ISO 2016-2017 Transmission Planning Process

Supplemental Sensitivity Analysis: Risks of early economic retirement of gas fleet

January 4, 2018

Contents

1. Introduction

This report summarizes the analysis conducted by the ISO of potential risks to system reliability if similarly economically-situated generators retire more or less simultaneously, and provides the results of the additional sensitivity analysis conducted in 2017 as an extension of the studies conducted during the ISO's 2016-2017 planning cycle.

As discussed in more detail below, additional sensitivities were found to be necessary in the course of the 2016-2017 planning cycle, leading to the further analysis conducted in 2017.

Given the evolution of the analysis over several years, it is necessary to review the background of the past efforts, to put into context the latest results and the observations drawn from those results.

2. Background

During the 2016-2017 planning cycle the ISO undertook a preliminary analysis of potential risks to system reliability if similarly economically-situated generators retire more or less simultaneously. The study and results were documented in Section 6.1 of the 2016-2017 Transmission Plan.

The significant amount of new renewable generation capacity being added to the grid is also putting economic pressure on the existing gas-fired generation fleet, especially for those generators not obtaining resource adequacy contracts. Further, the bulk of the grid-connected renewable generation developed to date has been "deliverable", e.g. capable of providing capacity towards the state's resource adequacy program, leaving more uncertainty as to the future of system resource adequacy compensation availability for the existing gas-fired generation fleet. Compensation for provision of flexibility services can also be uncertain, with the gas-fired generation fleet facing competition from other sources.

As generation owners are independently assessing market conditions and their own particular circumstances, the ISO has therefore undertaken this preliminary analysis of potential risks to system reliability if similarly economically-situated generators retire more or less simultaneously.

This analysis focused on two aspects of reliability:

- Are there localized areas of the grid transmission system where the retirement of a number of similarly situated generators would create reliability issues or other negative impacts on the operation of the transmission system, and,
- Are system-wide reliability requirements, e.g. load following, operating reserves and regulating reserve levels, unduly compromised?

To study the second aspect regarding system-wide reliability, the study relied upon Energy Exemplar's PLEXOS production simulation package and approach consistent with the methodologies employed by the ISO in participating in the CPUC's long term procurement plan (LTPP) proceeding. It used the Base Case that is discussed in section 6.5 "Benefits Analysis of Large Energy Storage" of the ISO 2016-2017 Transmission Plan.[1]

In the course of that process, the need for additional sensitivity studies was identified, which were conducted in 2017 and documented in this report.

Calculating Shortfalls

In the simulation, shortfalls occur when supply is insufficient to meet the combination of load, ancillary services, and load following requirements. If all available resources, including demand response and import capability, are depleted during these hours, the shortfalls are capacity shortfalls since there is no more capacity available for use. Alternatively, there are cases in which there is still unused capacity available but that capacity is not capable of following load ramp. These are referred to flexibility shortfalls.

A shortfall may occur either in meeting ancillary service or load following requirements, or in meeting load. The model sets a priority order for the shortfall, similar to that in the ISO market scarcity pricing mechanism. The order from high to low is energy, regulation-up, spinning, non-spinning, and load following-up on the upward side, and dump power, regulation-down, and load following-down on the downward side. That means when there is an upward shortfall, the shortfall occurs first in load following-up. If the shortfall is large enough, it will spill over to non-spinning, spinning, regulation-up and finally to unserved energy (loss of load).

Flexibility shortfalls occur mostly when the system net load has fast ramping in either upward or downward direction. The fast ramping is usually caused by the intermittencies and special patterns of renewable generation. If the renewable generation is dispatchable (or curtailable) the fast ramping net load curve may be balanced through curtailment. The requirement for system flexibility is significantly reduced and a flexibility shortfall may not occur at all, depending on the level of renewable generation that can be curtailed. Thus, there is a trade-off between the dispatchability of renewable generation and requirements for system flexibility.

In this study, it is assumed that all the California RPS solar and wind generation is curtailable at a cost lower than that of shortfall of load-following and ancillary services and the volume of renewable curtailment is unlimited.[2] Therefore flexibility shortfall will not occur and the production simulation is intended to capture capacity shortfalls only.

When experiencing a shortfall in operating reserves, including non-spinning and spinning, the ISO will declare a staged system emergency and take necessary actions to restore the reserve.[3] This study uses

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[1] See http://www.caiso.com/Documents/Board-Approved_2016-2017TransmissionPlan.pdf

[2] "Assigned Commissioner's Ruling Adopting Assumptions and Scenarios for Use in the California Independent System Operator's 2016-17 Transmission Planning Process and Future Commission Proceedings", R.13-12-010, May 17, 2016.

[3] See https://www.caiso.com/Documents/EmergencyFactSheet.pdf

shortfall in operating reserves as the threshold to determine capacity sufficiency, and therefore the maximum amount of capacity that can be retired without sacrificing the ISO system's reliability.

Initial Study Cases

Six cases of gas generation resource retirement were analyzed in this study, as shown in Table 6.1-5 below.

