Exhibit No.: _____
Commissioner: Dian Grueneich
Administrative Law Judge: Charlotte TerKeurst
Witness: Christopher McLean

BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

In the Matter of the Application of Southern California Edison Company (U 338-E) for a Certificate of Public Convenience and Necessity Concerning the Devers-Palo Verde No. 2 Transmission Line Project.	Application 05-04-015 (Filed April 11, 2005)
Order Instituting Investigation on the Commission's Own Motion into Methodology for Economic Assessment of Transmission Projects.	Investigation 05-06-041 (Filed June 30, 2005)

SUPPLEMENTAL DIRECT TESTIMONY ON BEHALF OF THE CALIFORNIA INDEPENDENT SYSTEM OPERATOR

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November 22, 2005

BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

In the Matter of the Application of Southern California Edison Company (U 338-E) for a Certificate of Public Convenience and Necessity Concerning the Devers-Palo Verde No. 2 Transmission Line Project.	Application 05-04-015 (Filed April 11, 2005)
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SUPPLEMENTAL DIRECT TESTIMONY ON BEHALF OF THE CALIFORNIA INDEPENDENT SYSTEM OPERATOR

I. SUPPORTING WITNESS

My name is Christopher McLean. I am the same Christopher McLean who was listed as a sponsoring witness on behalf of the California Independent System Operator ("CA ISO") in its Opening Testimony, served on October 21, 2005, in the above-referenced dockets. My qualifications are set forth in attachment 14 to the Opening Testimony.

II. TESTIMONY OVERVIEW

The purpose of my testimony is to 1) address specific issues identified in the "Administrative Law Judge's Ruling Addressing Phase I Testimony and Evidentiary Hearings" ("ALJ Ruling"); 2) authenticate a document previously submitted by the CAISO relating to its Transmission Economic Assessment Methodology ("TEAM"); and 3) include for the record additional information submitted by the CAISO in the context of commenting on the Commission's sponsored September 14-15 workshops that addressed a framework for assessing the economics of transmission projects.

Specifically, with regard to the first category, my testimony will discuss:

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- Whether and, if so, how the recent increases in natural gas prices may affect the economics of the Devers-Palo Verde No. 2 ("DPV2") project.
- How the use of DPV2 to import electricity delivered from proposed transmission lines from Wyoming to northern Arizona would affect the economics of DPV2?
- Discount rates, including the appropriateness of using a social discount rate and, if the Commission uses a social discount rate in analyzing the DPV2 project, what that discount rate should be.

With regard to the second category, as noted above, the CAISO participated in workshops sponsored by the Commission to discuss the CAISO's TEAM approach on September 14-15, 2005. As part of that workshop, the CAISO prepared a document entitled "CAISO Standards for Transmission Economic Assessment Methodology (TEAM) Application." A true and correct copy of that document is attached hereto as Attachment 15.[1]

Further, in response to the request of the presiding Administrative Law Judge ("ALJ") that parties comment on the workshops, the CAISO submitted reply comments that further attempted to advance consideration of the appropriate principles or framework underlying the economic assessment of transmission projects. That document included:

- An evaluation matrix for project comparison.
- Acceptable methodology to be used in performing the evaluation measurements.
- Determine threshold values for the matrix that would indicate an acceptable project.

The above three items define how one: (a) evaluates a proposed project; (b) performs the study; and, (c) determines if the project should be recommended. Given that the ALJ Ruling indicated that information distributed as part of the workshop process are not part of the evidentiary record, my testimony repeats the substance of the prior reply comments.

[1] Attachments 1 through 14 were made part of the CAISO's Opening Testimony served on October 21, 2005.

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III. GAS PRICE IMPACT

Changes in the price of natural gas can have a significant impact on the economic viability of the proposed DPV2 transmission upgrade. The following factors regarding natural gas price changes are important to consider, since they can impact the overall DPV2 benefits: (1) Gas Price Differential; (2) Heat Rate Differential; and (3) Increased Coal Generation.

Gas Price Differential -- One of the major drivers in the economic analysis of DPV2 is the difference in gas prices assumed for California as compared to Arizona. In the CAISO study submitted as part of the October 21, 2005 direct testimony, the CAISO assumed that gas prices in California were $0.37/mmbtu (2008$) higher than those in Arizona due primarily to additional transportation charges. Arizona is physically closer to the natural gas production basins that serve the western United States. California gas transportation rates are approved by the Commission. Thus, an increase in the commodity cost of gas may or may not change the differential. However, if the transportation charge is impacted by the commodity cost, or if California's commodity price diverges from Arizona, the differential could increase. A substantial increase in the gas price differential could significantly increase the economic benefits of DPV2.

Heat Rate Differential – The savings to California consumers due to more efficient combined cycle generation in Arizona displacing less efficient, older gas-fired generation in Southern California would increase with an increase in gas prices. For example, the savings in total gas usage for 2008 due to the addition of PVD2 is estimated by the CAISO to be about 6,400,000 mmbtu/year.[2] For every $1/mmbtu increase in gas price over the gas price assumed for 2008,[3] the economic benefits would increase by approximately $6.4 million in 2008 $.

