APPENDIX TO CPUC STAFF COMMENTS

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Technical comments on specific study cases, requests for detail in the study results:

1. ***The Report Should Provide Fuller Explanation of "Unquantified Benefits", Focusing Especially on Risk Mitigation/Reliability Benefits and Recognizing that Some Separately Identified "Benefits" are Actually Overlapping Aspects of a Single Fundamental Benefit Category.***

   CPUC Staff agree that there are types of benefits of a WECC-wide ISO beyond those explicitly quantified in the Study. Since these unquantified benefits were not precisely defined or studied, it is difficult to assess their magnitudes, their overlap or their dependence on particular assumptions regarding a WECC-wide ISO. The final report should more fully describe and justify such unquantified benefits, without leaving all of the specifics to Appendices, and should be clear that different aspects of a fundamental source of benefits are just that – different aspects, and not independent sources of benefit (see below).

   For example, unquantified benefits in the form of "improved use of the physical capabilities of the existing grid" is unclear in the main text of the May 24 presentation, although it is further clarified in Appendices. It apparently overlaps with centralized operational optimization and reduced market "friction" which are already explicitly captured in the quantitative studies. If the intent here is to emphasize that even case 1A overstates efficiencies and coordination under existing operations, then this should be explained more clearly and prominently without relying mainly on an Appendix to make the central point.

   Furthermore, unquantified benefits in the form of "improved regional and inter-regional system planning to increase efficiency of transmission buildout"[1] and "stronger generation efficiency incentives and better long-term investment signals across a larger regional footprint"[2] appear to overlap with what is being quantitatively modeled by adding revised RPS portfolios and associated transmission. Perhaps the point is that there would very likely be additional investment efficiencies made possible by a WECC-wide ISO, beyond those depicted in case 3. If so, this should be clarified and such additional efficiencies should be more fully described (not necessarily fully enumerated).

[1] May 24 presentation, page 9.
[2] Ibid.

Unquantified benefits in the form of "increased system reliability" and "risk mitigation" appear to represent essentially the same fundamental kind of benefit, perhaps best characterized as better ability of the system to respond effectively under a range of stressed or extreme (not average) conditions. This appears to be a valuable point but should be more fully explained perhaps with convincing examples of the stresses in question, as well as the system properties that enable actual (historically experienced) or likely (projected) successful system response. It appears (and could be discussed) that such situations could be modeled to provide fuller insight, although this would compete with other study priorities within the short timeline provided for this study.

The Following Comments Emphasize the Value of Analyzing and Interpreting a Wider Range of Cases and Sensitivities, Often by More Fully Reporting Cases that Have Already Been Run

2. ***The Report Should More Fully Describe and Depict the Implications of Case 1B (Enhanced Bilateral Coordination) When Assessing the Consequences of a WECC-Wide ISO.***

   Mainly, this should be done not because Case 1B is necessarily more likely as a baseline in a changed world 14 years from now than is Case 1A, although some may argue that point. Rather, this should be done because *more fully* including such a case in various comparisons of cases and their consequences helps readers understand and consider the amounts and kinds of calculated benefits that depend on specific assumptions regarding a West-Wide ISO – in this instance the assumption of greater ability to export California over-supply representing a form of reduced commercial friction. This would help clarify

   a. the projected effectiveness of relaxed export barriers alone (Case 1B) in managing curtailment problems and providing economic benefits, as well as
   b. the impact of the modeled geometric (more than linear) relationship of curtailment (renewable energy replacement) costs to the MWh level of curtailment

   Separate from the modeled hourly net export ceiling, inter-BA commercial hurdles[3] represent another form of commercial friction modeled in Cases 1A and 1B to reflect current practices but omitted when modeling a WECC-wide ISO in cases 2 and 3. It is unclear why Case 1B's representation of enhanced bilateral coordination should not include <u>*both*</u> relaxation of year 2030 net export limit (as currently included in Case 1B) and also elimination of at least part of the inter-

[3] Inter-BA Commercial hurdles (as distinct from and additive to wheeling rates) were applied in Cases 1A and 1B and are depicted in page 142 of the May 24 SB 350 Study Results presentation.

BA commercial hurdles (as distinct from tariff-based wheeling rates). This should be more fully discussed, to provide better illumination of the role of eliminating commercial "friction" as a key driver of calculated WECC-wide ISO benefits. The inter-BA hurdle rates depicted on slide 142 of the May 24 SB 350 study presentation appear to be substantial. (The relationship between the text and the table on that slide should be clarified.)