Table 6.1-5: The Six Cases of Resource Retirement Analyzed in the Study

Retirement by Technology (MW)	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
CCGT	-3,739	-4,325	-4,325	-5,107	-5,107	-5,107
CHP	-219	-286	-751	-751	-840	-1,138
GT	0	-200	-250	-250	-939	-1,632
ST	0	0	0	0	-10	-10
Total	**-3,958**	**-4,811**	**-5,325**	**-6,107**	**-6,895**	**-7,886**

In the six cases the generation resources for retirement were selected from a list of candidate generation resources that were created in the "Risk to Transmission System Reliability" assessment as discussed in Section 6.1.2 of the ISO 2016-2017 Transmission Plan. The six cases were incremental. For example, Case 2 has all the generation resources retired in Case 1 plus some additional resources. The study used the six cases to identify the trend of impacts on the system reliability caused by capacity shortfalls.

3. Objectives of Further Study

This additional sensitivity analysis consisted of two sensitivity cases:

The first sensitivity case focused on the impacts of additional achievable energy efficiency (AAEE) forecast:

- Base Case has the SB350 AAEE assumption that the 2015 IEPR Mid-AAEE forecast will be doubled by 2030
- This sensitivity replaces that SB350 AAEE assumption with the 2015 IEPR Mid-AAEE forecast, aligning with other 2016-2017 plan results

The second sensitivity explored the impact of various combinations of CCGT or GT retirement, based on the first sensitivity case described above:

- To evaluate the effects of retirement of 2,000 MW CCGT or GT, or the combination of the two types of resources

4. Summary of Results

The study results from the 2016-2017 analysis and the results of the further sensitivity analysis are set out in the attachment.

Base Case

Results of the Base Case were discussed in Section 6.1.3.3 of the ISO 2016-2017 Transmission Plan. From the study, it was concluded that:

- Unlimited renewable curtailment masks the need for flexible capacity during downward ramping in the morning and upward ramping in the afternoon;
- The shortfalls in load-following and reserves reflect the insufficiencies of capacity;
- Capacity insufficiencies occur in early evening after sunset, which is the new peak (net) load time; and,
- Capacity insufficiency start to emerge between 4,000 to 6,000 MW of retirement, considering some uncertainties in the modeling assumptions, and in particular, with the SB350 AAEE assumption that the 2015 IEPR Mid-AAEE forecast will be doubled by 2030.

Supplemental Sensitivity Cases

In the first sensitivity case, with the AAEE reduced to the 2015 IEPR Mid-AAEE forecast, only 1,000 to 2,000 MW gas-fired generation capacity could be retired without causing capacity insufficiency reliability issues.

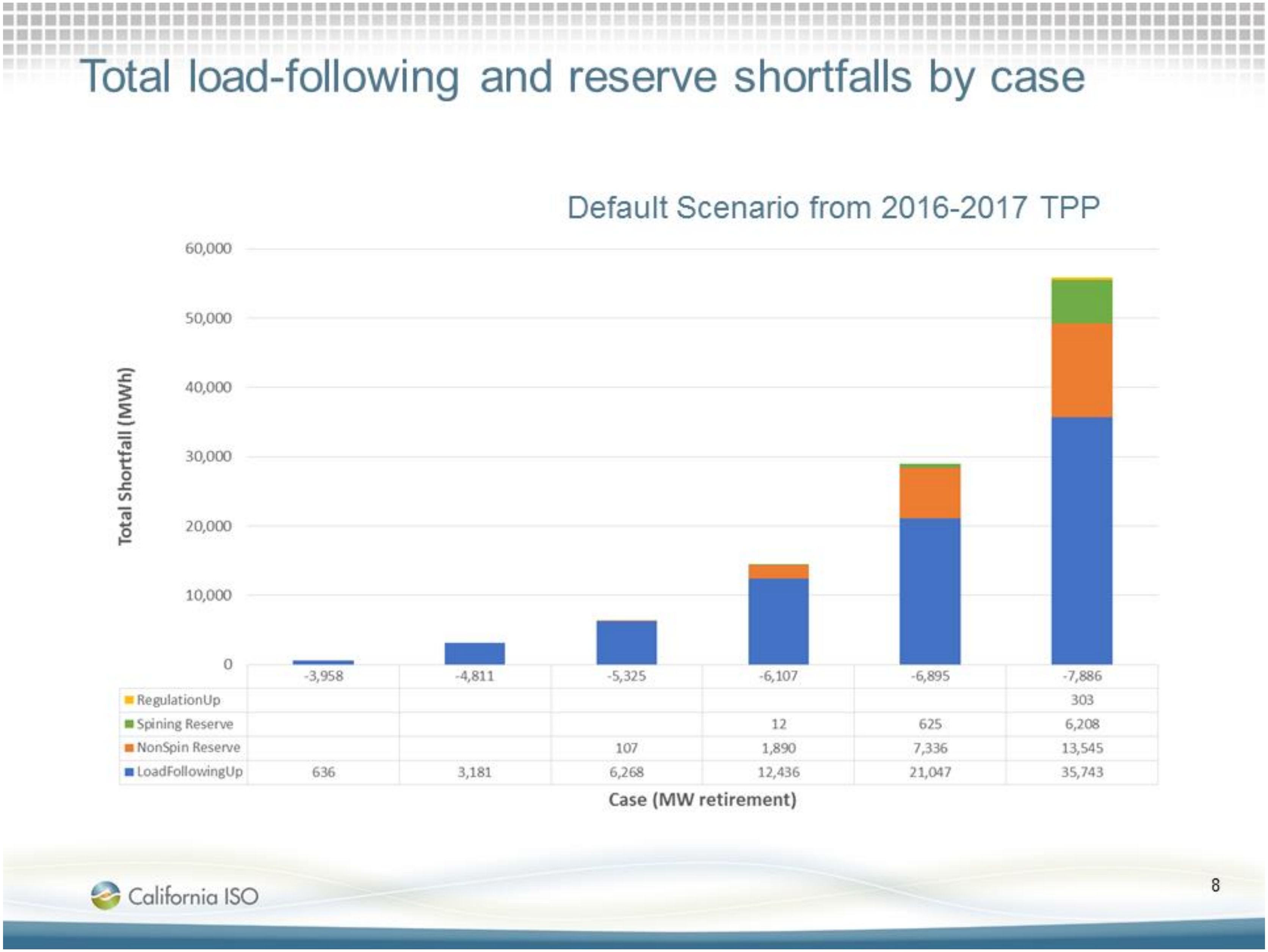
In the second sensitivity case, the three combinations of CCGT and GT capacity retirement show different impacts. In case of retiring 2,035 MW CCGT the ISO needs to use more import and GT generation to replace the “baseload” CCGT generation. That increases CO2 emission for both California and WECC. On the other hand, with 2,031 MW GT retirement, the ISO loses flexibility of its generation fleet and needs to use less flexible CCGT to follow load. The direct impact is that more renewable is curtailed to reduce the needs for ramping capability. The combination of the two, retiring 1,010 MW CCGT and 1,017 MW GT, provides a more balanced outcome.