Increased Coal Generation – Increases in natural gas prices may increase the amount of coal generation in the future in potentially three ways. First, coal plants that are not fully

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[2] PVD2 – Final and Other Appendices, Feb. 15, 2005, Table R.2, "Forecast of Emission and Fuel Benefits By Plant", 0. 68/68.

[3] The CAISO gas price assumptions for 2008 are $5.08/mmbtu for Southern California and $4.71 for Arizona.

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dispatched may increase their level of generation when coal generation becomes less expensive compared to gas-fired generation. Second, some coal plants that are currently scheduled for retirement (e.g. Mohave) may be refurbished and operated due to their increased value in the face of higher gas prices. And third, investment in new (traditional or clean) coal generation may occur due to the increased economic and risk benefits of coal generation. Since future coal plants are expected to be built outside of California, the impact would be to increase supplies and lower the price of exports from the Southwest to California. Therefore, in this context, additional coal-fired generation from existing, refurbished, or new plants would be expected to increase the economic benefits attributable to DPV2.

In summary, a significant increase in the price of natural gas is likely to increase, and potentially substantially, the economic viability of DPV2. For example, in the CAISO DPV2 study, a 105 percent increase in Southern California gas prices in 2008 caused a 150 percent increase in DPV2 benefits.[4] This is a comparison of CAISO Ratepayer Benefits (LMP Only) for the expected and high gas cases. In this example, the differential of $0.37 is maintained for both the base and high case (instead of increasing as a function of gas prices).

From the CAISO study results, it appears that the change in DPV2 benefits is relatively linear with changes in the underlying gas price (assuming that the differential is constant). Of all the variables analyzed in the CAISO study, the DPV2 benefits appeared to be most sensitive to changes in gas price assumptions. Reduction in gas prices would be expected to have a similar impact on reducing DPV2 economic benefits.

IV. WYOMING POWER IMPACT

Irrespective of the fuel source, increased imports into Arizona would be expected to increase the supply of power, and lower the market price of supplies available to California. This would

[4] Comparison of 2008 BBBN (Case #1, CAISO Ratepayer Benefits, LMP Only, $19.8 million) to 2008 BHBN (Case #4, CAISO Ratepayer Benefits, LMP Only, $48.8 million). See, DPV2 Board Report, Table VII.3 "Summary of Cases to Determine Energy Benefit for PVD2." Southern California gas prices in 2008 for the base and high case were assumed to be $5.08/mmbtu and $10.40/mmbtu, respectively.

translate into an increase of benefits attributable to the DPV2 upgrade.

Depending on California's ability to access and import this additional Wyoming power, the impact could be significant. As a point of reference, the increase in DPV2 benefits when the 1,580 MW coal-fired Mohave Generating Station is refurbished (and not retired), is about $12 million or a 22 percent increase.[5]

V. SOCIAL DISCOUNT RATE

The CAISO believes that the appropriate discount rate to use for the economic evaluation of capital projects is the actual weighted cost-of-capital and not a social discount rate. Using the social discount rate for the "public-good" project,[6] and the weighted cost-of-capital for the "non-public-good project" results in flawed economic analyses, poor decision-making, and an abandonment of the principles of integrated resource planning.

For example, assume a utility was evaluating two generating projects. One project is considered a "public-good" project and the other project is not. Both projects are capital intensive, and for purposes of this illustration, do not have any significant operating or fuel costs. The public-good project has a capital cost of $100 million. The non-public-good project has a capital cost of $40 million. Assume that the economic benefits of both projects are identical and are $10 million per year in real terms for a 20-year economic life. The present value of the economic benefits of the public-good project is $150 million (i.e. benefits are discounted at a social discount rate of 3 percent). The present value of the economic benefits for the non-public good project is $85 million (i.e. benefits are discounted at a weighted cost of capital of 10 percent.

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[5] PVD2 Board Report, Table VII.3 "Summary of Cases to Determine Energy Benefit for PVD2", Case 54, CAISO Ratepayer Benefit (LMP Only).

[6] A public good is defined as a good for which it is impractical to make users pay individually and difficult to exclude non-payers.

The economic conclusions using this approach can be summarized in the table below:

Project	"Public Good"	"Non-Public Good"	Difference
PV -- capital costs	$100	$40	$60
PV -- benefits	$150	$85	$65
NPV -- net benefits	$50	$45	$5

The public-good project would be selected since the net present value ("NPV") is greater for this project. However, this analytical approach results in a ratepayer subsidy of $60 million. Since the actual cost of capital does not change for either alternative, the ratepayers would pay $60 million more for the public-good project. Simply put, the social discount rate distorts the decision.