Finally, please see topics 7-9 below regarding curtailment, especially noting that ability of a Case 1B versus Case 2 comparison to illuminate the role of curtailments is limited by the fact that Case 2 actually starts with a significantly different RPS portfolio than Case 1B.

3. ***Besides More Out-of-State RPS Resources, Case 3 also Includes 5000 MW of Additional Western Wind "Enabled by the Regional Market", and the Report Should Include Clear Comparison of Benefits and Other Consequences of a WECC-Wide ISO With vs. Without this Extra Wind Generation.***

   Since a Case 3 variant without this added wind generation was run (as shown in slide 118 of the May 24 presentation), a fuller depiction and assessment of the impact of this added wind generation should be possible with limited additional effort. The comparison of different cost categories and other results (e.g., CO_2 as in slide 118) with versus without this added 5000 MW of wind, for both California and WECC-wide, should be clearly presented. Since these extra wind resources are not built for California or its RPS, their costs do not show up as California RPS procurement costs (e.g., in slide 45 from May 24). Additionally,

   a. Transmission additions (if any) attributed to and modeled for this 5000 MW of additional wind should be clarified, especially since it is unclear what loads are assumed or inferred (via modeling) to utilize this "beyond RPS" generation.

   b. Requiring an additional case or two and thus unlikely for the final Report, it would be informative to see how the added 5000 MW of wind would impact Cases 1A and 1B, relative to the impact on Case 3.

4. ***While Arguably Less Likely, it is Not Implausible that There Would be Significant Future California Use of RPS Imports Even Without a WECC-Wide ISO, and Combining an Out of State RPS Portfolio with "Current Practices" as in Case 1A and with "Enhanced Bilateral Coordination" as in Case 1B Would Enhance Insights Regarding the Benefits of a WECC-Wide ISO.***

   This requires additional study cases and portfolios and is not expected to be run for the final Report. However, such resources have been proposed and subjected to planning assessments for some time, and modeling of their operation in the

absence of a WECC-wide ISO would help clarify the benefits of such an ISO.[4] How such a case would be modeled and what would be the results appear to depend significantly on how deliverability to California and related transmission additions are treated (see Topic 11).

It would be helpful if the Report would qualitatively discuss the implications of the above.

5. ***The Report Should Specifically Discuss and Illuminate the Interaction of a WECC-Wide ISO with a Potential California Energy Future Emphasizing Distributed and Demand Side Measures and Investments.***

   Whether and how these two views of the future (WECC-wide ISO, distributed/demand-side focus) are competing or complementary, or both, is a significant planning question. A potential complementary interaction is suggested on slide 62 from May 24. Overall, it appears that the study cases and portfolios that have been analyzed can provide a meaningful albeit limited basis for considering this issue in the Report.

Curtailment Issues and Situations Appear to be Major Drivers of Projected WECC-Wide ISO Benefits and of Planning Strategies Generally, and the Report Should Include Fuller Explanation of Modeling Methods and Interpretation Regarding over-supply and Curtailment

6. ***The Report Should More Fully Explain Why Case 1B (Enhanced Bilateral Coordination) Needs to Curtail Over 400,000 MWh More[5] In-State Renewable Generation than Does Case 2, which has the Same 8000 MW Hourly Net Export Limit.***

To aid understanding of study assumptions, methodology and their consequences, the reasons for this difference between Case 1A and Case 2 curtailments should be explained. For example, to what extent is this difference due to more coordinated scheduling and dispatch and/or reserves sharing, or is it due to the commercial "friction" hurdles still being retained in case 1 B (see topic 3)?

7. ***The Report Should Clarify in Greater Detail Why, Relative to Case 1B, Case 2 Produces $391M of Annual RPS Resource Procurement Cost Savings[6]***

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[4] Furthermore, an intermediate (not modeled) possibility might be that such resources would be developed under a much more modest extension of the ISO to only a few neighboring BAs.
[5] See slide 45 of the May 24, 2016 SB 350 Study results presentation. This is for IOUs only.
[6] Slide 32, Ibid., and specifically the line labeled "High coordination under bilateral markets."

Combined with 416,000 MWh of Annual Curtailment Reduction[7], Which Amounts to Over $900 per MWh of Curtailment Reduction.

