Comments of Powerex Corp. on
Day Ahead Market Enhancements
Straw Proposal

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Powerex appreciates the opportunity to submit comments on CAISO's February 3, 2020 *Day-Ahead Market Enhancements Straw Proposal* ("Straw Proposal") and related discussions at the stakeholder meetings on February 10 and March 5, as well as at the Market Surveillance Committee ("MSC") meeting on March 13.

Powerex strongly supports the conceptual design and the foundational elements of the Straw Proposal, which it believes will increase reliability, lower total production costs, and provide more accurate market price signals. Discussions with stakeholders indicate that certain aspects of the technical formulation of the Straw Proposal may need to be revised, while additional fine-tuning may enable further benefits to be achieved. Powerex is optimistic that further collaboration between stakeholders and the CAISO can yield a significantly improved day-ahead market that is beneficial and workable for all participants.

Powerex's main comments are summarized below, while more detailed issue-specific comments are contained in Appendix A. Powerex is also a member of the EIM Entities, which are submitting joint comments in this initiative.

I. The Straw Proposal Will Improve Reliability And Market Efficiency Of The CAISO BAA

Powerex strongly supports the conceptual design and the foundational elements of the Straw Proposal. In particular, Powerex believes the key elements of the Straw Proposal are:

- Day-ahead procurement of flexible capacity through a new Imbalance Reserve product that is efficiently co-optimized with day-ahead energy and current Ancillary Services; and
- Requiring that the day-ahead solution include sufficient physical capacity awards—either as physical energy awards or stand-alone hourly (or sub-hourly) flexible capacity awards—to meet CAISO's day-ahead forecast of demand

conditions, effectively replacing the current sequential Residual Unit Commitment ("RUC") process that is used to backstop net virtual supply and/or load under-scheduling in the day-ahead market.

As discussed in greater detail in Sections I - III of Appendix A, Powerex believes these key elements will provide several significant reliability and efficiency benefits to the CAISO BAA:

1. **Increased reliability**—introducing a formal day-ahead flexible capacity product, with a transparent market-clearing price will provide the CAISO with the much-needed ability to secure flexible capacity through the day-ahead market, rather than relying on non-transparent, sequential, out-of-market procurement mechanisms.
2. **Lower total production costs**—a single co-optimized market process that simultaneously considers all system needs—including energy, capacity, flexibility, and Ancillary Services—will be able to achieve a lower total production cost than the current framework of multiple fragmented sequential procurement processes and operator interventions.
3. **Eliminate systemic profits for virtual sellers**—the current sequential procurement actions by the CAISO—including RUC, exceptional dispatch, load biasing, and others—are taken predominantly when CAISO operators anticipate real-time conditions to be *tighter* than were forecast in the day ahead (*i.e.*, CAISO operators anticipate the need to secure additional upward flexibility and/or capacity). But the real-time price suppression impacts of these actions effectively mitigate virtual sellers' losses under those conditions, which is generally when real-time prices would be expected to rise materially above day-ahead levels. This one-sided financial protection increases the ongoing profitability of virtual seller strategies, as hours in which virtual sellers would typically incur losses are mitigated, but profitable hours are generally unchanged. The Straw Proposal would significantly reduce the need for RUC and other sequential, out-of-market procurement, which would help eliminate the systemic price distortions that provide persistent, inefficient profits to virtual sellers.
4. **More accurate price formation**—a single co-optimized day-ahead market will produce internally consistent prices that more accurately reflect the marginal value to the grid of the products provided by each resource. These prices would be the result of an efficient optimization process that simultaneously considers all available trade-offs between products and resources, identifying the combination that minimizes total production costs. Accurate and robust price formation is perhaps the most effective mechanism for providing incentives for resources with the right attributes to be available at the right time and at the right locations.

II. Further Refinements Should Be Explored To Address Specific Concerns That Have Been Raised And To Provide Additional Benefits

Powerex believes that the Straw Proposal provides a sound starting point for how the core design objectives and elements can be achieved in an efficient day-ahead market optimization. Stakeholders have expressed a range of perspectives on the Straw Proposal. Some stakeholders are strongly supportive; others express tentative support while raising specific questions or concerns. There also appears to be general conceptual support from the MSC, which also highlighted specific areas for further consideration.

This constructive input has revealed some areas where changes to the technical details of the Straw Proposal may be necessary, as well as potential opportunities to further refine the Straw Proposal to yield additional benefits.

Powerex believes three particular concerns have been raised that warrant further consideration and potential refinements to the Straw Proposal:

1. The MSC meeting raised the concern that compensation that is available only to physical supply, but not to virtual supply, could lead to "implicit virtual bidding" that may need to be addressed.
2. California load-serving entities ("LSEs") have raised concerns that the Straw Proposal's compensation for day-ahead physical capacity commitments (applicable to both stand-alone capacity and to reliable physical energy schedules, or "REN:EN") could result in California ratepayers incurring duplicative capacity-related costs, as California LSEs are already compensating physical resources to be available in the day-ahead and real-time markets under existing Resource Adequacy ("RA") contracts.
3. Some stakeholders have expressed concern regarding potential market outcomes under hypothetical examples presented by CAISO. While Powerex believes these concerns are largely misplaced, the discussion indicates an opportunity to improve the design to make potential market outcomes more intuitive.

Powerex believes that the above concerns warrant further discussion and consideration of changes to the Straw Proposal. Some possible changes that could address these concerns, as well as potentially increase the overall efficiency of the market design, are outlined below, with additional detail provided in Section V of Appendix A.

Powerex notes that there are some parties that appear to oppose pursuing any significant change to the day-ahead market design. The shortcomings of the current market design—in terms of ensuring reliability, minimizing total production costs, and providing accurate and transparent price signals—are significant and well established. All market inefficiencies—as well as any changes that reduce those inefficiencies—will inevitably be

beneficial to some entities while being detrimental to others, however. Powerex believes it would be unrealistic to expect unanimous support for this initiative, and it would be untenable for the CAISO to decline to pursue these much-needed reforms to its day-ahead market.

