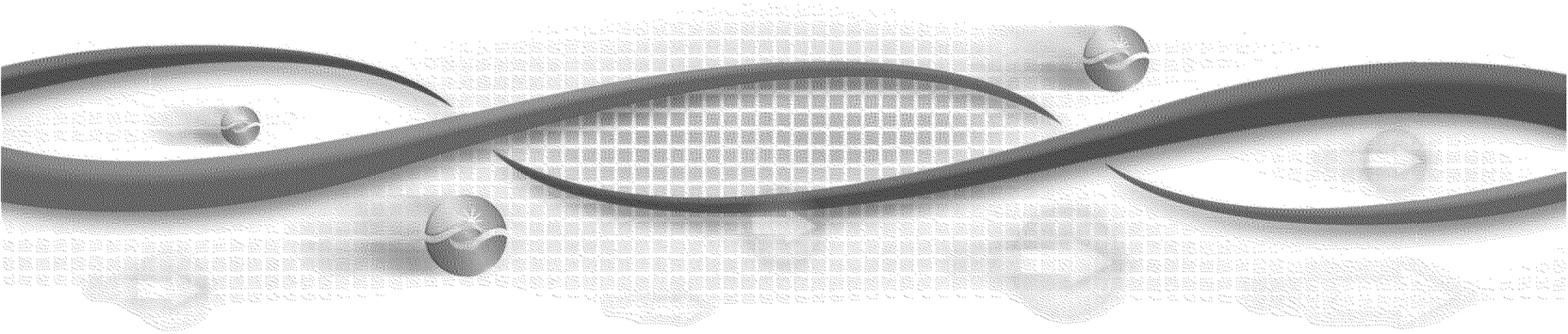
**Karl Meeusen** – Market Design and Regulatory Policy Lead



# Overview

- Data collected from LSEs
- Expected renewable build-out as of April 2014
- Load forecast and wind/solar build-out for future years
- 3-hour flexible requirements for 2015-2016
  - Maximum 3-hour ramps
  - Contingency reserve
- CPUC LSEs' contribution to flexible capacity needs
- Flexible capacity categories

# Disclaimers

- The results shown in the presentation are preliminary and should not be considered final
- The ISO is still in the process of validating the data submissions with the scheduling coordinators for the LSEs and following-up with those scheduling coordinators that did not reply to the data request
- The ISO will re-run the assessment if warranted
- The ISO will issue the final results of this study to each LRA with the Final Local Capacity Requirements study

# Summary of preliminary assessment results

- Flexible Capacity need is largest in the off-peak months
  - Flexible capacity makes up a greater percentage of resource adequacy needs during the off-peak months
  - Increase almost exclusively caused by 3-hour ramp, not increase in peak load
- Lower forecasts of variable energy resource build out contributes to lower flexible capacity requirements
- Compared to last year's forecast of 2015 flexible capacity needs:
  - Flexible capacity needs are lower in many months,
  - Distribution of daily maximum three-hour net-load ramps are comparable
- Using the ISO flexible capacity contribution calculation majority of three-hour net-load ramps are attributable to CPUC jurisdictional LSEs
- Flexible capacity categories demonstrate that there is ample opportunity for participation from various resource types

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# Study Methodology and Assumptions

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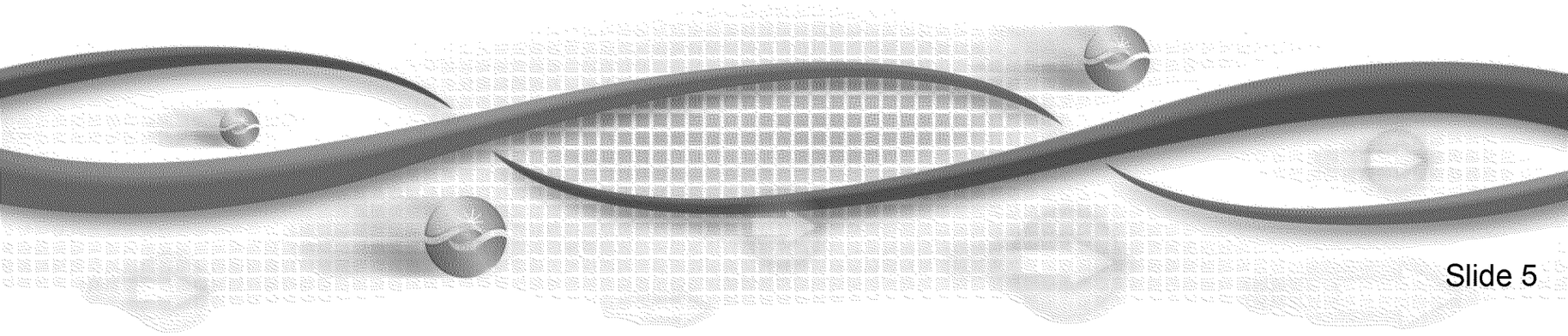
Senior Advisor, Renewable energy Integration



# Analysis Methodology

- External resources that are firmed by another balancing authority are treated as firm imports and are not included in the flexible capacity requirements assessment
- Dynamically scheduled external resources that are not firmed are treated comparably to internal ISO resources
- The ISO assumed no additional growth of VERs for the LSEs that did not submit a response to the ISO's data request
- Changes in distributed Solar PV resources are assumed to be captured in load forecast

# Summary of aggregated expected variable energy resources build-out collected from load serving entities

| R.12-03-014 Replicating Base Case) Load | Existing (2013) | 2014 | 2015 | 2016 |
|---|---|---|---|---|
| ISO Solar PV | 4,173 | 4,504 | 5,700 | 6,200 |
| ISO Solar Thermal | 419 | 1,058 | 1,183 | 1,183 |
| ISO Wind | 5,351 | 5,728 | 5,578 | 5,578 |
| Distributed PV | 1,280 | 1,971 | 2,353 | 2,740 |
| *Sub Total of VER* | ***11,223*** | ***13,261*** | ***14,814*** | ***15,701*** |
| Non ISO Resources<br><br>All external variable energy resources not firmed by external BAA and treated as dynamic schedule into the ISO | 127 | 127 | 317 | 467 |
| Non ISO Resources<br><br>All external VERS firmed by external BAA | 398 | 398 | 398 | 398 |
| Total ISO and Non-ISO Resources used in the 2014 Flexible Capacity Needs Assessment | **11,621** | **13,659** | **15,212** | **16,099** |
| Incremental New Additions in Each Year | | 2,038 | 1,553 | 887 |
| | | | | |
| Final estimated build out used in the 2013 Flexible Capacity Needs Assessment (for comparison purposes) | **11,906** | **14,374** | **15,779** | **17,382** |