The 416 GWh of curtailment differential (slides 45 and 162 of the May 24 presentations) apparently represents *only IOUs* and thus could be somewhat larger statewide, but nowhere near large enough to explain the large RPS procurement cost differential between Cases 1B and 2. The explanation may be that even before adding additional California RPS resources to compensate for modeled curtailment, the initial Case 1B and Case 2 RPS portfolios were already substantially different, so that they do not represent the same "current practices" RPS procurement.[8] Perhaps the initial portfolio for Case 2 (before additions to compensate for curtailment) represented considerably lower annual RPS procurement costs (annualized recovery of capital investment). In fact, while having 232 MW less total RPS resource additions than Case 1B overall (likely reflecting lower curtailments), Case 2 had 475 MW less California solar, 1100 MW less California wind, and 1343 MW more out-of-state RPS resources apparently not requiring any incremental out-of-state transmission investment (and mostly representing non-physically delivered RECs). It would be helpful if RPS procurement costs were also compared across *initial* portfolios for all cases, i.e., prior to adding more RPS resources to compensate for curtailment.

Thus it appears and should be clarified that the comparison of Case 2 with Case 1B (and also with Case 1A) substantially reflects not only differences in "current" versus "WECC-wide" operating and market practices[9] but also significant differences in RPS portfolios used as starting points, before compensating for curtailments. On the one hand, this could be rationalized as representing slightly different optimization of the initial Case 2 portfolio versus the initial Case 1A/1B portfolio because assumed WECC-wide operating/market practices made out-of-state resources moderately more attractive in Case 2. However, this complicates interpretation of study results in that comparison of Case 2 with Case 1A or 1B then represents more than just the effects of changed operating and market practices, because it also significantly reflects changed RPS investments.[10] This must be taken into account when readers try to understand and consider the roles in producing benefits of (a) system operational changes directly attributed to formation of a WECC-wide ISO, versus (b) assumed indirect (consequent) changes in market practices, versus indirect (further consequent) changes in investment patterns.

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[7] Ibid., slides 45 and 162 (f*or IOUs only).*

[8] These two cases did add the same 500 MW amount of additional storage.

[9] Examples of modeled "operating and market practices" include commitment and dispatch, inter-BA wheeling rates, hourly and system annual reserve requirements, hourly net export limits, and inter-BA hurdle rates.

[10] Case 3's assumed RPS investments are changed much more dramatically.

8. ***RESOLVE and Brattle's Power Systems Optimizer (PSO) Produce Different Curtailment Levels for the Same Portfolios (May 24 Slide 62), and the Reasons and Implications Should be Clarified.***

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Comparison of projected curtailment levels (May 24 presentation, slide 162) indicates similar absolute MWh curtailment *differentials* between pairs of cases (e.g., case 1A versus Case 3, Case 1B versus Case 2, etc.) given by RESOLVE versus given by PSO. However, for any single case the absolute MWh of curtailment projected by PSO is substantially lower than what is projected by RESOLVE. The ratios are even more striking, reaching 0.45, 0.31, and 0.08 (PSO curtailment as a fraction of RESOLVE curtailment) for Cases 1B, 2 and 3 respectively.

The Report should strive to explain the cause and implications of these differences, considering that:

a. The ratio (PSO curtailments/RESOLVE curtailments) drops strongly as constraints causing overgeneration are removed, going from Case 1A to 1B to 2 to 3.

b. Compared to PSO, RESOLVE tends to give higher curtailments. Since the assumed marginal supply (in RESOLVE) of additional renewable generation to replace curtailed MWh entails a greater-than-linear relationship of growing curtailment cost versus growing curtailment MWh,[11] this means that a given MWh change in curtailment between two cases produces a greater cost differential between the cases when the absolute MWh curtailment level of both cases is higher to start with.

The Report Should Include Fuller Explanation of Key General Modeling Methods and Conventions (Those used Across Cases)

9. *The Report Should Explain How Calculation of Load Diversity Benefits (Reduced Costs for System Capacity) Takes Into Account (a) The Extent to Which California Would be Short of System Capacity Under the Futures Examined, (b) How Meeting Local and Flexible Capacity Needs Regardless of Load Diversity Contributes to Meeting California System Capacity Needs, and (c) The Ability (and Transmission Needs) to Import Additional RA Deliverable Out-of-State System Capacity.*

10. *The Report Should More Fully with Numerical Examples Explain How the Following are Distinguished, Quantified and Assigned to Different Load Areas Based on Production Simulation Results: (a) RECs Versus Delivered Out of State Renewable Energy, (b) Contracted Versus Generic California Imports, and (c) Overgeneration-Related Energy Prices and Costs for Buyers and Sellers In-State and Out-of-State (Specifically Including California Exports).*

[11] This relationship might be roughly fitted to a geometric or exponential curve.

This includes defining how import flows to CA are allocated among different out of state resources including accounting or not accounting for flows on individual as opposed to aggregate California interties. It also includes describing how the ultimately assigned energy prices and costs at in-state of out-of-state locations (including during California overgeneration hours) are related to the locational prices that result directly from production simulation-modeled energy bids and dispatch.