A. Powerex Suggests Consideration Of Targeted But Important Modifications To The Straw Proposal

Powerex suggests that CAISO and stakeholders consider the following potential refinements to the Straw Proposal:

1. *Introduce a clawback settlement rule to address the MSC's concern regarding implicit virtual bidding.*

A resource that receives a day-ahead physical energy award, but reduces that award in the real-time market by submitting a DEC bid at a price above its day-ahead offer price, would have its day-ahead upward capacity shadow price revenues clawed back. The resulting compensation would be the same as for explicit virtual bids, which settle only against the day-ahead and real-time energy prices. This clawback mechanism could also be applied to any day-ahead physical awards—whether physical energy, stand-alone RCU or stand-alone IRU—that do not perform in real-time.

2. *Consider eliminating the RCD product*

While the CAISO grid regularly experiences a need for both upward and downward *flexibility*, and also experiences a need for *upward* total capacity to meet potential peak demand, it does not currently face reliability challenges related to excess supply. The continuing expansion of the Western EIM and increasing levels of economic bidding by renewable resources can be expected to continue in the years ahead, which may improve the CAISO's ability to avoid downward capacity challenges. Moreover, the introduction of IRD will provide CAISO with a fixed quantity of additional downward flexibility deployable in real-time. The elimination—or at least deferral—of the RCD product at inception should address some of the confusion regarding some of the hypothetical (and often unrealistic) examples discussed thus far.

3. *Consider re-writing the reliable energy constraint as an upward capacity constraint as follows:*

REN:EN + RCU + IRU >= CAISO's forecast demand (p50) + IRU demand

This formulation enables additional IRU to substitute for RCU when it is lower cost. The flexible capacity constraint of the Straw Proposal would still be enforced (*i.e.,* requiring a certain minimum quantity of IRU). Resources awarded IRU would receive the same

compensation as under the Straw Proposal, but, importantly, it would now be decomposed into an upward capacity shadow price and an upward flexible capacity shadow price.

4. *Consider modifications to the settlement of the upward capacity constraint shadow price to avoid potential "double-payment" of capacity by California LSEs.*

The Straw Proposal would compensate physical capacity awarded in the day-ahead market—either as reliable physical energy, stand-alone RCU, or stand-alone IRU. California LSEs have noted that, under existing RA contracts, they have arguably already contracted for (and agreed to compensate for) physical resources to be available for deployment in both the day-ahead and real-time markets.

While Powerex understands this concern and perspective, it is important to recognize that existing commercial arrangements are generally not considered an acceptable rationale for preventing the development of a more efficient market design. Moreover, going forward, this concern with the Straw Proposal should largely be alleviated, as new RA contracts would be able to reflect the additional compensation available to physical resources in the day-ahead market; all else equal, this would be expected to reduce the compensation that needs to be provided through the RA contracts. The concerns raised by California LSEs are therefore an important but transitional consideration, perhaps best addressed through a transitional arrangement rather than necessitating changes to the Straw Proposal.

Nevertheless, it may be possible to identify changes to the Straw Proposal that would still provide appropriate marginal incentives for the procurement and compensation of physical capacity in the day-ahead market, while also recognizing the forward commitment and associated compensation for physical capacity under RA contracts. One approach that could be considered is to treat all RA resources as effectively having a "short" financial exposure to the upward capacity shadow price going into the day-ahead market. The net settlement impact would depend on the performance of each resource, preserving the Straw Proposal's desired marginal incentives:

- An RA resource that receives a day-ahead award would be paid the upward capacity shadow price, and would therefore be <u>net neutral</u> in the day-ahead market to the CAISO's capacity price. Their capacity compensation would thus entirely come from their RA contract, consistent with the negotiated compensation under those contracts.
- An RA resource that is not available in the day-ahead or real-time market in any RA contract hour (*e.g.,* it fails to be awarded to provide REN:EN, RCU or IRU and/or it fails to perform in real-time when called upon), would incur a <u>net charge</u> equal to the capacity shadow price, appropriately reflecting the cost of replacing

the physical capacity it committed to provide under the RA contract, but failed to provide.

- An RA resource that is available but incurs a marginal opportunity cost to provide physical capacity through real-time could reflect this in its RCU offer price. Such economic participation enables RA resources to improve their overall financial outcomes by allowing the market to identify a more economic resource to provide this capacity instead.

B. The Proposed Modifications Appear To Address The Major Concerns Raised To Date With The Straw Proposal, And Offers Several Additional Benefits

Powerex recognizes that the above would represent significant changes to the Straw Proposal, and requires significant discussion and examination by CAISO, the MSC and stakeholders. But based on its own review thus far, Powerex believes the revised formulation could largely address the key concerns raised with the Straw Proposal and provide significant additional benefits as well, including:

1. Implicit virtual bidding will be deterred by eliminating profits from this activity.
2. Production costs can be further minimized (relative to the Straw Proposal) through efficient substitution of hourly RCU with additional 15-minute IRU, if additional IRU is more cost-effective.
3. Eliminating the RCD product will enable bid-in demand to be met by physical supply as well as virtual supply, consistent with their bid prices, increasing competition to meet bid-in demand and leading to more intuitive outcomes.
4. Charging RA resources the upward capacity shadow price will eliminate claims that California ratepayers may "pay twice for capacity" during a transition from existing RA contracts to new contracts, while also:
    - retaining efficient incentives for all resources to submit capacity offers that reflect their marginal cost of making capacity available through real-time; and
    - minimizing or eliminating any potential for market power in meeting the upward capacity constraint, as the *entire RA fleet* will enter the day-ahead market "short" the upward capacity shadow price, and *also* face competition from non-RA physical resources.