# The monthly flexibility capacity requirement is calculated using the most recent full year of the ISO's load, wind, and solar 1-minute data

- Use 2013 actual ISO's load, wind and solar 1-minute data
- For new VERs installation, use NREL's simulated production data for CREZs located in close geographic proximity to develop minute-by-minute production profiles
- Solar profiles were created using both technology type and location of the new resources
- Generate net-load profiles for 2014 through 2016
  - Generate 1-minute load profiles for 2014 through 2016
  - Generate 1-minute solar profiles for 2014 through 2016
  - Generate 1-minute wind profiles for 2014 through 2016

# The ISO used the CEC's 2013 IEPR 1-in-2 monthly peak load forecast with no additional achievable energy efficiency to develop the load forecast

- Used 2013 actual 1-minute load data to build 1-minute load profiles for subsequent years
- Scaled the actual 1-minute load value of each month of 2013 to CEC forecasts for 2015 and 2016 using a load growth factor of monthly peak forecast divided by actual 2013 monthly peak

***2014 Load Growth Assumptions***

- Scale the actual 1-minute load value of each month of 2013 by the fraction ($Monthly_{2014\_Peak\_Load\_Forecast}$/$Monthly_{2013\_Actual\_Peak\_Load}$)

***2015 Load Growth Assumptions***

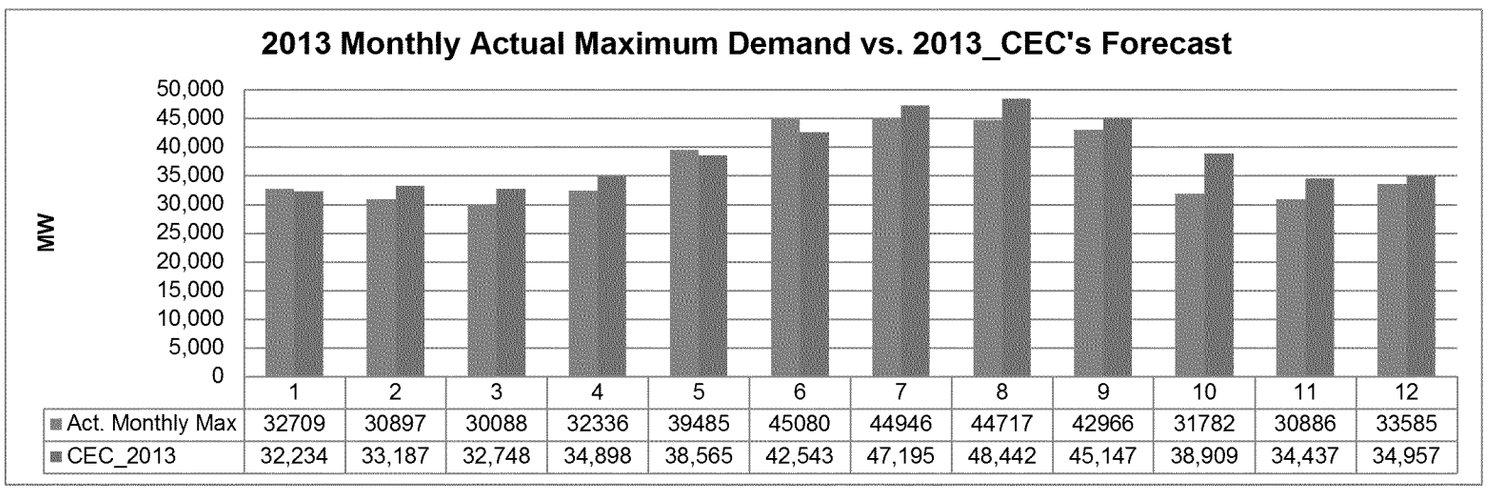
- Scale each 1-minute load data point of 2014 by the fraction ($Monthly_{2015\_Peak\_Load\_Forecast}$/$Monthly_{2014\_Peak\_Load}$)

***2016 Load Growth Assumptions***

- Scale each 1-minute load data point of 2015 by the fraction ($Monthly_{2016\_Peak\_Load\_Forecast}$/$Monthly_{2015\_Peak\_Load}$)

# ISO Coincident 1 in 2 monthly peak load forecast (MW) and 2013 monthly actual peak load vs. CEC forecast

| Mid Demand Scenario, No AAEE | | | | | |
|---|---|---|---|---|---|
| **Month** | **2013** | **2014** | **2015** | **2016** | **2017** |
| January | 32,234 | 32,879 | 33,513 | 33,915 | 34,336 |
| February | 33,187 | 33,851 | 34,504 | 34,918 | 35,361 |
| March | 32,748 | 33,404 | 34,048 | 34,456 | 34,884 |
| April | 34,898 | 35,596 | 36,282 | 36,718 | 37,174 |
| May | 38,565 | 39,337 | 40,095 | 40,577 | 41,086 |
| June | 42,543 | 43,394 | 44,230 | 44,761 | 45,317 |
| July | 47,195 | 48,140 | 49,068 | 49,657 | 50,273 |
| August | 48,442 | 49,412 | 50,364 | 50,969 | 51,602 |
| September | 45,147 | 46,051 | 46,938 | 47,502 | 48,091 |
| October | 38,909 | 39,688 | 40,453 | 40,938 | 41,446 |
| November | 34,437 | 35,127 | 35,804 | 36,233 | 36,683 |
| December | 34,957 | 35,657 | 36,344 | 36,781 | 37,237 |

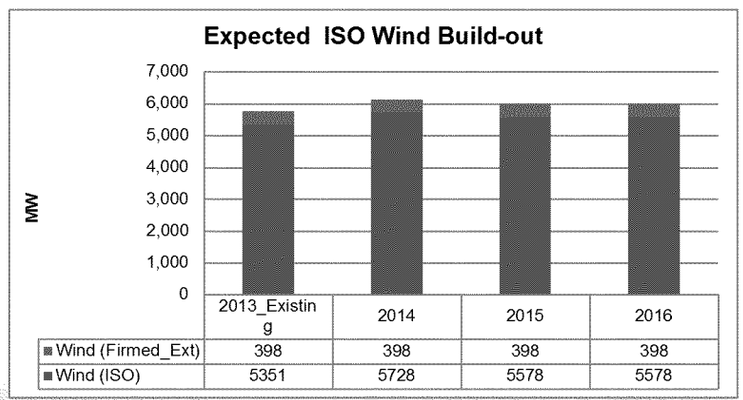


# Wind growth assumptions

- Use actual 1-minute wind production data for the most recent year e.g. 2013 actual 1-minute data was used to build 2014 1-minute data
- 1-minute wind profiles for projects installed in 2013 were created using 2013 actual data for the months the projects were not in-service (i.e. profiles for projects installed in May 2013 were created for January through April)
- Wind 1-minute profiles for 2014 were created by scaling the 1-minute wind data for 2013 based on installed capacity

$$2014\,W_{1\text{-min}} = 2013W_{Actual\_1\text{-min}} * 2014W_{Installed\ Capacity}/2013W_{Installed\ Capacity}$$