The better approach is to compare all resource alternatives on a common basis (with a standard resource evaluation matrix), and make decisions based on this framework where all factors can be considered directly, instead of masking the decision-making process with a social discount rate.

VI. FRAMEWORK PRINCIPLES FOR ECONOMIC ASSESSMENT

The CAISO believes that the following principles for economic assessment of transmission projects should apply prospectively in terms of being a requirement for proponents of projects under Commission jurisdiction. While the CAISO applied these principles in determining that the DPV2 project was economic, the CAISO does not believe it is appropriate to require Southern California Edison ("SCE") to revise its submission on DPV2 to the extent it is deemed to deviate from the principles articulated below. DPV2 should be assessed on its own evidence, whether submitted by SCE or the CAISO.

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A. Evaluation Matrix for Project Comparison

At the end of the September 15th workshop, the CAISO proposed a "Strawman for Discussion on Evaluation Matrix." This matrix was composed of the Benefit-Cost-Ratio ("BCR") for several perspectives, benefit and cost risks, and non-monetized considerations.

Although a consensus was not reached on the applicable threshold values, there appeared to be agreement that a transparent and standard evaluation matrix would be valuable. The CAISO recommended, and continues to recommend, the following evaluation matrix for consideration by the Commission and respective stakeholders.

- Benefit-Cost-Ratio (lifecycle)
  - WECC
  - CAISO Modified Ratepayer
  - CAISO Nominal Ratepayer
  - CAISO Modified Participant
- Risks -- Benefits
  - Insurance Value Indicator – top 5 percent probability-weighted-average from the resulting probability distribution function (pdf)
  - Worst Case Indicator – bottom 5 percent probability-weighted-average from the resulting probability distribution function (pdf)
  - Tornado diagram (or similar graphical summary) – estimate 5-10 most sensitive assumptions and show base value, project break-even, and sensitivity of results to a range of input values[7]
- Risks -- Costs
  - Indicate range of probable project costs at the time of the economic analysis (i.e. plus 50%, minus 20%).
- Non-Monetized Considerations
  - Yet to be defined. May include increased access to renewables, non-monetized environmental values, additional reliability considerations, etc.

[7] The Tornado diagram includes the information contained in a "tipping point" analysis. The Tornado diagram shows the break-even point – in other words, at what point do the results start "tipping" in the opposite, or uneconomical, direction. The disadvantage of using only the tipping point analysis is that it shows only the downside potential and not the upside. The Tornado diagram provides information in both directions. For an example of a Tornado diagram, please refer to Figure ES.2 in the TEAM Report. (Attachment 1 to CAISO Opening Testimony.) The CAISO is proposing that this type of diagram be modified to include the break-even point.

The evaluation matrix would be the key tool for summarizing and analyzing alternative projects including non-transmission alternatives.

B. Proposed Principles for Study Requirements

As noted by the CAISO at the workshops, different study requirements are likely appropriate depending on the characteristics of the proposed project studied. The CAISO suggests that it would be prudent to have several categories of transmission projects based on estimated capital cost, number of utilities impacted, and other agreed-upon criteria. The CAISO has not currently had the opportunity to fully develop these categories and their suggested parameters and continues to believe that additional workshops, rather than evidentiary hearings constitute the more appropriate mechanism to further develop the categories. However, the concept is that the larger a proposed transmission project is in terms of cost and utility impact, the more rigorous the study methodology will need to be.

The following proposed methodology is intended for projects costing several hundred million dollars or more, and having a significant impact on at least several major utilities -- in other words, the category of projects requiring the full study methodology. Compromises to this methodology can be considered after this category and the associated methodology for the category is complete.

C. Input Assumptions

The CAISO recognizes that the results of any agreed-upon methodology can differ depending on the input assumptions. In an attempt to standardize the input assumptions, and help alleviate the concern regarding different conclusions using the same methodology, the CAISO provides the following assumption protocol for consideration:

- Start with latest release of SSG-WI data.
- Update SSG-WI data with most recent California Energy Commission Integrated Energy Planning Report ("IEPR") data.[8]
- Add environmental externalities as appropriate.[9]

[8] Resource plans reviewed and compiled by the California Energy Commission as part of the IEPR process.

[9] Externalities for CO2, NOx, Sox, and other airborne emissions can be considered as part of this docket. However, the CAISO again reiterates that the workshop process is a more appropriate procedural mechanism to address this issue.

- Develop generator-bidding strategies consistent with the TEAM or superior approach.

- Use SSG-WI data for the hydro uncertainty (as available). The SSG-WI data would form the basis of, at least, one cost-based reference case for comparability purposes. The proponent could then develop other variable distributions consistent with TEAM or superior approach.

- Determine sensitivity cases and associated probabilities consistent with TEAM or superior approach.

D. Study Methodology

The CAISO proposed methodology was presented at the September 14-15 workshops. This proposed methodology, with some modifications, is summarized in Table 1 below.