Additional details of Powerex's suggested revisions, the manner in which they appear to address the major concerns related to the Straw Proposal, and the additional anticipated beneficial attributes, are discussed in Section V of Appendix A.

Powerex is optimistic that further review of this proposal by stakeholders and by CAISO can assess whether it offers an important incremental improvement over the Straw Proposal formulation, as well as identify further areas requiring refinement.

III. Pursuit Of The Straw Proposal Is A Pre-Requisite For A Workable EDAM Design

Powerex joins in the comments submitted by the EIM Entities, which highlight the need for any Extended Day-Ahead Market ("EDAM") design to commit sufficient *physical* capacity and flexibility to ensure reliability. Without such a design, the potential benefits of participating in an EDAM will be significantly reduced, and the viability of an EDAM will be undermined.

The Straw Proposal, if carefully designed and implemented, would produce a day-ahead market solution that includes sufficient physical capacity and flexibility to meet demand with a high degree of certainty. In contrast, the current day-ahead market solution does not ensure that energy awards are backed by physical supply. If the current design is extended to the EDAM footprint, it would leave EDAM participants in the untenable position of relying on imports to serve firm load, but with no assurance that those imports are backed by real physical supply. Powerex does not believe that any potential EDAM participant with responsibility for reliability would be willing to participate in a market where unit commitment decisions and reliability are determined by financial speculators or hedge funds. To provide the reliability that such a market lacks, potential EDAM participants may need to commit additional local generation resources, increasing costs and undermining the potential benefits of participating in the EDAM. Ultimately, some potential participants may determine they cannot participate in the EDAM due to reliability concerns.

The Straw Proposal also addresses a critical gap between the CAISO's market design and energy transactions elsewhere in the West. Outside of California, entities have traded physical firm energy, which the expectation that the seller has the physical resources necessary to support its obligations. Firm energy commitments therefore include compensation both for the production of energy, and for the commitment of physical capacity to ensure performance. Non-firm energy can also be transacted explicitly, and receives different compensation. The current CAISO day-ahead market design does not require energy awards to be backed by physical resources, nor does it distinguish between virtual and physical supply in its dispatch, price formation, or compensation. The current day-ahead market design is effectively a market for non-firm energy, with sequential, fragmented procurement used to commit incremental physical supply through out-of-market transactions.

Extending an "energy only" market design to the rest of the west would cause extensive economic harm to the ratepayers of entities outside of California that are net sellers from

capacity-backed resources. Such a market design would compensate net sellers of firm, physical supply the same as “non-firm energy” or if they were simply virtual suppliers, with no physical assets behind their sales at all. This is a very significant concern for hydro entities in the Northwest, but the same concerns also apply to utilities in the Desert Southwest, which regularly start-up and commit thermal generation units not only to meet their own demand, but also to make exports to meet the needs of California. Moving forward with the refinement and implementation of the Straw Proposal’s key market design principles is critical to the viability of an EDAM.

Appendix A — Comments On Specific Issues

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I. Co-Optimized Procurement Of Energy, Capacity, and Flexibility Is Necessary To Minimize Total Production Costs

The key motivator for the DAM Enhancements stakeholder process is that the current day-ahead solution does not provide CAISO operators with the physical resources needed to reliably operate the grid in real-time. CAISO operators are, appropriately, unwilling to rely only on 15-minute and/or 5-minute procurement in the real-time market to procure all of the additional supply that they anticipate will be needed; doing so would carry a significant risk that the needed supplies may not be available, in which case a reliability event may occur. Stated differently, it is now clear that the reliable operation of the CAISO BAA requires additional physical resources to be committed in advance in the day-ahead timeframe.

This observation leads to considering *how* such advance commitment of physical capacity should occur. Specifically, is it better to:

1. Procure physical capacity commitments in a sequential manner, after first running the day-ahead market to see how much physical supply happens to clear; or
2. Procure physical capacity commitments simultaneously with, and as part of, the day-ahead market optimization process?

The current day-ahead market largely resembles the first approach of sequential and fragmented procurement. First, bid-in demand for energy is cleared against bid-in supply offers, from both virtual sellers and physical suppliers. This process determines a set of market-clearing prices for energy. Second, the CAISO runs its RUC process, through which it commits additional physical capacity to be available in the real-time market, recognizing that the day-ahead market solution includes net virtual supply, and may clear at a quantity substantially below CAISO's forecast of real-time demand. Third, as conditions evolve closer to real-time, CAISO operators enter into out-of-market transactions with physical suppliers, either to be confident of being able to meet the peak demand level, or being able to balance rapidly-changing levels of net demand (*i.e.,* demand minus energy from variable energy resources).

The main problem with this sequential, fragmented procurement approach is that it is virtually guaranteed to result in excess production costs. This is because the day-ahead market selects resources based only on the cost of providing energy, without regard to whether a particular resource might instead be better suited to providing standby capacity that can be deployed in real-time. It is only in the subsequent procurement efforts that a resource's ability to be deployed in real-time is considered; but if a flexible resource has already received a day-ahead energy award—which occurs first in the procurement sequence—then the resource is effectively unavailable to help meet the CAISO's need for standby capacity. Stated differently, each step of the procurement sequence limits

the remaining options that are available in the *next* procurement step. Each step of the procurement sequence is also "selfish," as it considers only its own needs while ignoring the needs to be met in a subsequent step.

The alternative to sequential, fragmented procurement is for all procurement decisions to be made simultaneously, considering all available resources and their ability to meet all of the needs of the CAISO as the operator of the grid, as well as the demand submitted by market participants. In this manner, the inherent tradeoff between using a resource to provide energy or using it to provide standby capacity that can be deployed in real-time can be considered explicitly.