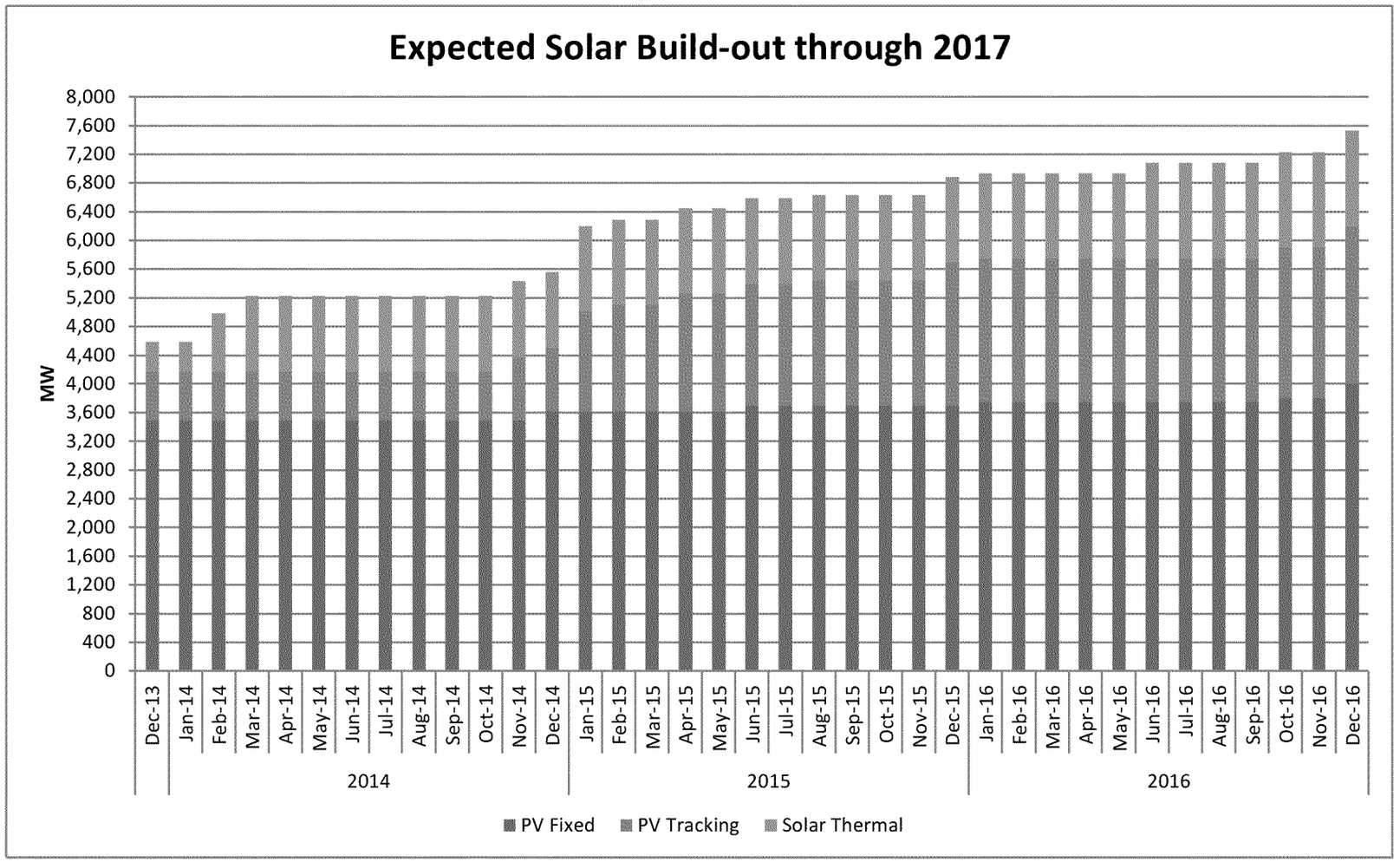
- 398 MW of wind resources were not modeled because they are expected to be firmed outside the ISO
- Maintained load/wind correlation for over 94% of the wind capacity






Wind peak production: 4,244 MW on 6/17/2013

# Expected solar build-out as of 2013 using LSE's data shows a significant increase in solar PV tracking




Solar Peak Production: 4,278 on 4/7/2014

# Solar growth assumptions

***Existing solar***

- Use actual solar 1-minute production data for the most recent year (e.g. 2013 actual 1-minute solar data was used to develop 2014 profile
- 1-minute solar profiles for projects installed in 2013 were created for the months the projects were not in-service using 2013 actual solar data

***New solar installation***

- Develop 1-minute solar production profiles for CREZs based on their geographic location and technology using NREL's 2005 solar profiles (i.e. solar thermal, solar PV tracking & solar PV fixed)
- Aggregate all new solar 1-minute production data by technology
- New CREZs does not have the load/solar correlation but the maximum 3-hour ramps during the non-summer months are highly influenced by sunset which is consistent with existing solar data
- Sum the actual 1-minute existing solar production data with the aggregated simulated solar data for new installation

$$\text{Total solar } 2014_{\text{1-min}} = 2013_{\text{Actual\_1-min}} + 2014_{\text{Simulated\_1-min data}}$$