Attachment

Slide Deck – September 20, 2017 (Revised)

Transmission Planning Process

Stakeholder Session



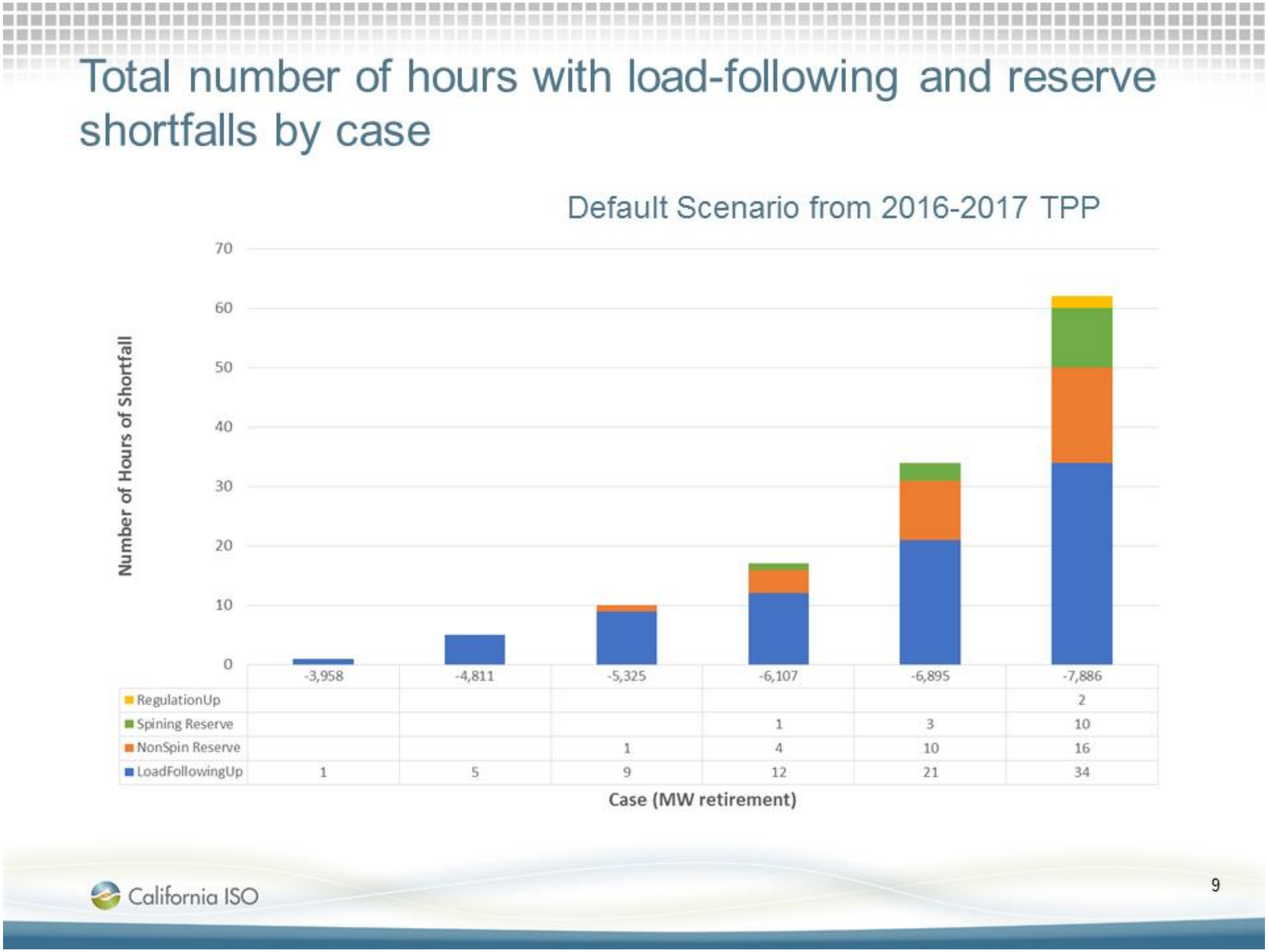
Total load-following and reserve shortfalls by case