The current CAISO day-ahead market does involve co-optimized procurement, but only for a particular subset of products. Specifically, the CAISO day-ahead market co-optimizes meeting bid-in demand for energy together with meeting the need for Spinning Reserve and Non-Spinning Reserve to satisfy NERC and WECC contingency reserve requirements, and the need for Regulation Up and Regulation Down, as determined by the CAISO. In this manner, a physical resource that meets the relevant technical criteria can be selected to provide energy *or* Spinning Reserve *or* Regulation Up, or any internally consistent combination of these products. Thus, even if such a resource submits a very low offer price for energy, the CAISO day-ahead market may still determine that the best use of that resource is to provide Spinning Reserve, depending on the availability and offer prices from alternative providers of energy or of Spinning Reserve. This is a cost-reducing outcome that is simply not possible under a sequential, fragmented procurement approach.

Extending the scope of the current CAISO day-ahead co-optimization to include procurement of *all* products—including bid-in demand for energy, CAISO's demand for capacity and flexibility to ensure reliability, and the CAISO- and NERC/WECC-defined demand for Ancillary Services capacity—would bring the full capabilities of CAISO's sophisticated optimization software to bear on the challenge of meeting all of these needs at the lowest total production cost.

A second major problem with sequential, fragmented procurement is that market-clearing prices do not accurately reflect the marginal cost of serving demand, and thus fail to achieve the most important goal of price formation. Under the current CAISO day-ahead market, for instance, the clearing price of energy generally reflects the price at which bid-in demand for energy equals the offered supply of energy. But the bid-in demand for energy does not fully reflect the demand for all products needed to reliably operate the grid, which also includes the demand for standby capacity and flexibility to be available for deployment in real-time. By excluding from the day-ahead market the demand for capacity and flexibility, the value of specific types of resources is chronically understated.

The resulting price of energy will persistently fail to reflect the cost of using a resource for energy that could instead have been used to provide standby capacity or flexibility.

Furthermore, sequential, fragmented procurement involves a large volume of transactions that occur without any transparency regarding price, volume, or even the nature of the product being procured. There is no granular information, for example, on either the quantity or the price of RUC commitments for any given operating hour; only aggregate information is published with any regularity. And the *ad hoc* out-of-market procurement undertaken by CAISO grid operators is subject to even less transparency, with no ability to distinguish procurement for capacity from procurement to meet flexibility challenges.

One of the most important functions of market prices is to signal the relative value of a product to all current and potential suppliers of that product. But potential suppliers can only respond to price signals they actually see. The lack of transparency therefore contributes to CAISO grid operators having relatively few options when procuring capacity, flexibility or energy out-of-market; even if this procurement is very costly, there is no way for a lower-cost resource to be aware of the need and make itself available. A co-optimized market, by comparison, would determine and publish the clearing price of each product that was procured—just as it does for Energy, Spinning Reserve, Non-Spinning Reserve, Regulation Up and Regulation Down. Potential suppliers could readily see what resource attributes are most valuable in the market, and respond by making additional resources with those valuable attributes available and offering them into the CAISO markets when they are of greatest benefit.

II. Fragmented Procurement Creates Inappropriate Benefits For Virtual Sellers And California LSEs, While Harming Physical Suppliers

Sequential, fragmented procurement leads to excess production costs, inaccurate market-clearing prices, and substantial volumes of transactions with little or no price transparency. While it should be readily apparent that sequential, fragmented procurement is inefficient, this does not necessarily mean that the fragmented procurements are harmful to every market participant. To the contrary, the inefficient fragmented procurement that occurs in the CAISO markets today is *highly beneficial* to certain entities, as well as to those that engage in particular types of market strategies.

As discussed in the prior section, one of the principal consequences of a day-ahead market that does not include the demand for all electricity products is that the market-clearing prices are systemically depressed to levels below the incremental cost of serving demand. Lower prices are generally beneficial to net purchasers, who incur lower purchase costs than if the product was accurately priced. The primary net purchasers in the CAISO day-ahead market are the California LSEs. Having divested the majority of their generation capacity as part of California's electric industry restructuring, California LSEs must purchase most of the energy consumed by their retail customers. The day-ahead market is an important source of those energy purchases. In addition, prices in the day-ahead market are frequently used to financially settle forward financial energy contracts, and to inform the pricing of forward fixed-price physical contracts as well. For these reasons, even relatively modest reductions in the day-ahead market price for energy can translate to large cost reductions for California LSEs.

Every megawatt-hour that costs a purchaser less money is also a megawatt-hour for which a supplier receives less revenue, however. The financial benefit to California LSEs of *inefficiently suppressed* day-ahead market prices comes directly at the expense of physical suppliers, including generators located within the CAISO BAA and suppliers located outside of it that sell their output in the CAISO markets.

Virtual sellers, unlike physical suppliers, may not experience any harm from suppressed day-ahead market prices. While virtual sellers do receive a lower day-ahead price, what ultimately drives the profitability of virtual trading strategies is not the level of prices, but the *difference* in prices between the day-ahead and real-time markets. Sequential, fragmented procurement has an impact on real-time market prices as well. In particular, standby capacity procured out-of-market increases supply available in the real-time market, resulting in lower real-time prices than if the additional capacity did not participate. Beyond that, however, many of the fragmented procurement decisions result in the delivery or production of energy as a price-taker, as units are operated at minimum output levels in order to provide upward headroom that can be deployed in real-time. This introduction of price-taker energy is one of the major reasons why real-time market

clearing prices in the CAISO have been very low even when the grid has experienced capacity or flexibility challenges. CAISO operators, in an effort to ensure reliability of the grid when tight conditions appear likely, may understandably err on the side of procuring what they *might* need, which is often more than what the grid actually turns out to need.