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# Preliminary Results

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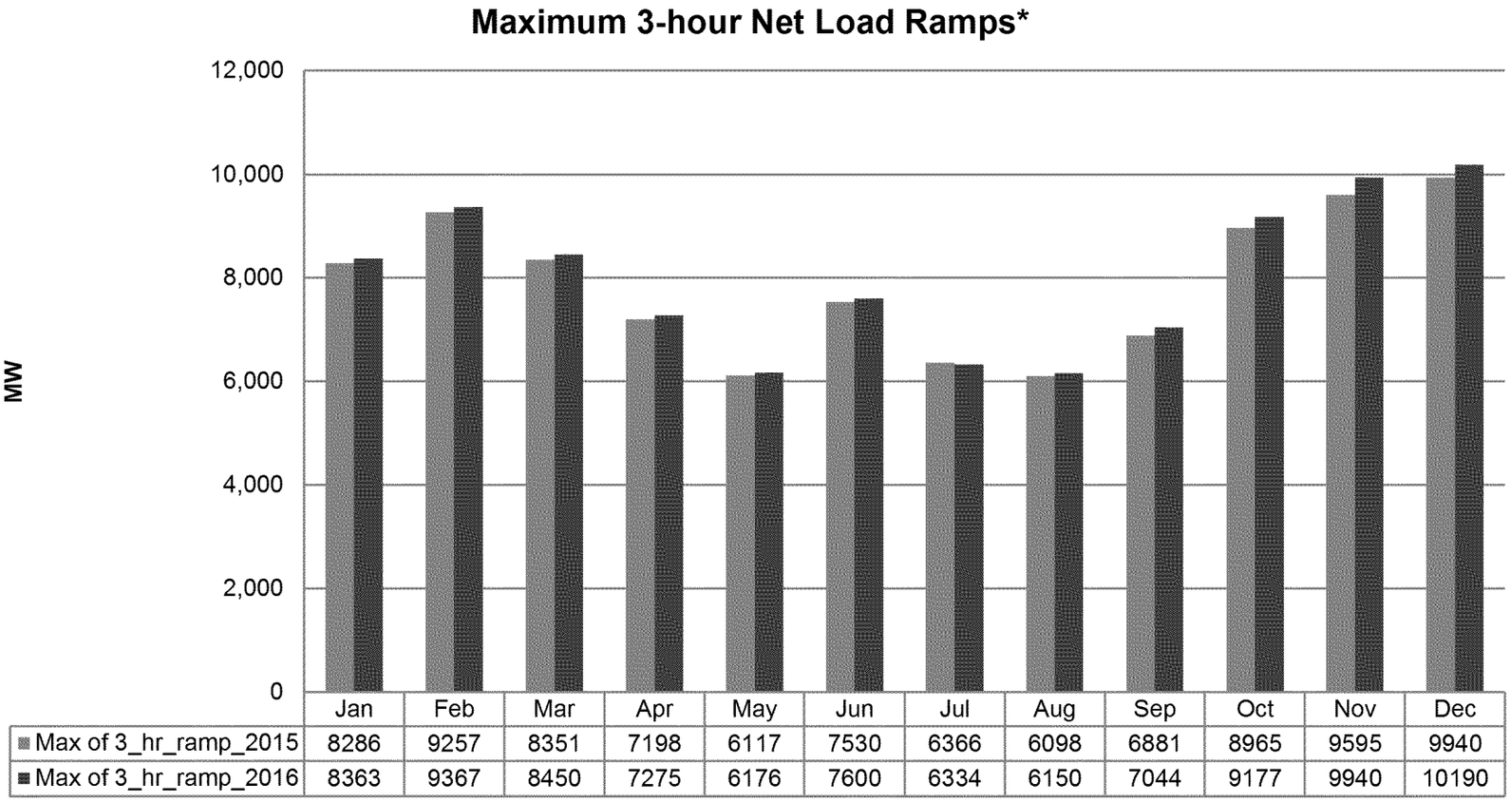
Market Design and Regulatory Policy Lead

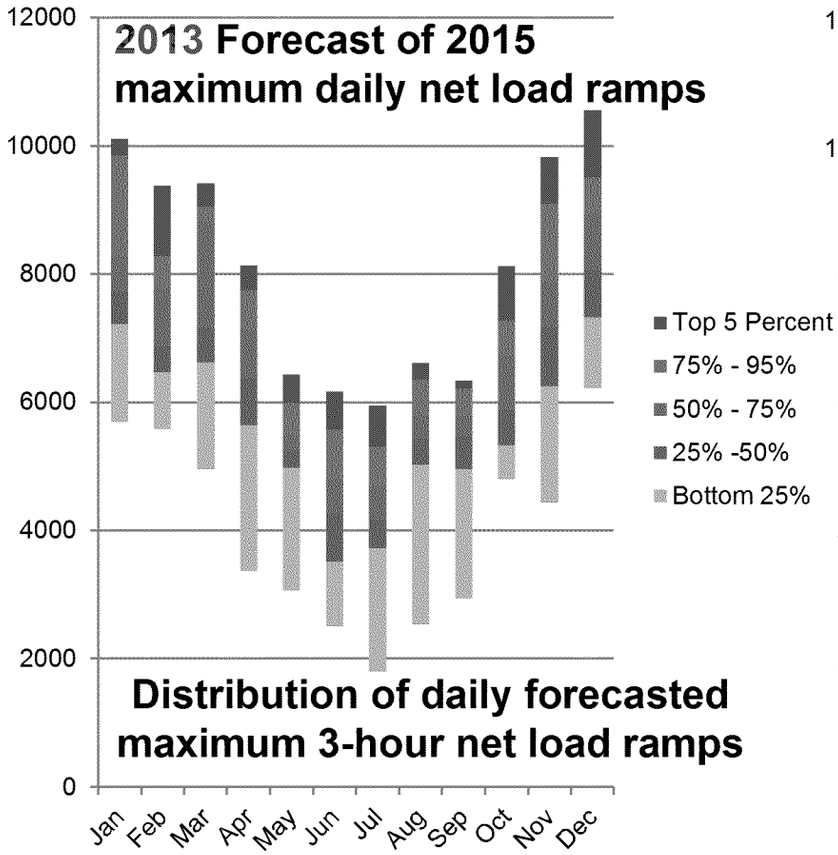
# Forecasted maximum monthly three-hour net-load ramps