Default Scenario from 2016-2017 TPP

	-3,958	-4,811	-5,325	-6,107	-6,895	-7,886
🟨 RegulationUp						303
🟩 Spining Reserve				12	625	6,208
🟧 NonSpin Reserve			107	1,890	7,336	13,545
🟦 LoadFollowingUp	636	3,181	6,268	12,436	21,047	35,743

Case (MW retirement)

California ISO



Total number of hours with load-following and reserve shortfalls by case

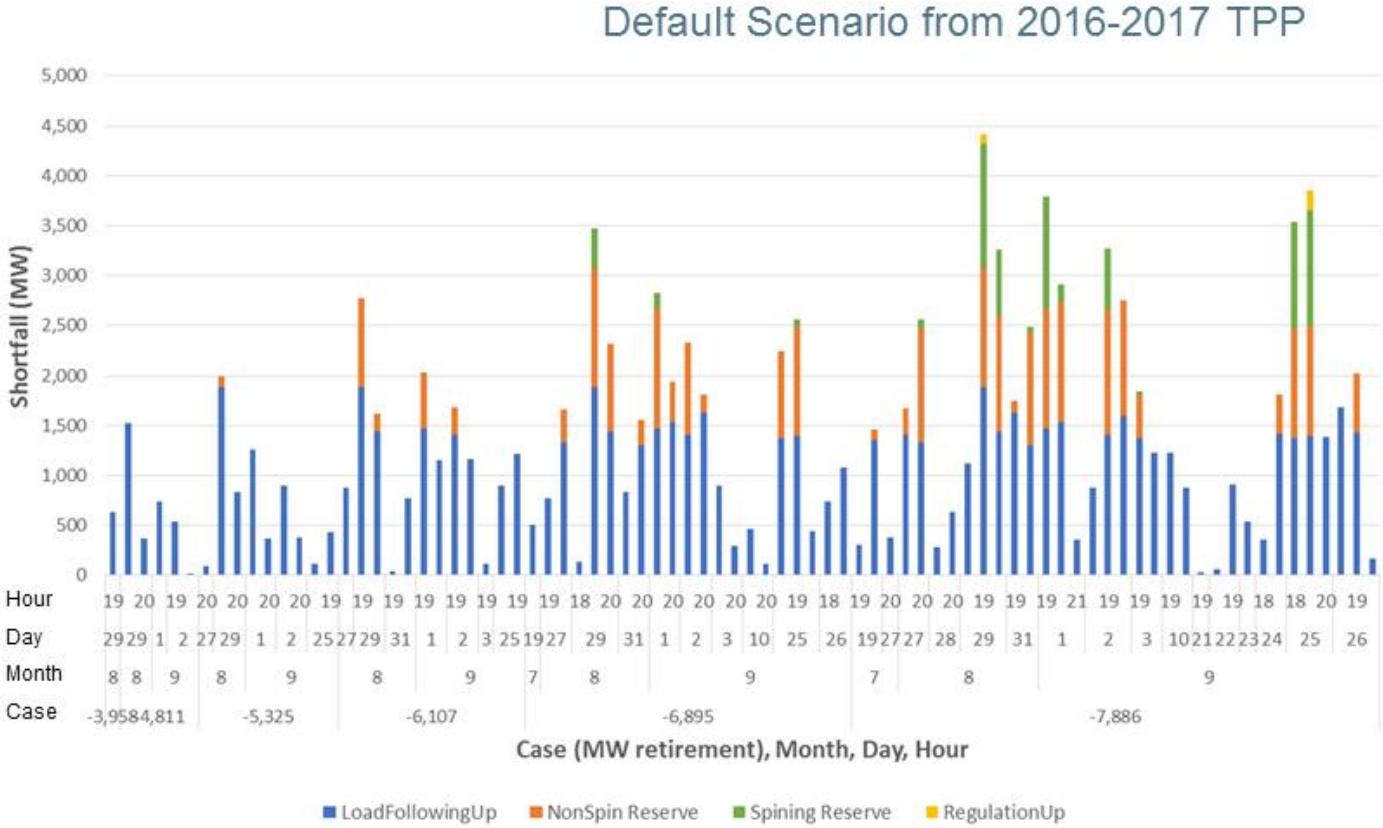
Default Scenario from 2016-2017 TPP

	-3,958	-4,811	-5,325	-6,107	-6,895	-7,886
🟨 RegulationUp						2
🟩 Spining Reserve				1	3	10
🟧 NonSpin Reserve			1	4	10	16
🟦 LoadFollowingUp	1	5	9	12	21	34