The extent of fragmented procurement—and the effect it has on day-ahead and real-time prices—varies from day to day, and across different hours of the day. In general, tighter grid conditions appear to be associated with higher levels of RUC, exceptional dispatch, and load biasing. This is to be expected, as tight grid conditions are precisely the conditions under which CAISO grid operators may view additional resource procurement as necessary to ensure reliability. But this same relationship between tight real-time grid conditions and increased out-of-market procurement also creates a structural relationship between grid conditions and the suppression of real-time prices. That is, real-time prices will tend to be suppressed primarily when real-time grid conditions are more challenging than was expected in the day-ahead. Conversely, when real-time grid conditions are expected to be similar to or perhaps less challenging than was anticipated in the day-ahead timeframe, there would tend to be less out-of-market procurement and consequently less distortion of real-time prices.

For a marketer engaging in virtual trading activity in the CAISO markets, the out-of-market procurement by CAISO grid operators that occurs largely when real-time conditions are tight—but not otherwise—means that the risk of losing money on virtual supply awards is significantly reduced. A virtual supply award loses money when real-time prices exceed day-ahead prices, such as if real-time prices spike when the grid experiences particularly tight conditions. Yet the very nature of out-of-market procurement is to prevent real-time prices from rising substantially. The same actions that CAISO grid operators understandably are required to take in order to protect reliability have the unintended effect of enabling systemic profits to virtual supply.

III. Virtual Supply Must Be Differentiated from Physical Supply To Reflect The Different Value Provided To the Grid

The production cost savings that can be achieved by a co-optimized market are due to its ability to consider the potential alternative uses of different types of supply offers. But before evaluating these trade-offs, the co-optimization must first accurately identify what the potential alternative uses of each resource or supply offer actually are. Not every resource will be capable of providing every product needed by the market. For example, two 100 MW thermal generators may be equally capable of helping meet the CAISO's maximum expected hourly demand, but the units may differ greatly in their ability to change their output within the operating hour, or with little lead time. In terms of the products to be procured in a co-optimized day-ahead market, both of these generators could provide energy and capacity, but only one may be able to provide flexibility. Accurately determining each physical resource's ability to provide each of the day-ahead market products is a critical part of realizing the efficiency benefits that are possible under a co-optimized market design.

The need to accurately identify which supply sources can provide particular day-ahead products applies also to virtual supply. Virtual supply plays an important role in the current day-ahead market design, and will continue to have an important role in a fully co-optimized day-ahead market. Specifically, virtual supply can contribute to meeting the demand of purchasers to lock in the cost of their purchases at the day-ahead price of energy. Unlike a physical supplier—who supports this obligation with its ability to physically deliver energy in real-time—a virtual supplier supports its obligation by accepting financial exposure to paying the real-time price of energy. Thus, it is appropriate for both virtual and physical supply to be eligible to meet the bid-in demand for energy in the day-ahead market, as this is effectively demand for *financial certainty.*

Unlike the procurement of energy, however, the purpose of procuring day-ahead capacity and flexibility is not to provide *financial certainty,* but to ensure the *actual availability* in real-time of sufficient physical resources with the attributes necessary for the CAISO to reliably operate the grid.

The current day-ahead market already makes this distinction to perform its limited co-optimization of energy and Ancillary Services. Virtual supply offers can and do receive day-ahead energy awards. But virtual supply offers are not eligible to receive day-ahead awards for Spinning Reserve, Non-Spinning Reserve, Regulation Up or Regulation Down. In procuring these critical reserves on a day-ahead basis, the CAISO is not merely seeking to lock in the *price* of finding these resources in real-time; it is seeking to commit physical resources to actually provide these services, recognizing that it would not be prudent to count on these services being available entirely in the real-time market.

For a co-optimized market to function properly, it will also be necessary to distinguish between energy awards to virtual supply and energy awards to physical supply. Failure to do so can be expected to lead to a continuing need for systemic out-of-market procurement, and to inefficient and systemic profits to virtual supply strategies.

A co-optimized market will ensure that the total quantity of energy awards—from both virtual and physical supply—equals the total quantity of cleared bid-in energy demand. At the same time, the day-ahead market will seek to procure enough total capacity to meet the upper end of the range of CAISO's day-ahead forecast of what real-time conditions might be. "Capacity" in this context means the aggregate amount of physical supply that will be available in real-time, and consists of:

- Energy awards to physical resources (*i.e.,* "REN:EN" in the Straw Proposal); and
- Stand-alone capacity awards (*i.e.,* RCU).[1]

There is therefore an interdependence between (1) energy awards to virtual supply; and (2) the CAISO's need to procure RCU. More specifically, for a given quantity of bid-in demand for energy, each additional MW of energy awarded to virtual supply reduces the energy awarded to physical supply by a MW; and a 1 MW reduction in energy awards to physical supply requires a corresponding 1 MW increase in CAISO's procurement of RCU.

Stated differently, the quantity of RCU that CAISO needs to procure is not a number that can be known prior to the day-ahead market optimization. *Rather, it depends on CAISO's forecast of demand and the quantity of energy awards to physical supply.* This makes it necessary for the market design to distinguish between energy awards to virtual sellers and energy awards to physical suppliers. This is achieved by recognizing that an energy award to a physical resource reduces the need for CAISO to procure RCU, whereas an energy award to a virtual resource does not. Under the Straw Proposal, energy awards to physical resources are compensated at the sum of the energy shadow price and the price of RCU; energy awards to virtual resources are appropriately compensated the energy shadow price only.