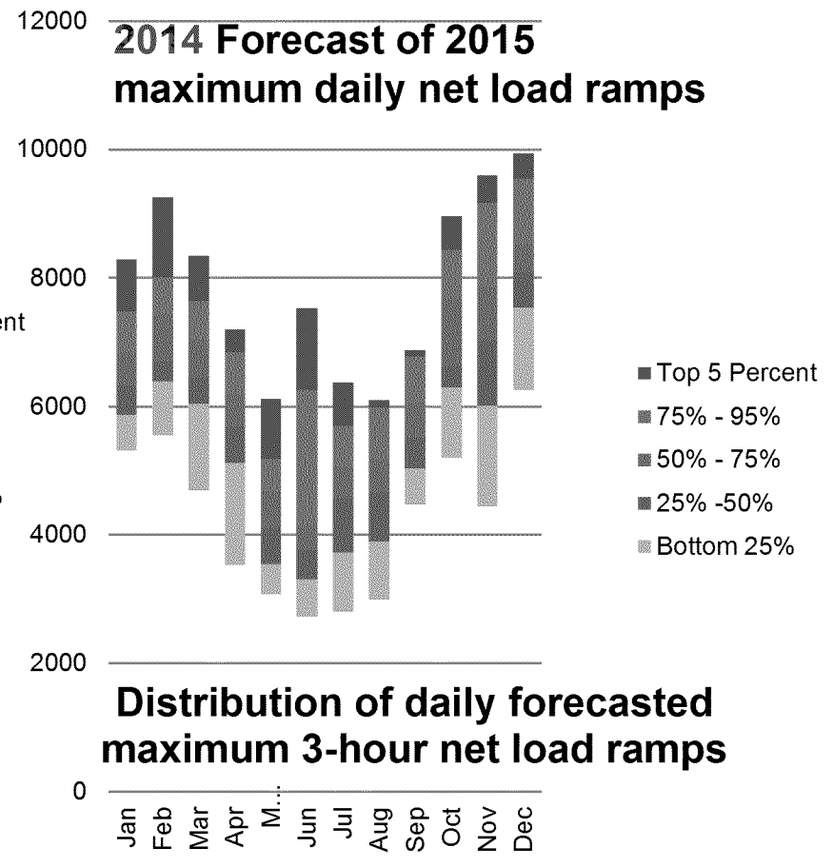



| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Max of 3_hr_ramp_2015 | 8286 | 9257 | 8351 | 7198 | 6117 | 7530 | 6366 | 6098 | 6881 | 8965 | 9595 | 9940 |
| Max of 3_hr_ramp_2016 | 8363 | 9367 | 8450 | 7275 | 6176 | 7600 | 6334 | 6150 | 7044 | 9177 | 9940 | 10190 |

* Excludes contingency reserves

# The distribution range of daily maximum 3-hour net load ramps relative to last year's assessment



# The proposed interim flexible capacity methodology designed to provide the ISO with sufficient flexible capacity

- Methodology

$$\text{Flexibility Requirement}_{MTHy} = \text{Max}[(3RR_{HRx})_{MTHy}] + \text{Max}(MSSC, 3.5\% * E(PL_{MTHy})) + \varepsilon$$

Where:

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

E(PL) = Expected peak load

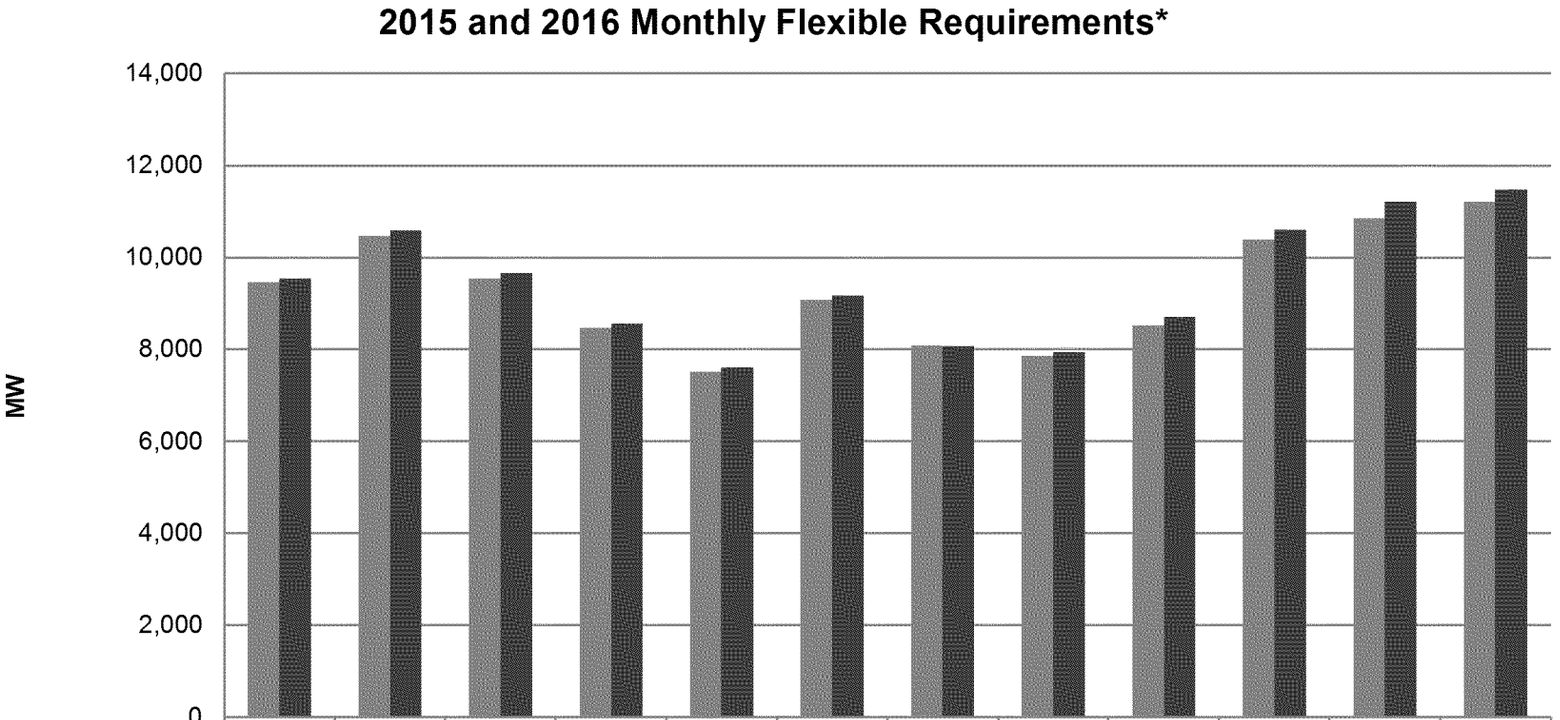
MTHy = Month y

MSSC = Most Severe Single Contingency

$\varepsilon$ = Annually adjustable error term to account for load forecast errors and variability

- Methodology for 2017 and beyond needs to be developed as needs change

# Forecasted monthly 2015 and 2016 ISO system-wide flexible capacity needs




| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Flex_Req_2015 | 9,459 | 10,465 | 9,543 | 8,468 | 7,520 | 9,078 | 8,083 | 7,861 | 8,523 | 10,381 | 10,848 | 11,212 |
| Flex_Req_2016 | 9,550 | 10,589 | 9,656 | 8,560 | 7,596 | 9,166 | 8,072 | 7,934 | 8,706 | 10,610 | 11,209 | 11,477 |

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

ε = 0

# Flexible capacity requirement is split into its two component parts to determine the allocation

- Maximum of the Most Severe Single Contingency or 3.5 percent of forecasted coincident peak
  - Allocated to LRA based on peak-load ratio share
- The largest 3-hour net-load ramp is decomposed into four components to determine the LRA's allocation