Case (MW retirement)

California ISO

Hourly load-following and reserve shortfalls by case



Default Scenario from 2016-2017 TPP

Summary of Findings

- Unlimited renewable curtailment masks the need for flexible capacity during downward ramping in the morning and upward ramping in the afternoon
- The shortfalls in load-following and reserves reflect the insufficiencies of capacity
- Capacity insufficiencies occur in early evening after sunset, which is the new peak (net) load time
- Capacity sufficiency issues start to emerge between 4,000 to 6,000 MW of retirement, considering some uncertainties in forecasts.

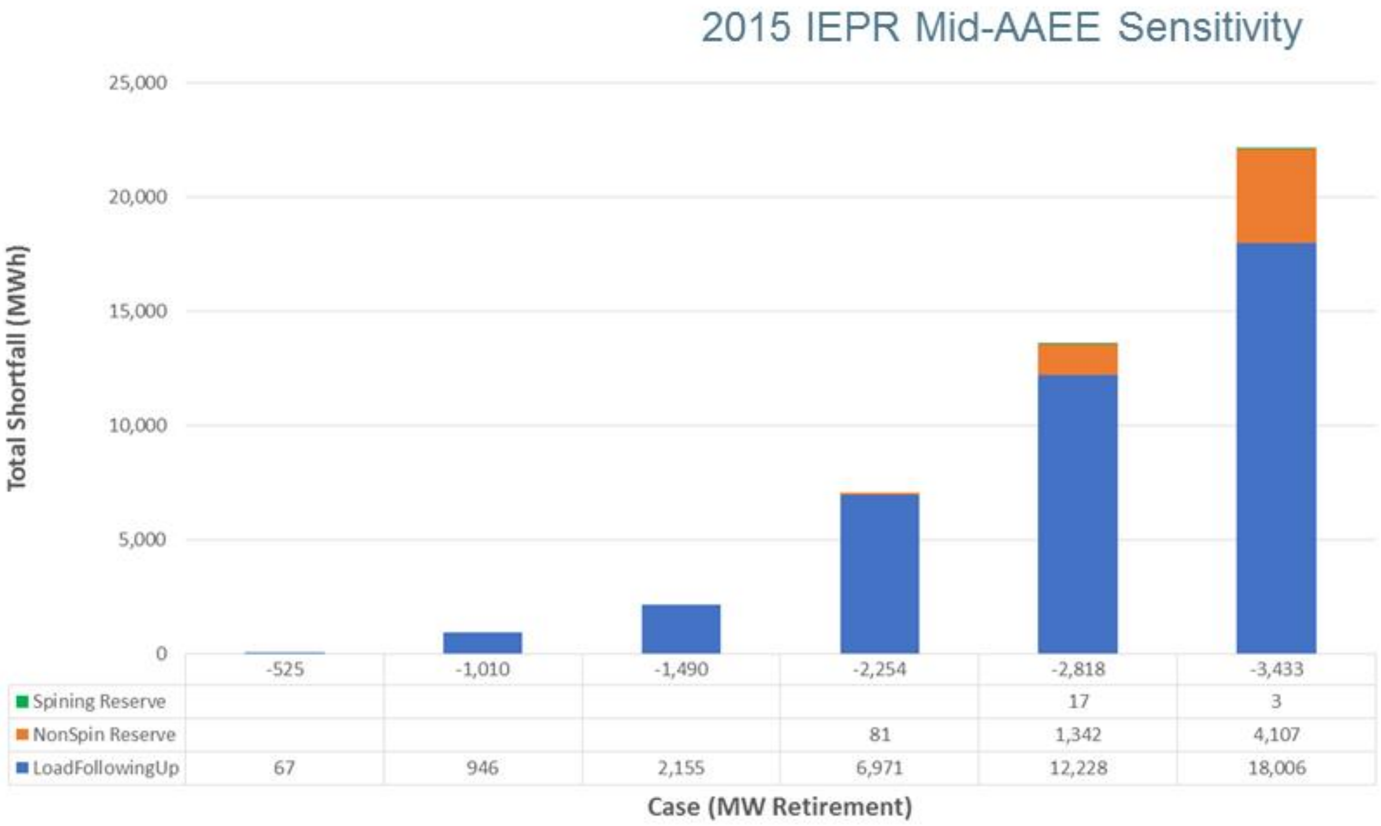
Sensitivities in 2017-2018 TPP cycle