CAISO Proposed Methodology Guidelines

	Key Principle	Study Attribute	Notes
1	Benefit Framework	- Demonstrate benefit identify	Total benefits = ΔPC = ΔCS + ΔGS + ΔTS
		- Demonstrate revenue identify	CTL - GR = TR
		- Compute participant benefits	WECC subregions, CAISO market participants, non-CAISO participants, sum equal to societal
2	Network Representation	- DC-OPF model with nodal pricing	AC power flow optional, transportation model unacceptable
3	Market Prices	- Inclusion of credible bid strategies	Bid strategies must be theoretically sound and reflect system operating reserves and pivotal ownership on an hourly basis
4	Uncertainty	- Develop expected value and 30-year NPV probability distribution function	Recommend inclusion of a Tornado Diagram with break-even information for most sensitive assumptions.
5	Resource Alternatives	- Identify, consider, and discuss resource alternative(s)	Alternatives include specific resource types and portfolios
	Other Requirements	- Operating, capacity, system loss, environmental, insurance, and other benefits	Benefits in addition to energy need to be identified and quantitatively considered as appropriate and feasible
		- Multiple years	Minimum of two study years, 5 or more years apart. Additional successive years are discouraged.
		- Chronology	Minimum of 168 chronological hours per week, 12 weeks per year, preference is 8760 hours per year.

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VII. THRESHOLD VALUES FOR EVALUATION MATRIX

Potential threshold values for the evaluation matrix were discussed at the September 15th workshop. There was some disagreement regarding whether "threshold values" or "minimum requirements" should be developed. The CAISO has not developed such threshold values or minimum requirements at this time. The CAISO believes such development should take place in a collaborative workshop environment, rather than through testimony. However, the CAISO notes that the most difficult criterion to define is the "non-monetized considerations." On one hand, this criterion does not currently lend itself to a measurable index. Indeed, some may maintain that the measurement for this consideration must remain flexible, so it can act as a "catch all" for important parameters and considerations that are not reflected in the more traditional BCR or risk indices. On the other side, some may contend that a lack of a standard measurement and associated index undermines the transparency of the overall process and is therefore undesirable. While the CAISO does not believe that many of the foregoing issues constitute "issues of fact," as identified by the ALJ Ruling, it includes the foregoing discussion out of an abundance of caution.

That concludes my testimony.

ATTACHMENT 15

Supplemental Testimony on behalf of the California Independent System Operator Corporation

November 22, 2005

CAISO Standards for Transmission Economic Assessment Methodology (TEAM) Application

I. Introduction

This document provides a preliminary foundation to begin addressing the issues raised in Investigation (I.) 05-06-041, as clarified in the "Scoping Memo and Assigned Commission Ruling," dated August 26, 2005. The Scoping Memo described the issues as:

- What general principles or methodologies should be employed in assessing the economic benefits of transmission projects within the Commission's jurisdiction?
- Is the CAISO's TEAM approach a reasonable methodology for assessing the economic benefits of transmission projects?
- What validation is needed by the Commission in order to rely on a CAISO assessment of need in a Commission certification proceeding for a transmission project proposed for its economic benefits?
- If the Commission determines in a certification proceeding for a transmission project proposed for its economic benefits that a CAISO assessment of need has been adequately validated, are there additional requirements that must be met in the Commission's determination of economic benefits and need for the project?
- For those certification proceedings for transmission projects proposed for economic benefits where there is no validated CAISO assessment of need, what requirements should the Commission adopt for consideration of economic benefits and need?

In particular, the CAISO sets forth the basic principles or elements of the CAISO's Transmission Economic Assessment Methodology (TEAM) approach and places these elements on a continuum from mandatory to permissive. As noted during the recent prehearing conference in this proceeding, the CAISO endeavored to prescribe TEAM at its lowest level of detail. However, in developing this document, the CAISO determined that an overly prescriptive

application of TEAM is unlikely to be beneficial or practical. TEAM represents the best synthesis of recent advances in applying dynamic bidding strategies in a network model and in developing a consistent benefits methodology. Nevertheless, the implementation and application of TEAM is not, and should not be, static. Rather, TEAM's implementation should reflect an evolutionary process that allows professional engineers and economists the flexibility to pursue creative refinements in various study areas. Accordingly, in order to avoid stifling the critical judgment of transmission planners, the CAISO has defined the fundamental TEAM elements as a reasonably broad set of core principles.

