Application No.:	16-10-012
Exhibit No.:	
Witness:	Yi Zhang
ALJ:	MacDonald
Commissioner:	Randolph

In the Matter of the Application of DCR Transmission, LLC for a Certificate of Public Convenience and Necessity for the Ten West Link Project	Application 16-10-012

TESTIMONY OF YI ZHANG
ON BEHALF OF
THE CALIFORNIA INDEPENDENT SYSTEM OPERATOR CORPORATION

December 20, 2019

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I. INTRODUCTION

Q1. What is your name and by whom are you employed?

A1. My name is Yi Zhang. I am employed by the California Independent System Operator Corporation (CAISO), 250 Outcropping Way, Folsom, California as a Regional Transmission Engineer Lead.

Q2. Please describe your educational and professional background.

A2. I received a PhD (Doctor in Philosophy) from Washington State University with a focus on power system stability and real time control, an MS (Master of Science) from Tianjin University in China with focus on power system planning and reactive power optimization, and a BS (Bachelor of Science) in electrical engineering and automation from Tianjin University in China.

I joined the CAISO in June 2006 in the Regional Transmission group. Prior to joining the CAISO, I worked in EPRI of China (Electric Power Research Institute of China), where I developed power system applications including SCADA/EMS/DMS (Supervisory Control And Data Acquisition/Energy Management System/Distribution Management System), and Power system optimization and Power Market support system.

Q3. What are your job responsibilities?

A3. My current job responsibilities include conducting and leading the economic-driven transmission assessment portion of the CAISO's TPP. I have held the current position of Regional Transmission Engineer – Lead since September 2014.

Q4. What is the purpose of your testimony?

A4. My testimony provides detailed information regarding the CAISO's production cost simulation analysis and the overall benefit-to-cost ratio for the Ten West Link Project (Proposed Project). The analyses are based on the economic-driven analysis conducted

in the CAISO's transmission planning process, which the CAISO updated for the purpose of this proceeding.

II. BACKGROUND REGARDING THE CAISO'S ECONOMIC ASSESSMENT PROCESS

Q5. Please explain how the CAISO identified the need for the Proposed Project.

A5. As described in Mr. Millar's testimony, the CAISO identified the need for the Proposed Project as a result of the economic-driven assessment in the 2013-2014 transmission planning processes. The CAISO evaluates the need for economic-driven transmission solutions in Phase 2 of the CAISO's annual Transmission Panning Process.

The CAISO's 2013-2014 transmission plan economic assessment concluded that the Proposed Project would provide economic benefit to CAISO's ratepayers in excess of the estimated total project cost. This means that Proposed Project demonstrated a benefit-to-cost ratio greater than 1.0. The economic assessment considered both the production benefits and capacity benefits of the Proposed Project. The CAISO provides details regarding these economic assessment results in Section 5.7.4 in the 2013-2014 TPP report[1]

Q6. Please explain how the CAISO conducts its transmission economic assessment.

A6. The CAISO conducts its economic assessments consistent with the transmission economic assessment methodology (TEAM).[2] TEAM requires the CAISO to assess the potential economic benefits of proposed transmission upgrades from the CAISO ratepayer perspective. CAISO ratepayer benefits include production cost benefits and additional benefits or capacity benefits, and other benefits, if applicable. The CAISO uses TEAM to quantify the benefits that are subsequently used to inform the benefit-to-cost ratio analysis.

[1] http://www.caiso.com/Documents/Board-Approved2013-2014TransmissionPlan.pdf
[2] http://www.caiso.com/Documents/TransmissionEconomicAssessmentMethodology-Nov2_2017.pdf

III. CAISO'S UPDATED ECONOMIC ASSESSMENT OF THE PROPOSED PROJECT

Q7. Please describe the CAISO's updated economic analysis for the Proposed Project.

A7. The CAISO performed an updated economic assessment of the Proposed Project for this proceeding. The CAISO conducted its updated analysis in three steps, as described in detail below:

- **Step 1:** The CAISO developed resource portfolios analysis based on Commission's RESOLVE model. Mr. Yimer's concurrently filed testimony explains this process and identifies capacity benefits provided by the Proposed Project.