  Allocation =

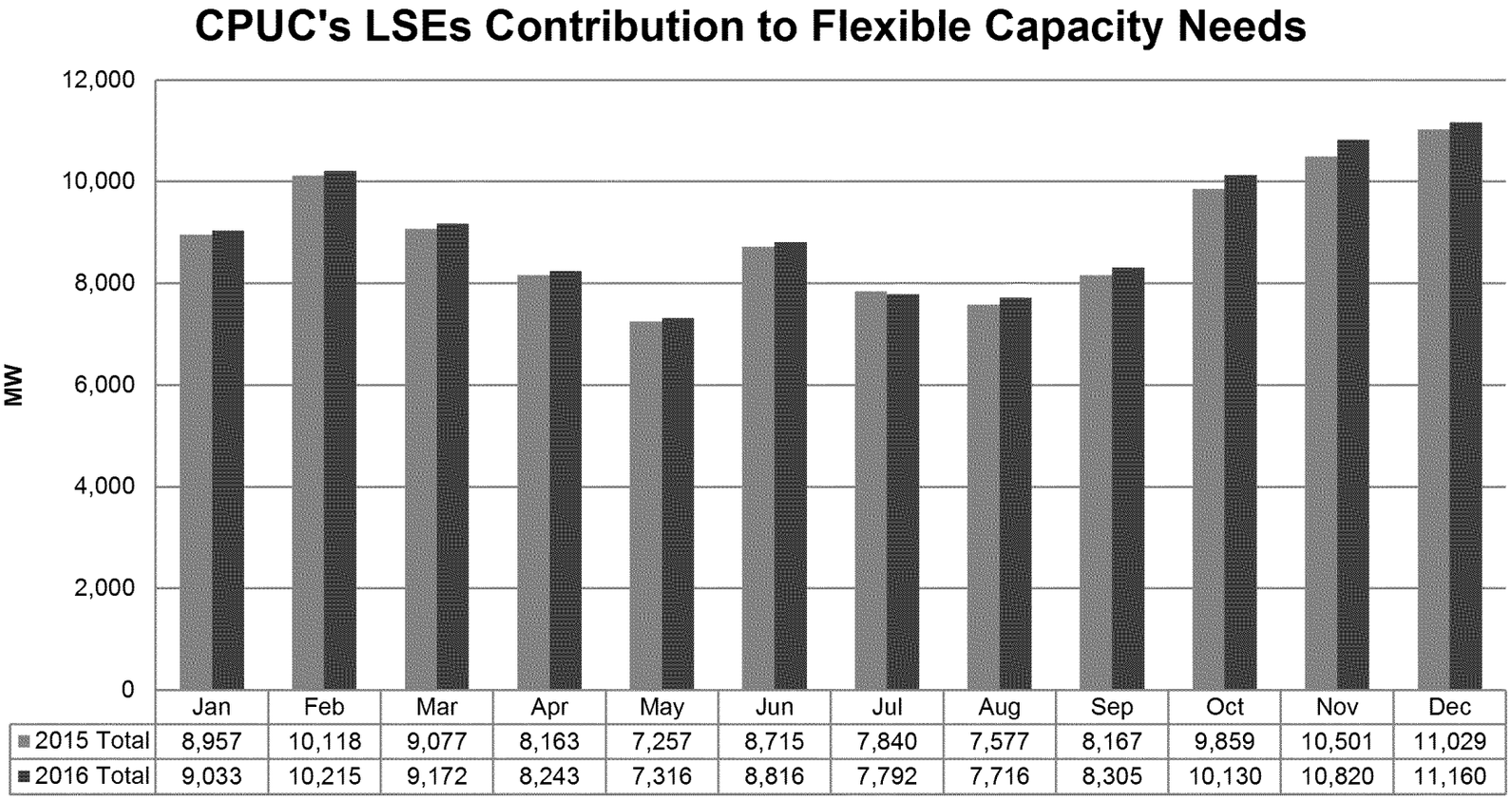
  Δ Load – Δ Wind Output – Δ Solar PV – Δ Solar Thermal

# Flexible capacity needs are largely attributable to CPUC jurisdictional LSE's

**CPUC Jurisdictional LSEs' Contributions to Flexible Capacity Needs**

| | | 2015 | | | 2016 | | |
|---|---|---|---|---|---|---|---|
| | Δ Load | Δ PV Fixed | Δ Solar Thermal | Δ Wind | Δ PV Fixed | Δ Solar Thermal | Δ Wind |
| Jan | 94% | 100% | 100% | 99% | 99% | 100% | 98% |
| Feb | 95% | 100% | 100% | 99% | 99% | 100% | 98% |
| Mar | 95% | 100% | 100% | 99% | 99% | 100% | 98% |
| Apr | 96% | 100% | 100% | 99% | 99% | 100% | 98% |
| May | 96% | 100% | 100% | 99% | 99% | 100% | 98% |
| Jun | 96% | 100% | 100% | 99% | 99% | 100% | 98% |
| Jul | 98% | 100% | 100% | 99% | 99% | 100% | 98% |
| Aug | 98% | 100% | 100% | 99% | 99% | 100% | 98% |
| Sep | 94% | 100% | 100% | 99% | 99% | 100% | 98% |
| Oct | 93% | 100% | 100% | 99% | 99% | 100% | 98% |
| Nov | 96% | 100% | 100% | 99% | 99% | 100% | 98% |
| Dec | 99% | 100% | 100% | 99% | 99% | 100% | 98% |

# CPUC jurisdictional LSE's contribution to need



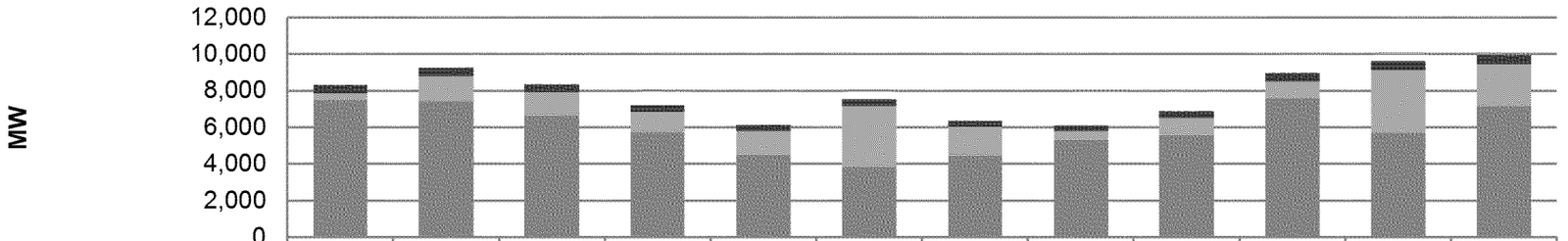

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2015 Total | 8,957 | 10,118 | 9,077 | 8,163 | 7,257 | 8,715 | 7,840 | 7,577 | 8,167 | 9,859 | 10,501 | 11,029 |
| 2016 Total | 9,033 | 10,215 | 9,172 | 8,243 | 7,316 | 8,816 | 7,792 | 7,716 | 8,305 | 10,130 | 10,820 | 11,160 |