– Default Scenario with 2015 IEPR Mid-AAEE

Assumptions for this sensitivity case

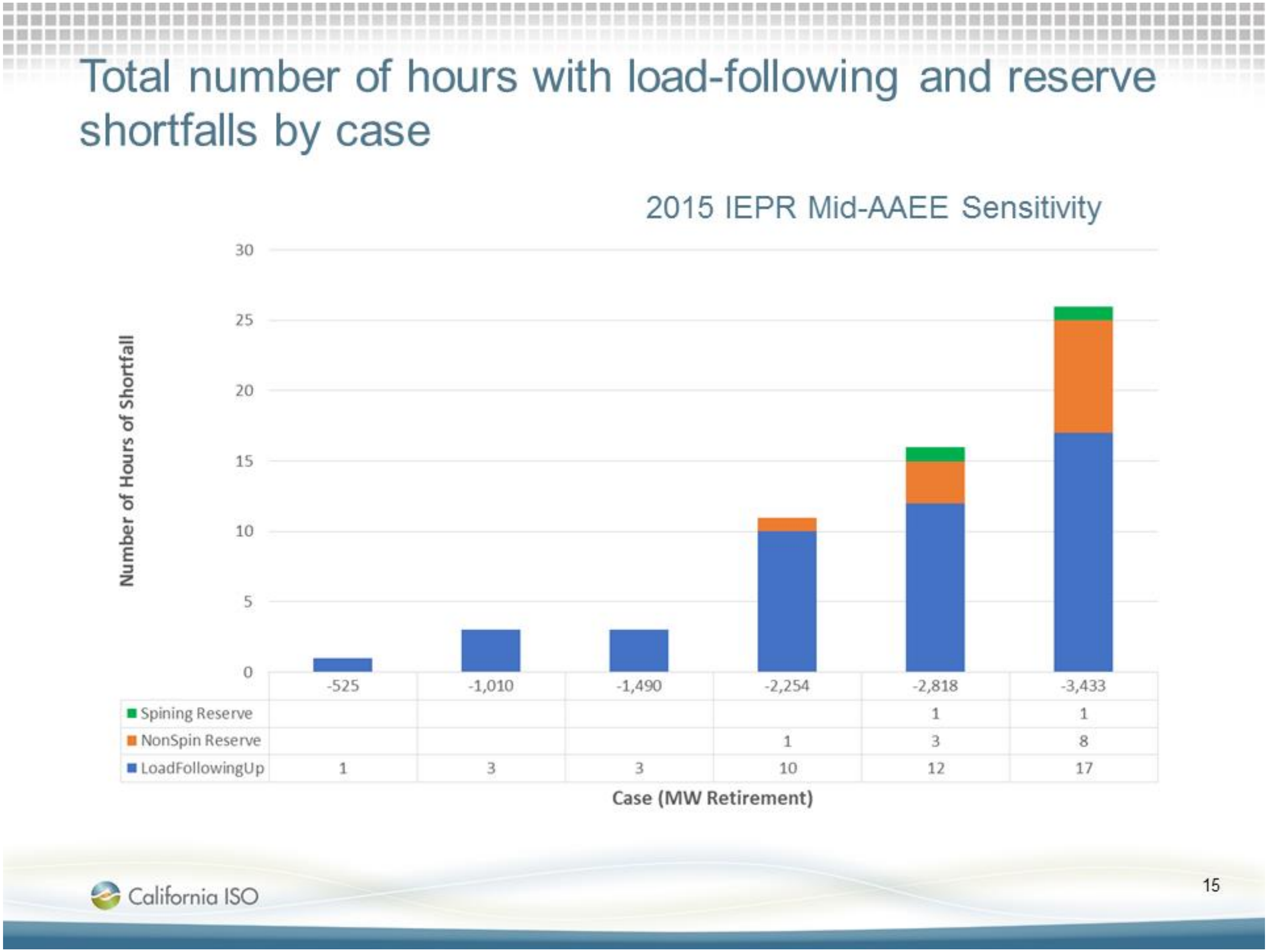
- This is the sensitivity of the Base Case
  - Base Case has the SB350 AAEE assumption that the 2015 IEPR Mid-AAEE forecast will be doubled by 2030
  - This sensitivity replaces that SB350 AAEE assumption with the 2015 IEPR Mid-AAEE forecast
  - Aligned with other 2016-2017 plan results

Total load-following and reserve shortfalls by case


2015 IEPR Mid-AAEE Sensitivity

	-525	-1,010	-1,490	-2,254	-2,818	-3,433
🟩 Spining Reserve					17	3
🟧 NonSpin Reserve				81	1,342	4,107
🟦 LoadFollowingUp	67	946	2,155	6,971	12,228	18,006

Case (MW Retirement)