Some stakeholders have opposed, or appear confused by, virtual sellers receiving different compensation than physical suppliers for energy awards. But consider what would occur if this were not the case. Importantly, recall that in the day-ahead market the CAISO needs to procure enough total physical capacity to meet the upper end of the

[1] This description reflects the Straw Proposal's "REN" constraint. As discussed in Section V.B of Appendix A, Powerex suggests that CAISO and stakeholder consider an alternative formulation that requires the sum of physical energy, RCU and IRU to equal or exceed the sum of CAISO's day-ahead forecast of demand plus CAISO's demand for IRU.

range of its forecast of real-time demand, which is subject to substantial uncertainty. This day-ahead uncertainty declines as each operating hour approaches, however. This implies that, in the large majority of hours, the physical capacity and flexibility needed to cover the range of potential grid conditions will also decline between the day-ahead and real-time market, in the large majority of cases. When the CAISO runs its real-time market, then, a substantial portion of the physical supply that was set aside to provide capacity or flexibility in the day-ahead market will no longer need to be set aside at all, and can be dispatched to provide energy to the extent its energy offer price is economic relative to other offers. In effect, ensuring reliability requires the CAISO to set aside physical supply from being used to provide day-ahead energy, but much of that set-aside supply will be "released" and able to provide energy in the real-time market in most hours. In the majority of hours, then, the compensation to physical resources that receive a day-ahead energy award will exceed the compensation for a real-time energy award.

If day-ahead energy awards to virtual sellers received the same compensation as energy awards to physical suppliers, virtual supply strategies would be persistently profitable. This would naturally lead to greater quantities of virtual supply clearing the day-ahead. But this would reduce the amount of physical supply that receives an energy award, and consequently require the CAISO to procure additional stand-alone physical capacity, either within the market (as RCU) or through out-of-market actions. Left unchecked, virtual traders would earn systemic profit from the inefficient market solution, and the CAISO may be forced to once again rely on out-of-market actions to procure sufficient physical supply.

The only way to break this inefficient feedback loop is to properly recognize that energy awards to physical supply meet two needs of the co-optimized market—the need to meet bid-in demand from purchasers, and the need for CAISO to procure physical capacity to meet its forecast of real-time demand—whereas energy awards to virtual supply meet only the first of these market needs. Given the difference in services provided, it is appropriate and necessary for compensation to differ as well.

IV. The Straw Proposal Is Sound, And Closer Examination Of CAISO's Example 2 And Example 4 Shows They Achieve The Correct Results

The CAISO has provided and discussed a range of hypothetical examples with stakeholders to illustrate how the Straw Proposal would work under different scenarios. Such examples are helpful, as they can reveal flaws in a proposed approach. They can also reveal instances in which the correct result is not intuitive at first glance. At the MSC meeting, two specific examples were presented by the CAISO as potentially raising concerns; some stakeholders have cited these examples as an indication that the Straw Proposal is inefficient. Powerex disagrees, and believes the closer examination that these examples produce the right outcomes in terms of minimizing total production costs and calculating prices that accurately reflect the incremental cost of serving demand.

CAISO's "Scenario 2" consists of 125 MW of bid-in demand at $21/MWh, and a CAISO forecast of 155 MW. The resulting LMP for energy is $21/MWh, with only 100 MW of the 125 MW of bid-in demand clearing the market. CAISO also procures 55 MW of stand-alone RCU, at a price of $2/MW. The CAISO presentation at the MSC meeting described this outcome as "load is exposed to a REN cost they can't avoid."

As an initial matter, it is evident that the solution in this example indeed maximizes social welfare (*i.e.,* the bid-in value of cleared demand net of the bid-in production cost of cleared awards). Resource 1 is awarded its maximum quantity (100 MW), and the bid in cost of all other resources exceeds the maximum price that bid-in demand is willing to pay.

It is also evident that, to ensure reliability, the solution procures 55 MW of RCU (from Resource 3) at a clearing price of $2/MW. This ensures that the combination of the energy award to Resource 1 plus the RCU award to Resource 3 is equal to the CAISO's day-ahead load forecast, thus ensuring CAISO has sufficient physical capacity available in real-time to meet anticipated demand.

The concerns regarding this example are therefore related to the compensation that is paid to Resource 1, which meets two distinct needs in the day-ahead market: it meets the load's bid-in demand for energy, and it meets the CAISO's demand for sufficient capacity to meet forecast demand. Importantly, the cost of this latter service is *not* a cost associated with the quantity of bid-in demand. The CAISO must ensure sufficient capacity is available to ensure reliability, regardless of how much energy loads elect to purchase in the day-ahead market. That is, even if load had not bid to purchase *any* day-ahead energy whatsoever, the day-ahead market would still have procured 155 MW of upward capacity to satisfy its reliability needs (and at greater cost). Indeed, what this example shows is the significant savings that can be realized by a market that co-optimizes these multiple needs.

CAISO's "Scenario 4" also consists of bid-in demand of 125 MW at $21/MWh, but in this scenario the CAISO's forecast is 75 MW. The LMP for "EN" is $21/MWh, and the LMP for "REN" is $-1/MW. The CAISO's presentation at the MSC meeting states that, in this example, "load is prevented from procuring its desired day-ahead energy position."

The result of this example may appear, at first glance, to be incorrect. After all, load is willing to pay $21/MWh, and there is a resource willing to sell up to 100 MW of energy at a price of $20/MWh. Why, then, does this example only clear 75 MW of energy awards? Closer examination of this example shows that this is precisely the correct outcome when considering the need for CAISO to ensure sufficient downward capacity to maintain reliability. More specifically, each MW of additional *physical* energy awards cleared in the day-ahead market would also require CAISO to procure an additional MW of RCD in order the ensure that, in real-time, the CAISO has sufficient downward capacity to respond to the potential over-supply conditions *resulting* from the additional physical energy awards.