There are two consequences of defining TEAM as broad principles. First, this document does not attempt to repackage or distill TEAM from an explanatory standpoint. The CAISO has explained the application of TEAM in detail in its *Transmission Economic Assessment Methodology* Report submitted in June 2004 to the Commission in I.00-11-001 ("TEAM Report") and in its *Economic Evaluation of the Palo Verde-Devers Line No. 2* Report and accompanying technical appendices.[1] Attempting to condense these documents is likely to create significant confusion without enhancing participants' understanding of TEAM. These documents will continue to form the basis of the CAISO's workshop discussion, including a description of how the principles were applied to Palo Verde-Devers No. 2 ("PVD2"). However, the detailed descriptions and

[1] The TEAM Report evaluated Path 26. (See CAISO website: http://www.caiso.com/docs/2003/03/18/2003031815303519270.html.) The TEAM PVD2 Report is also on the CAISO's website at http://www2.caiso.com/docs/2005/01/19/2005011914572217739.html.

justifications contained in those documents regarding the underlying theories and formulas utilized in TEAM will not be duplicated here.

Second, and directly related to the issues in this proceeding, a correlation exists between the level of prescription in defining the elements of TEAM and the nature and ability of the Commission to "validate" application of those elements in order to rely on an CAISO assessment of need. For example, if the Commission believes its authority or ability to defer to an CAISO's need assessment is somehow contingent on an ability to validate a recipe-like application of TEAM, the present approach would need to be modified to support this outcome. Whether or not such a limitation exists, the CAISO nevertheless believes that the present investigation and the CAISO's submission have value in facilitating the transmission siting process. As noted, TEAM constitutes the most complete and well-developed framework available to evaluate the economics of proposed transmission upgrades. It provides a consistent methodology to identify benefits, incorporates a process to reflect the impact of bids on market prices, and integrates decisions regarding generation and transmission investment. Standardization between the Commission and CAISO with respect to these broad requirements of future transmission evaluation studies will significantly assist regulatory decision-making and therefore enhance the efficiency of the regulatory review process for economic transmission upgrades in a restructured electricity environment.

In order to describe the fundamental elements of TEAM, this document organized as follows:

Section II – Applicability of TEAM
Section III - Description of Requirements Continuum
Section IV - Description of TEAM Key Principles
Section V – Summary of Standards

II. Applicability of TEAM

The CAISO recognizes and strongly supports the concept that the economic analysis regarding potential transmission projects represents only one of the many criteria that stakeholders must consider when investing in the future transmission infrastructure of California. Other important considerations that may not be fully considered in the current TEAM approach include:

- Project siting, schedule and cost risk
- Public acceptance
- Difficult-to-quantify environmental impacts (e.g. water, aesthetic)
- Difficult-to-quantify contingencies or extreme events (e.g. new market paradigms, terrorist acts)
- Support of state resource policy goals (e.g. renewables, distributed generation)
- Enhancing operational flexibility
- Secondary reliability benefits

The economic analysis, however, remains a critical part of any transmission evaluation and is the focus on the CAISO's TEAM application. As noted, the CAISO demonstrated the methodology proposed in TEAM for two separate studies – Path 26 and PVD2. Each of these studies demonstrated the TEAM methodology and required significant CAISO resource commitment in order to implement and complete. Stakeholders in these studies occasionally expressed the following questions regarding the application of TEAM:

- Is a particular application included in the CAISO's r Path 26 and PVD2 studies a minimum (or mandatory) study requirement for an CAISO-acceptable evaluation of a potential transmission project?

- Are there other types of transmission feasibility studies that may not require the same depth of analysis for a reasonable conclusion?

The CAISO suggests that it is practical to develop standards for an acceptable economic evaluation depending on the category of study. For that purpose, CAISO suggests that the TEAM principles are necessary in some form for the following types of studies:

- ***Reliability Projects –*** Reliability projects are considered primarily for the reliability benefits they provide, and are evaluated on a "least-cost" basis. The least-cost portion not only includes all associated project and operating costs, but also includes the economic benefits that may be associated with a selected upgrade. For example, two alternatives may satisfy the same reliability need and have identical costs, but if one allows for lower system losses, or a different generation commitment, these impacts need to be economically evaluated and included the in the "net least cost" calculation.

- ***Economic Projects (Inter-Regional) –*** Economic projects are considered primarily for the economic benefits (e.g., reduction in system operating costs) that they provide, and are evaluated on a "net present value" basis. These economic projects can be further subdivided into large, inter-regional projects, and smaller intra-regional projects. The two studies that the CAISO performed (Path 26 and PVD2) would be considered as large, inter-regional projects evaluated primarily on the basis of their economic benefits. The level of analysis required for this type of project is generally more substantial than the other two categories of studies.

- ***Economic Projects (Intra-Regional) –*** Projects that impact primarily a single region or utility may require a less rigorous economic analysis. These projects might include utility-level upgrades and intra-regional projects, such as the proposed San Francisco trans-bay cable alternative.

III. Description of Requirements Continuum

Since the study requirements for the Inter-Regional Economic Projects are the most rigorous, those specifications will be outlined first. The other two categories will then be compared to the inter-Regional Economic Project requirements.