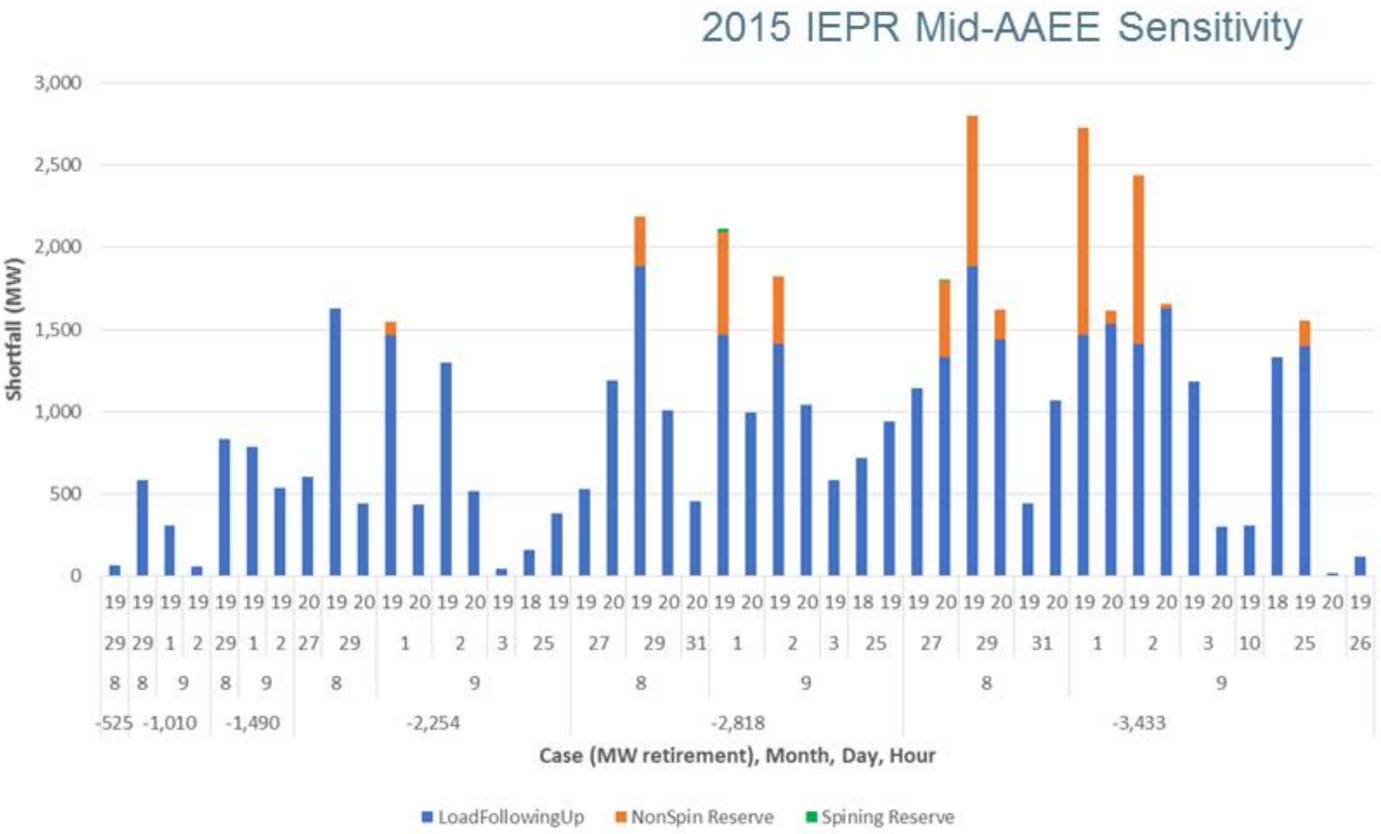


Total number of hours with load-following and reserve shortfalls by case

2015 IEPR Mid-AAEE Sensitivity

	-525	-1,010	-1,490	-2,254	-2,818	-3,433
🟩 Spining Reserve					1	1
🟧 NonSpin Reserve				1	3	8
🟦 LoadFollowingUp	1	3	3	10	12	17