# Flexible capacity categories allow a wide variety of resources to provide flexible capacity

- Category 1 (Base Flexibility): Operational needs determined by the magnitude of the largest 3-hour secondary net-load ramp
- Category 2 (Peak Flexibility): Operational need determined by the difference between 95 percent of the maximum 3-hour net-load ramp and the largest 3-hour secondary net-load ramp
- Category 3 (Super-Peak Flexibility): Operational need determined by five percent of the maximum 3-hour net-load ramp of the month

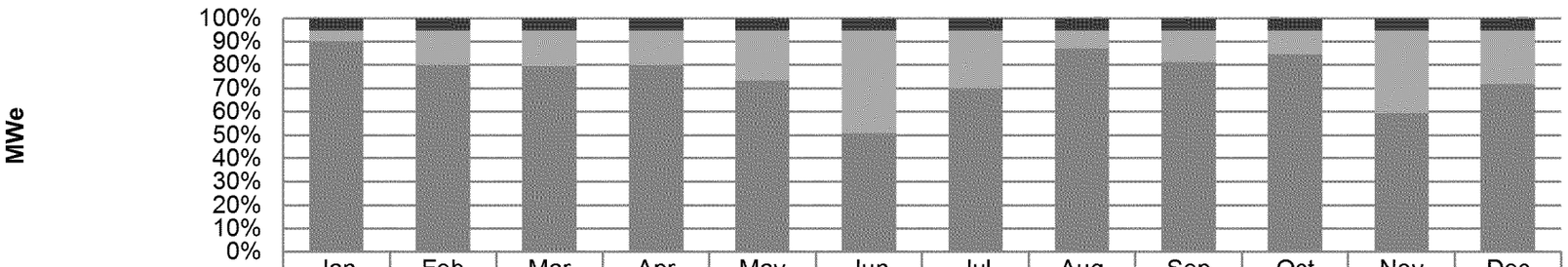
# Three categories of flexibility allow a variety of resource types to help address flexible capacity need

## Total Flexible Capacity MW Need by Category




| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Super-Peak Flexibility | 414 | 463 | 418 | 360 | 306 | 376 | 318 | 305 | 344 | 448 | 480 | 497 |
| Peak Flexibility | 387 | 1,367 | 1,284 | 1,080 | 1,320 | 3,323 | 1,581 | 473 | 944 | 938 | 3,409 | 2,287 |
| Base Flexibility | 7,484 | 7,428 | 6,650 | 5,759 | 4,491 | 3,830 | 4,466 | 5,320 | 5,592 | 7,579 | 5,706 | 7,156 |

## Percent of Total Flexible Capacity Need by Category




| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Super-Peak Flexibility | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% |
| Peak Flexibility | 5% | 15% | 15% | 15% | 22% | 44% | 25% | 8% | 14% | 10% | 36% | 23% |
| Base Flexibility | 90% | 80% | 80% | 80% | 73% | 51% | 70% | 87% | 81% | 85% | 59% | 72% |

# Review of preliminary assessment results

- Flexible Capacity need is largest in the off-peak months
  - Flexible capacity makes up a greater percentage of resource adequacy needs during the off-peak months
  - Increase almost exclusively caused by 3-hour ramp, not increase in peak load
- Lower forecasts of variable energy resource build out contributes to lower flexible capacity requirements
- Compared to last year's forecast:
  - Flexible capacity needs are lower in many months,
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- Using the ISO flexible capacity contribution calculation majority of three-hour net-load ramps are attributable to CPUC jurisdictional LSEs
- Flexible capacity categories demonstrate that there is ample opportunity for participation from various resource types

# Thank You!

# Questions

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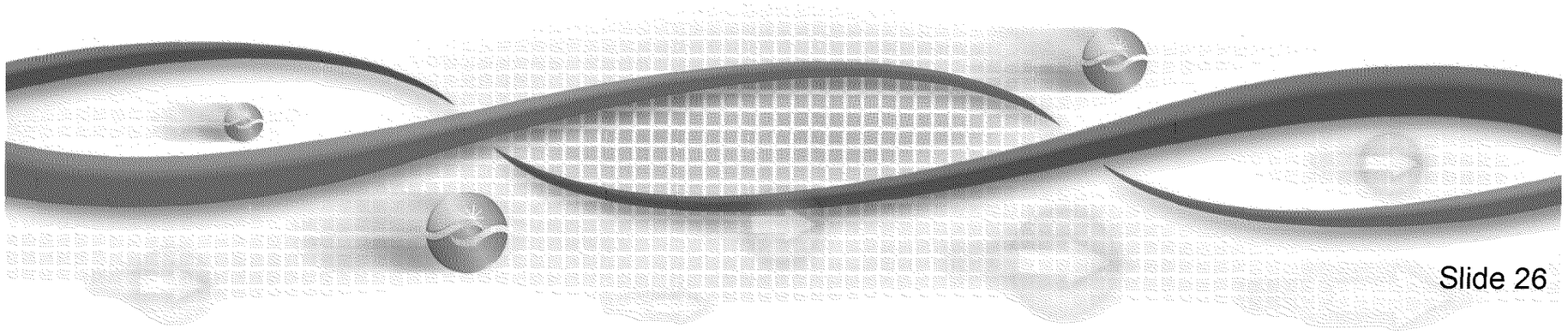
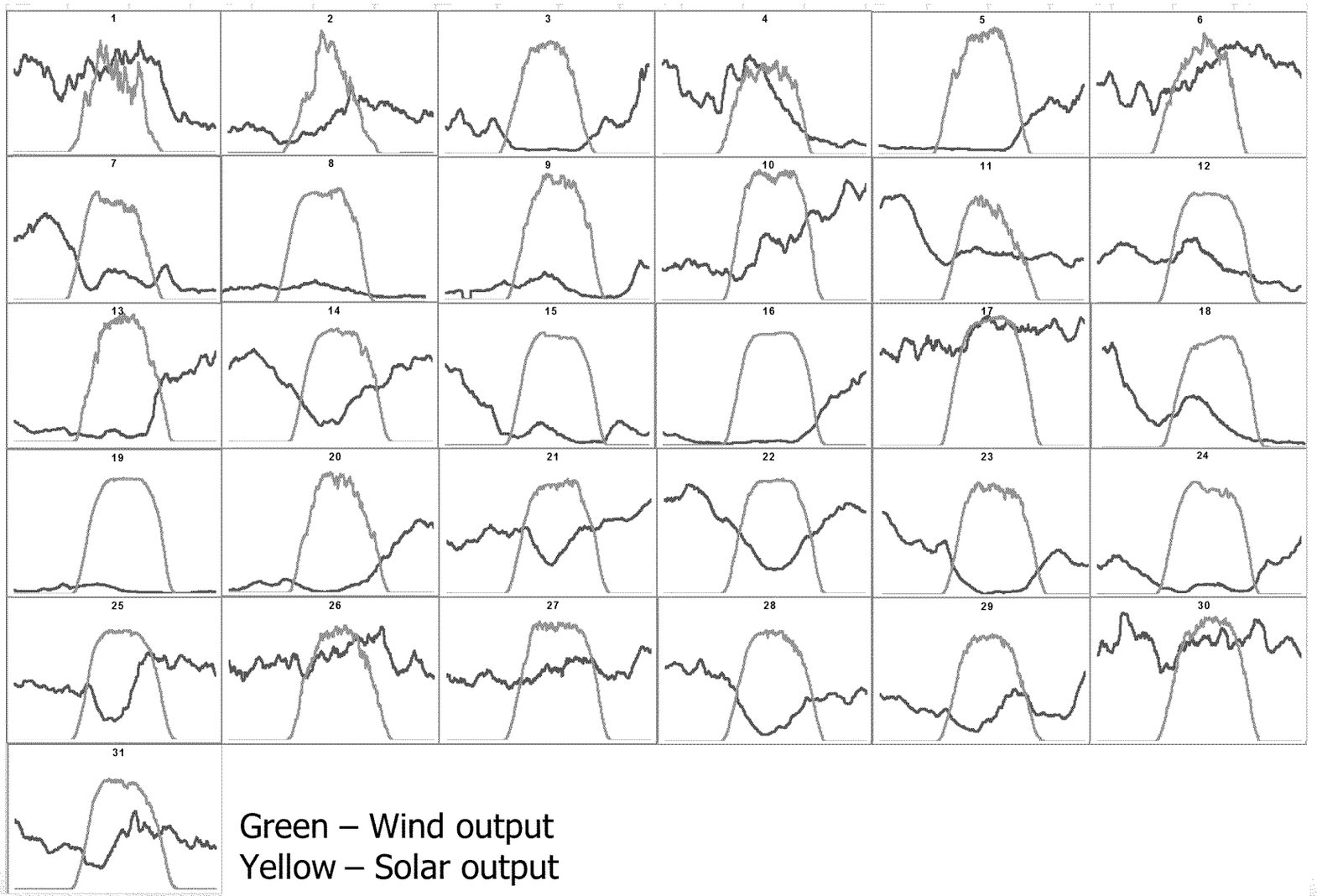
# Appendix