These requirements will be described by key principle. The following terms will be used in describing the analytical tasks or data / software capabilities for a study:

- ***Requirement –*** CAISO considers this as a minimum threshold for an acceptable study. If there are exceptions to this requirement, they will be clarified with a footnote.
- ***Recommended –*** CAISO strongly recommends that that this element be included, but stops short of making it required at this time.
- ***Preferred –*** CAISO strongly encourages this feature be part of the study, but recognizes that there may need to be additional research in this area for this feature to be practically implemented
- ***Optional –*** CAISO does not currently have a strong preference for this study element either primarily due to the difficulty in implementing it or a perceived lack of value.
- ***Unacceptable –*** CAISO will not accept studies with this attribute

IV. Description of TEAM Key Principles

The TEAM methodology is built around five key principles that are summarized below:

	Key Principle	Description
1	Benefit Framework	Methodology for calculating project benefits.
2	Network Representation	Use of physical transmission model capable of forecasting nodal prices.
3	Market Prices	Inclusion of potential bid strategies to forecast market prices.
4	Uncertainty	Methodology for understanding impact of uncertainty on results.
5	Resource Alternatives	Identification and consideration of alternative resource strategies and projects.

The basic study requirements for a proposed economic, inter-regional transmission project are summarized below:

CAISO Study Requirements
For Proposed Economic, Inter-Regional Transmission Project

	Key Principle	Study Attribute	Notes
1	Benefit Framework	- Demonstrate revenue identify	CTL - GR = TR
		- Demonstrate benefit identify	Total benefits = ΔPC = ΔCS + ΔGS + ΔTS
		- Compute participant benefits *	WECC subregions, CAISO market participants, non-CAISO participants, sum equal to societal
2	Network Representation	- DC-OPF model with nodal pricing	AC power flow optional; transportation model is unacceptable for prospective studies, but are permitted for current studies so long as the results are/were confirmed with a nodal model.
		- Current SSG-WI database	Minimum of one cost-based reference case with SSG-WI data for comparability purposes
3	Market Prices	- Inclusion of credible bid strategies *	Bid strategies must be theoretically sound and reflect system dynamics and pivotal ownership; prefer benchmark with regional prices
4	Uncertainty	- Develop expected value and distribution of benefits *	Recommend benefit histograms and consideration of capital cost risk
5	Resource Alternatives	- Identify, consider, and discuss resource alternative(s)	Alternatives include specific resource types and portfolios
	Other Requirements	- Operating, capacity, system loss, environmental, insurance, and other benefits *	Benefits in addition to energy need to be identified and quantitatively considered as appropriate and feasible
		- Multiple years	Minimum of two study years, 5 or more years apart. Additional successive years are discouraged.
		- Chronology	Minimum of 168 chronological hours per week, 12 weeks per year, preference is 8760 hours per year.

* Study attribute not required if cost-based reference case has lifecycle, societal BCR greater than 1.5.

These study requirements are discussed in greater detail below.

A. Benefit Framework – The benefit framework recognizes that there are several important equations that should hold true for any study (we refer to these as revenue and benefit "identities" since they are always valid). The benefit framework also helps stakeholders to determine the societal, as well as the relevant participant benefits. The study attributes for the benefit framework are listed below:

1. **Revenue identity (requirement) –** On a societal level, the following equation must always be valid for any simulation, for any hour (or larger time period):

   CTL – GR = TR

   where CTL = cost of load
   GR = generator revenue
   TR = transmission revenue

   The difference between what the consumers pay for energy, and what the generators receive for energy, is equal to the transmission revenue.[2]

2. **Benefit identity (requirement) --** On a societal level, the following equation must always be valid when comparing two simulations (one case) for any hour (or larger time period):

   Total benefits = ΔPC = ΔCS + ΔGS + ΔTS

   where Δ PC = difference in total system production costs
   Δ CS = difference in total consumer surplus
   Δ GS = difference in total generator surplus
   Δ TS = difference in total transmission surplus

   The total societal benefits are equal to the difference in production costs (plus capital and fixed costs if there is a different resource mix between the simulations). The total benefits are also equal to the change in consumer, generator, and transmission (owner or operator) surplus.[3]

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[2] The CTL is the Cost-Of-Load to the consumer and is equal to the consumer energy requirement multiplied by the energy price (for each hour, and for each node or zone). The GR is equal to the generator production multiplied by the energy price (for each hour, and for each node or zone). And the TR depends on the market scheme – it can either be equal to wheeling revenues in a contract-path market, or congestion revenue in a Locational Marginal Price (LMP) market.

[3] The Consumer Surplus is defined as the difference between the value of power, and the cost of power for that consumer. Since the value of power is difficult to define, and this term cancels out if the load is inelastic between simulations, the Consumer Surplus can also be defined as the difference in CTL for the two simulations. If the CTL goes down with the transmission addition, there is a Consumer Surplus. The Generator Surplus is defined as the generator net profit (energy revenue minus variable cost of production). And the Transmission Surplus is the difference in transmission revenue between the two cases.