These relationships can be observed by considering what would happen if the quantity of energy awarded to Resource 1 increased from 75 MW to 76 MW. First, the energy production cost of Resource 1 would increase by $20 (its offer price for energy). But this would result in REN being greater than the CAISO's load forecast, which in turn requires the market to procure 1 MW of RCD. In this scenario, RCD would be procured from Resource 1 at a cost of $5/MWh. Taken together, total production costs would increase by $25 in order to clear 76 MW of bid-in demand rather than 75 MW. This additional total cost exceeds the value of clearing that additional MW, however, as reflected in the bid price of $21/MWh. Contrary to initial impressions, Scenario 4 properly recognizes that the cost of clearing additional bid-in demand with physical supply requires procuring additional stand-alone downward capacity to satisfy the CAISO's reliability objectives. That is precisely what a co-optimized market is designed to do.

Powerex notes that, as discussed at the MSC meeting, the assumptions in this example are highly unrealistic. For instance, the scenario consists only of physical resources; if the example included offers of virtual supply, then additional bid-in demand could clear the market against additional virtual supply without requiring CAISO to procure RCD. Moreover, the scenario assumes that RCD is relatively costly; but the CAISO grid does not generally face challenges related to insufficient downward capacity (although it does experience challenges from insufficient downward *flexibility*). Eliminating the RCD product, and rewriting the REN constraint to be an upward capacity constraint, as Powerex suggests could be considered, would also produce a more intuitive result in this scenario.

V. Potential Enhancements To Address Concerns Raised

Based on the stakeholder discussions to date, and the comments at the MSC meeting, Powerex believes it may be worth considering potential refinements to the Straw Proposal. The proposed refinements below are preliminary, and require thorough vetting and examination by stakeholders and by CAISO. However, they appear at least in concept to have the potential to address issues that have been raised, or to augment the potential efficiency benefits of the proposed co-optimized day-ahead market contemplated by the Straw Proposal.

A. Proposed Enhancements To Address MSC's Concerns Over Implicit Virtual Bidding

The CAISO market design, as well as FERC policy, seeks to enable explicit virtual bids and offers to promote greater efficiency in its markets. At the same time, both CAISO and FERC policy seeks to discourage or prohibit "implicit virtual bidding." Powerex agrees with the concern expressed by the MSC that the Straw Proposal may create incentives for parties to engage in implicit virtual bidding, given the additional capacity compensation that would be available to physical supply resources but not available to virtual supply. Powerex supports exploring potential refinements that would discourage or prevent implicit virtual bidding under the Straw Proposal.

Powerex believes that the current market rules point to potential options to curb implicit virtual bidding. For example, there are current settlement provisions that reverse any positive net revenues for day-ahead imports that are reduced in the real-time market but do not submit an e-Tag (*i.e.,* an indication that the day-ahead award may not have reflected physical supply in the first instance, and hence represents an implicit virtual supply transaction). There are also clawback provisions that reverse revenues to holders of Congestion Revenue Rights ("CRRs") that are deemed to be engaged in implicit virtual bidding.

The CRR clawback rule, in particular, may offer a useful framework for distinguishing between (1) genuine physical day-ahead supply that is reduced in real-time simply because the CAISO grid no longer needs that supply; as opposed to (2) a day-ahead award that the seller "forced" to be reduced because the supply was not actually physical. Specifically, the CRR clawback rule is *not* triggered if a day-ahead energy award is reduced in real-time pursuant to a real-time DEC bid at a price that does not exceed the day-ahead market clearing price. A real-time DEC bid at or below the day-ahead price is effectively regarded as being willing and able to physically deliver unless the value of energy in the CAISO grid declines in real-time relative to the day-ahead market.

Powerex suggests that a similar price-based threshold be considered in the Straw Proposal to identify day-ahead physical energy awards that may indicate implicit virtual supply. Real-time reductions to day-ahead physical energy awards that fail the price-based threshold could trigger a settlement rule that reverses any day-ahead capacity compensation. In this manner, the net financial settlement for the schedule would be the same as for an explicit virtual bid.

This same concept could also be extended to reverse day-ahead capacity-related compensation for physical energy awards or stand-alone capacity awards that fail to perform (*e.g.,* do not submit a day-ahead e-Tag consistent with the award quantity, or curtail the e-Tag inside the operating hour).

B. Proposed Alternative To REN Constraint To Achieve Greater Efficiency And Address Concerns Raised

Powerex suggests consideration of two potential modifications to the Straw Proposal's formulation of the REN constraint.

First, Powerex suggests considering elimination—or at least deferral of the implementation—of the requirement to procure RCD to the extent REN exceeds the CAISO's day-ahead forecast of demand. It is Powerex's understanding that the CAISO grid does not currently experience material or frequent challenges due to an inability to reduce generation output in real time. Powerex notes that the CAISO grid *does* experience material and frequent challenges due to a lack of downward flexibility, due to the speed with which net demand declines, but it does not generally face challenges due to the minimum level of net demand. In general, the CAISO has sufficient real-time economic offers to reduce output within its BAA, as well as the ability to export energy to other areas in real-time through the EIM, to make advance procurement of downward capacity unnecessary at this time. Eliminating or deferring the RCD product would enable both physical and virtual supply to meet bid-in demand at levels that exceed the CAISO's day-ahead forecast of demand, obviating some of the misplaced concerns regarding CAISO's "Scenario 4" example.

Second, Powerex suggests re-stating the Straw Proposal's relationship between REN, RCU, and IRU. It is Powerex's understanding that the Straw Proposal envisions two distinct constraints regarding physical supply:

- IRU is procured based on the 97.5 percentile of net load imbalance; and
- RCU is procured for the positive difference, if any, between the CAISO's day-ahead forecast of demand and energy awards to physical resources.

A result of defining these as two separate constraints is the lack of any substitutability of IRU for RCU, even if it is available at lower bid-in cost.