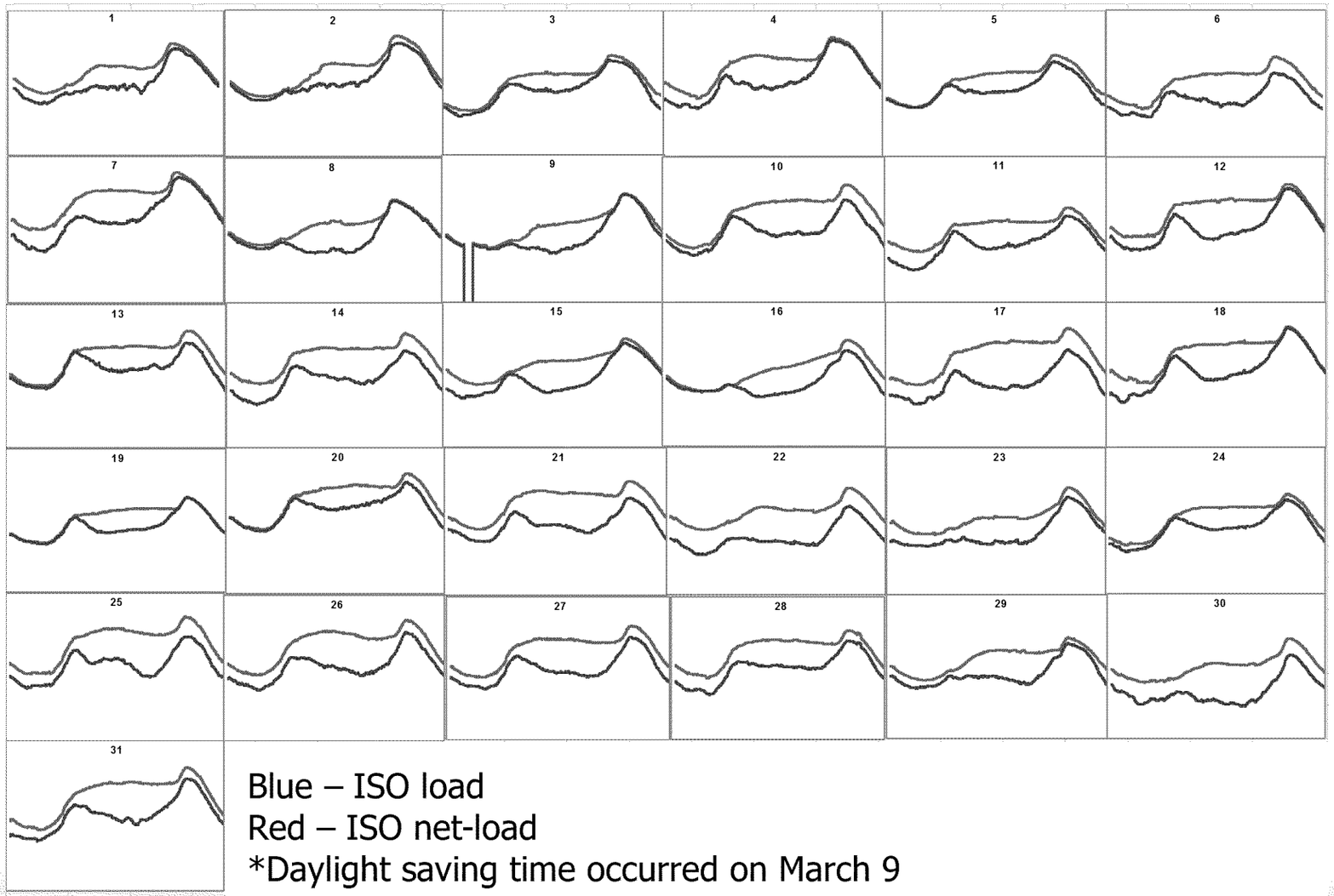


# Wind and solar production can change significantly from one day to the next --- March 2014




Green – Wind output
Yellow – Solar output

# Load and net-load ramps can change significantly from one day to the next --- March 2014*




Blue – ISO load
Red – ISO net-load
*Daylight saving time occurred on March 9