3. **Participant benefits (requirement)** – At a minimum, determine the relative benefits and costs to the following subgroups:[4]
    i. WECC subregions (e.g. CA, SW, NW, RM)
        1. consumers
        2. generators
        3. transmission owners
    ii. CAISO market participants
        1. consumers
        2. utility generators
        3. non-utility generators
        4. utility transmission owners
        5. non-utility transmission owners
    iii. Non-CAISO market participants
        1. municipal utilities **(optional)**

4. **Participant benefits – modified perspective (recommended)** – The participant benefits described above are based on forecast cash flows. The CAISO has developed an additional perspective that excludes "monopoly profit" (i.e. generator profits from uncompetitive market conditions). The reason for excluding these profits is that one of the CAISO's primary goals is to ensure a healthy, competitive California energy market. According to this perspective, generator profits resulting from market power should not be included in a measurement of the benefits to the California market.[5] Since calculation of the modified participant benefits requires enhancements that are not currently implemented in most software packages, this study attribute is not required at this time.

B. Network Representation – The energy benefits and costs of a proposed transmission upgrade need to be modeled accurately. The study attributes for the network representation are:

1. **DC OPF Transmission Model (requirement)** – Either an AC power flow or a DC OPF transmission model must be used in any prospective study. At this point, the AC power flow is optional, and the DC OPF is the minimum standard. The network model must be capable of deriving nodal prices so that the correct economic impact of a proposed transmission upgrade can be correctly computed. A transportation model is

[4] For more information regarding the calculation of participant benefits, please refer to TEAM Report, Chapter 2 "Quantifying Benefits", and Appendix B "Demonstration of Transmission Benefit Calculation Using a 3-Node Prototype Model."

[5] See TEAM Report, Chapter 2, starting on p. 2-10, for additional information on "modified perspective."

not unacceptable for future studies since it computes contract transmission flows instead of physical flows. However, for current studies, i.e., PVD2, a transportation model is acceptable with verification of results through the use of a nodal model.

2. **SSG-WI database (requirement)** – For purposes of validation and comparison, at least one cost-based reference case ("without" and "with" simulations, for multiple years) must be completed with the most recent SSG-WI database. If the project proponent feels that the SSG-WI database would strongly benefit with additional data revision, updating, or inclusion of proprietary data, the majority of cases may be performed with this "enhanced" database. However, a single case will need to be developed using the original SSG-WI data for the reasons explained above.

C. **Market Prices** – Economic evaluations have frequently been performed assuming a perfectly competitive market in which generators make power available at their marginal cost. Clearly, this is only part of the wholesale market picture. Hence, the impact of market power and bid strategies must be considered. The study attributes for market prices are:

1. **Inclusion of bid strategies (requirement)** – Unless the cost-based reference case provides a societal BCR over 1.5 (i.e. the proposed project is very economic), coherent and credible bid strategies should be developed, justified, and implemented.

2. **Dynamic bid strategies (recommendation)** -- Bid strategies should be able to change frequently enough so that the system dynamics are reflected on an hourly basis. The bid strategies will change for potential price setters based on system conditions (e.g., load, available generation and transmission, fuel prices, etc.) and opportunities for pivotal players. A "dynamic" bid strategy that can change with these conditions is preferred over a "static" bid strategy that is the same for every hour of the day irrespective of system conditions and market opportunities.

3. **Benchmark with regional prices (preferred)** – Detailed benchmark studies can be resource-intensive and of questionable benefit if they are not developed correctly. However, some indication of how well the proposed bid strategies perform in predicting either current or historical regional prices is valuable. Therefore, a high-level benchmark study is preferred.[6]

D. Uncertainty – The expected value of benefits can vary significantly from the reference or base case. Therefore, appropriate sensitivity cases need to be developed and summarized for the expected value as well as the distribution of benefits.

1. **Inclusion of sensitivity cases (requirement)** – Sensitivity studies designed to understand the expected value and distribution of benefits of a proposed transmission project are considered critical by the CAISO if the societal BCR is less than 1.5. Sensitivity studies need to include some extreme cases and single-parameter-modification cases.[7]

2. **Development of histograms (recommendation)** – A histogram shows the probability of various benefit ranges, with the total probability for all ranges equal to one. These histograms provide a visual summary of the relative benefit uncertainty and can be used to qualitatively or quantitatively compare alternatives.

3. **Development of potential range of capital costs (preferred)** – Although the CAISO proposed methodology did not focus on assessing the risk on the capital cost side of the equation, this information is important, and if available, should be included in some form in the analyses.

4. **Use of importance sampling (preferred)** – Currently, it is not feasible to develop sufficient cases (using a physical network model in a traditional Monte Carlo type of approach) to derive statistically-defensible results. Therefore, some type of methodology to reduce the number of potential cases to a manageable level is advisable. Importance sampling, as explained in the CAISO reports, can be used as a concept for achieving this reduction in a reasonable and defensible manner.