Powerex suggests that it may be possible and more efficient to achieve the Straw Proposal's intended outcomes by re-writing the reliability energy constraint as a total upward capacity constraint, as follows:

IRU >= IRU demand; and

REN:EN + RCU + IRU >= CAISO's forecast demand (p50) + IRU demand

The quantity of IRU procured continues to be required to be *at least* equal to CAISO's IRU demand, like under the Straw Proposal. But additional IRU could also be procured to meet the total upward capacity constraint if this led to lower total production cost. This is analogous to the "rational buyer" approach for CAISO's procurement of Ancillary Services, where a higher-quality service can be procured instead of a lower-quality service that has higher bid-in production cost.

The suggested formulation would yield three shadow prices:

- The energy power balance constraint shadow price (as under the Straw proposal);
- A flexibility shadow price, related to the IRU constraint; and
- An upward capacity shadow price.

Importantly, the upward capacity shadow price would be paid on all physical awards, including physical energy awards, stand-alone RCU, and stand-alone IRU. Additionally, resources that are awarded IRU will also receive the flexibility shadow price. The total compensation received by a resource awarded IRU is the same as under the Straw Proposal, but it is decomposed into an upward capacity component and a flexibility component.

The table below summarizes the shadow prices applicable to each day-ahead product:

Product	Shadow Price(s) Received
Energy (virtual)	Energy power balance constraint
Energy (physical)	Energy power balance constraint; Upward capacity constraint
Stand-alone RCU	Upward capacity constraint
Stand-alone IRU	Upward capacity constraint; Flexibility constraint

C. Potential Modifications To Address California LSEs' Concerns Over Double-Compensation Of RA Resources

It is not clear that the potential impact on existing RA contracts presents a compelling reason to change or reject the Straw Proposal and its proposed compensation for physical capacity. Nevertheless, Powerex recognizes that even transitional challenges can create inequities, or at least undermine support for otherwise beneficial changes to market rules. Powerex also believes that, since some form of transitional arrangements may be pursued in any event, it would be preferable ensure such arrangements do not work at cross purposes with the intended market design enhancements.

For instance, some stakeholders appear to have suggested that RA resources should be required to offer RCU at $0/MW, or that RA resources would need to assign any capacity-related compensation to the LSEs with which the resource has an RA contract. A significant concern with these approaches is that they may weaken or eliminate incentives for resources to submit offers that reflect the marginal cost of the resource, undermining the ability of any market optimization to maximize social welfare. Forcing RA resources to offer to provide capacity at $0/MW deprives the market of any meaningful basis for deciding which resources clear the market. Similarly, eliminating any compensation (*i.e.,* by requiring the assignment of any associated revenue) may encourage an RA resource to offer capacity at very high prices in order to avoid market awards that cause it to incur a marginal opportunity cost.

Powerex believes it may be beneficial to explore other mechanisms to reflect any forward obligations of resources to be available in the day-ahead and real-time markets, and do so in a manner that retains the incentives to submit offer prices that reflect a resource's marginal opportunity cost. One possible approach could be to reflect a resource's forward obligation to be available in the day-ahead and real-time markets as a *liability for paying* the upward capacity constraint shadow price. That is, an RA resource is recognized as being "short" the capacity price. From this starting point, both RA and non-RA resources would be eligible to receive the capacity price for any physical supply awards they receive (*i.e.,* physical energy, RCU, or IRU). This approach provides incremental compensation for all physical resources that receive day-ahead market awards, and therefore retains the desirable incentives to submit offers that reflect each resource's willingness to receive such market awards.

The settlement outcomes for RA resources can be seen under three possible scenarios:

1. If an RA resource is <u>not</u> available, then it will not receive any market awards or market compensation for capacity. The RA resource is exposed to the upward capacity shadow price, which appropriately funds the procurement of capacity from a different resource.

2. If an RA resource is available and is awarded physical supply, either as physical energy, RCU, or IRU, then it will be net neutral with respect to settlement of the upward capacity shadow price. This appropriately reflects that the resource entered into a forward obligation to make its physical supply available in the day-ahead and real-time market, and it fulfilled that obligation. All compensation to the resource for being available is derived from the RA contract.
3. If an RA resource is available but is not economic to be committed for capacity on day-ahead basis, and thus does not receive any physical supply award, then it will pay the upward capacity shadow price. Importantly, however, the upward capacity shadow price will be less than the resource's economic offer price for capacity (*i.e.*, RCU). This implies that the resource is financially better off paying to have a different resource provide capacity than if it provided the capacity itself and incurred its marginal opportunity cost to do so.

This approach appears to provide a way to recognize the existing forward obligations of resources under an RA contract to provide capacity—which appears to address any potential concerns by California LSEs—but does so in a way that preserves appropriate marginal incentives for economic participation. In addition, this approach appears to have at least one other beneficial attribute: it minimizes or perhaps eliminates concerns regarding the potential to exercise market power in meeting the upward capacity constraint. The entire RA fleet effectively enters the day-ahead market with exposure to paying the upward capacity shadow price; any attempt to raise this shadow price by reducing physical supply would only serve to increase to cost faced by the resources that do not receive a market award. In addition, RA resources would also face competition from non-RA resources that are offered into the market. It is difficult to identify a scenario that raises potential market power concerns regarding the upward capacity constraint, provided there are no aggregate deficiencies in RA procurement. (And in that event, the appropriate solution is to address the deficiency directly through additional procurement of RA.)

Further examination by the CAISO, MSC and stakeholders of this potential approach will be necessary to evaluate whether it is workable and beneficial. Among other issues, it may be helpful to consider the following questions:

1. Should exposure to the upward capacity shadow price by RA resources be included in the calculation of daily bid-cost recovery?
2. How should the CAISO address hours where less capacity needs to be committed than available from RA resources? (*e.g.,* Award additional RCU anyway? Redistribute surplus revenue from collecting upward capacity shadow price revenue from all RA resources back uniformly to RA resources? Apply a reduction

to the MW quantity that each RA resource is charged the upward capacity shadow price?)