Hourly load-following and reserve shortfalls by case

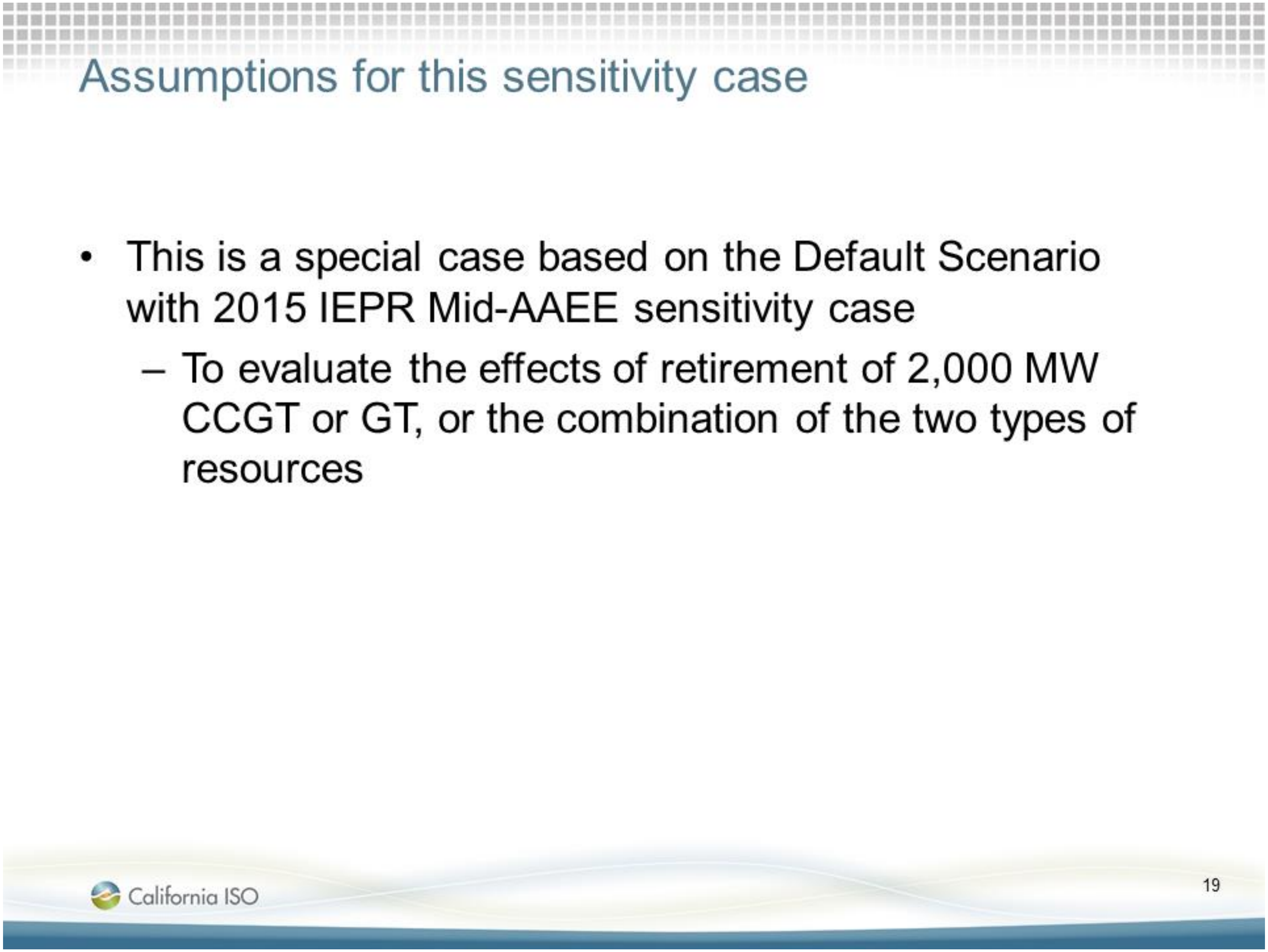


Summary of Findings

- Capacity sufficiency issues start to emerge between 1,000 to 2,800 MW of retirement, considering some uncertainties in forecasts.

Sensitivities in 2017-2018 TPP cycle

- Default Scenario with 2015 IEPR Mid-AAEE and 2,000 MW CCGT or GT Retirement



Assumptions for this sensitivity case

- This is a special case based on the Default Scenario with 2015 IEPR Mid-AAEE sensitivity case
  - To evaluate the effects of retirement of 2,000 MW CCGT or GT, or the combination of the two types of resources

Summary of results of the Default Scenario with 2015 IEPR Mid-AAEE with 2,000 MW CCGT or GT retirement

California-Wide	Base Case	Case 1	Case 2	Case 3	Change - Base to Case 1	Change - Base to Case 2	Change - Base to Case 3
Capacity Retirement (MW)							
- CCGT		2,035		1,010	2,035		1,010
- GT			2,031	1,017		2,031	1,017
- Total Retirement		2,035	2,031	2,027	2,035	2,031	2,027
Total Load (GWh)	305,891	305,876	305,874	305,822	-14	-17	-69
Generation (GWh)	243,749	241,951	243,922	243,017	-1,798	173	-732
Net Import (GWh)	62,142	63,925	61,952	62,805	1,783	-190	664
Renewable Curtailment							
- Energy (GWh)	2,365	2,370	2,395	2,371	5.4	29.7	6.4
- Number of Hours	708	715	736	725	7	28	17
Production Cost ($million)							
- WECC	15,619	15,634	15,653	15,645	15	34	26
- CA	3,899	3,844	3,938	3,909	-55	39	10
CO2 Emission (million M-Ton)							
- WECC	314.95	315.46	315.15	315.29	0.51	0.20	0.35
- CA (including net import)	52.54	52.91	52.71	52.80	0.37	0.17	0.26
CA CO2 Emission Cost ($million)	1,187	1,195	1,191	1,193	8.3	3.8	5.8
Capacity Shortfall							
- Shortfall Volume (MWh)	0	4,880	4,816	4,803	4,880	4,816	4,803
- Number of Hours	0	8	8	7	8	8	7

Summary of Findings

- The retirement of about 2,000 MW flexible resources has caused some system resource shortfalls