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[6] A high-level benchmark study may incorporate historical loads, hydro, and gas prices at a regional level, but would not try to true up generator and transmission availability on a unit level. The benchmark might be more of a directional comparison than an absolute price comparison.

[7] See TEAM Report, Chapter 5 “Sensitivity Case Selection”.

After the number of cases is reduced, some type of credible mechanism to assign probabilities to the remaining cases is necessary.[8]

E. Resource Alternatives – One of the primary economic values of a proposed transmission project is that the project may displace the need for alternative resources. Also, the proposed project may facilitate a different resource mix or portfolio than is achievable without the transmission upgrade. It is important to identify and consider these resource alternatives.

1. **Identify, consider, and discuss resource specific or portfolio alternatives (requirement)** – A proposed transmission upgrade may displace specific resources (e.g., in-basin combined cycle) or facilitate a different resource mix (e.g. increased renewables). These considerations can be important from not an economic, but also a policy, perspective.

F. Other – There are several other study attributes that are important for transmission evaluations. These attributes are as follows:

1. **Multiple years (requirement)** – Since the study is intended to represent the benefits for a 30 to 50-year economic life, at least two years must be evaluated. These two years should be at least 5 years apart. Multiple years in succession are generally less valuable than isolated years or additional sensitivity cases.

2. **Chronology (requirement)** – For each year evaluated, at least 12 weeks per year, 168 hours per week, need to be simulated -- 8760 hours per year is recommended.

3. **Unit Commitment (recommended)** – Software and associated data should be able to perform unit commitment and consider chronological parameters such as ramp rates, minimum up- and down-times.

4. **Hydro Optimization (preferred)** – It is desirable that the software and associated data be able to provide some level of hydro optimization, so that static hourly hydro patterns are not used irrespective of changes in input parameters.

V. Summary of Standards

[8] In the PVD2 Report, the CAISO used the Importance Sampling Concept and a Maximum Log-Likelihood linear program to assign probabilities. See, PVD2 Report Technical Appendices, Appendix A "Scenario Selection".

The study standards explained in the preceding section are for a single type of study – a large, economic, Inter-Regional Transmission Project (that does not demonstrate a strongly positive BCR for a cost-based reference case). However, these study requirements can vary for different study types. The requirements as applied to different studies are summarized as follows:

CAISO Study Requirements for Alternative Study Types

	Key Principle	Reliability	Economic -- Inter-Regional	Economic -- Intra-Regional
1	Benefit Framework	possible	Yes	yes
2	Network Representation	possible	Yes	yes
3	Market Prices	possible	Possible	no
4	Uncertainty	possible	Possible	possible
5	Resource Alternatives	No	Yes	yes
	Other Requirements	possible	Possible	possible

A. Reliability – Reliability projects are evaluated on the basis of least-cost, net of any economic benefits that differ between alternatives. If the CAISO or other party evaluates a reliability project, the impact of the difference in potential economic benefits should be estimated. If this difference between alternatives is significant compared to the difference in capital costs, then the economic benefits should be computed. In other words, if the economic benefits may change the least-cost ranking of alternatives, these economic benefits should be considered. Otherwise, economic benefits can be ignored.

As explained above, the designation of "sometimes" in the above-table for reliability projects indicates that the CAISO study requirements are necessary only if the economic benefits may change the least-cost ranking. In the case where the economic benefits may be a significant factor, and if it appears that the inclusion of market prices and uncertainty are not likely to substantially improve the economic differential estimate or conclusion, then these study requirements can also be waived. However, a discussion regarding why these factors were excluded from the analysis is necessary.

Resource alternatives are not required in the economic analysis since it is assumed that the resource alternatives have been identified from a reliability perspective and are being evaluated in the reliability study.

B. **Economic Projects (Inter-Regional)** -- These study requirements are outlined in Section IV – CAISO Study Requirements. If the benefit-cost-ratio (BCR) for the proposed transmission upgrade is significantly positive (BCR greater than 1.5), then it is not necessary to derive market prices or uncertainty since the recommendation to proceed is unlikely to change with the additional information.

C. **Economic Projects (Intra-Regional)** – Intra-regional projects can be considerably less complex with respect to the economic analysis than the Inter-regional proposals. In that vein, the study requirements are generally more relaxed. If the economic impact can be considered to be primarily limited to a single region, the region can be modeled with external markets from a societal basis to understand the benefits and compare these benefits to other alternatives. If there are clear economic differences at this level between alternatives, it may not be valuable to perform a more detailed study requiring market prices and sensitivity cases. In any case, the benefit framework needs to be utilized, a network model must be used, and resource alternatives to the proposed transmission line need to be considered.

CERTIFICATE OF SERVICE

I hereby certify that I have served, by electronic and United States mail, a copy of the foregoing Supplemental Testimony on behalf of the California Independent System Operator Corporation to each party in Docket Nos. A.05-04-015 and I.05-06-041.

Executed on November 22, 2005 at Folsom, California.

____/s/_____
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