- **Step 2:** The CAISO used the resource portfolio developed by Mr. Yimer (Updated Resource Portfolio) to conduct production cost simulation and production benefit analysis. The CAISO used its 2019-2020 Transmission Plan economic planning production cost model (PCM) with the Updated Resource Portfolio to conduct its production cost simulation. The key assumptions of the 2019-2020 economic planning PCM are described in Appendix I.

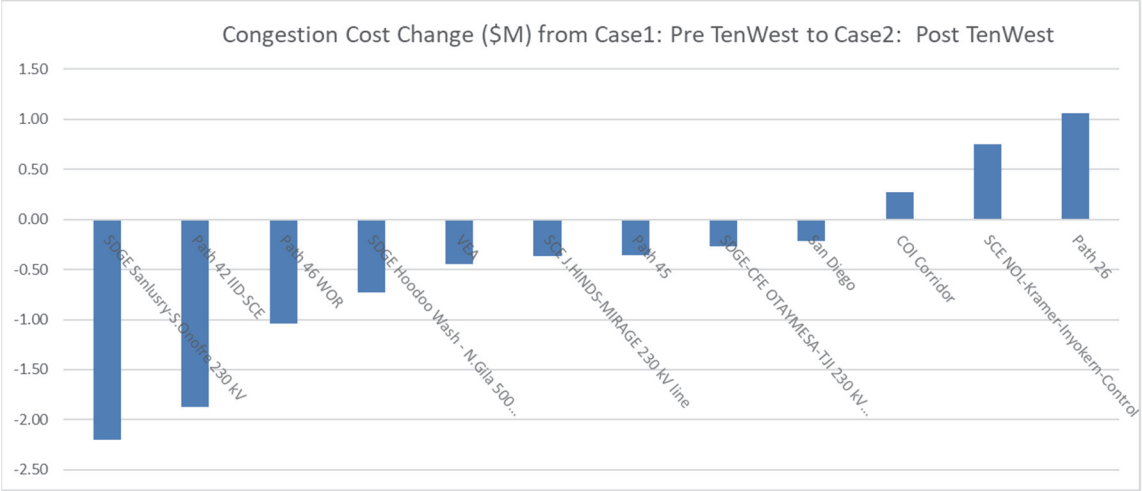
- **Step 3:** The CAISO used the results of the first two steps to calculate the benefit-to-cost ratio for the Proposed Project based on the latest estimated in-service date of the Proposed Project (2021). My testimony below describes Step 2—the assessment of the production cost analysis—and Step 3—the derivation of benefit-to-cost ratio based on the benefits quantified in the production cost simulation and the capacity procurement benefits calculated by Mr. Yimer. I use the sum of these benefits to establish benefit-to-cost ratio based on DCRT's updated cost estimates for the Proposed Project.

IV. PRODUCTION COST BENEFITS

Q8. Please describe how the Proposed Project affects transmission congestion.

A8. The CAISO's production cost simulation results show that the Proposed Project helps to reduce congestion on lines or corridors supplying Southern California. Specifically, the Proposed Project reduces congestion on lines that parallel the Proposed Project. For example, the Proposed Project reduces congestion on the San Luis Rey to San Onofre 230 kV lines, which is an inter-tie between San Diego Gas and Electric-owned system and Southern California Edison-owned system, in the south to north direction; on Path 42 from the Imperial Irrigation District to the CAISO's Southern California Edison-owned system; and on Path 46 and the Hoodoo Wash to North Gila 500 kV line, both are in the corridor between Southwest and California systems, in the east to west direction. Reduction of congestion on these lines or corridors indicates that the system dispatch can be more economic with the Proposed Project in the model than without the Proposed Project. Figure 1 shows the congestion changes in dollars based on the CAISO's analysis.

Figure 1: Congestion changes in the baseline study in the updated analysis



Q9. Please describe the Proposed Project's production cost benefits based on the CAISO's updated analysis.

A9. The CAISO calculated the Proposed Project's production cost benefits from the CAISO ratepayer perspective, as required by TEAM.[3] The ratepayer perspective focuses on the benefits that would accrue to the entities funding the upgrade, in this case, CAISO ratepayers. The CAISO calculated ratepayer production cost benefits based the difference in net load payment (*i.e.*, net production costs payable by CAISO ratepayers) with and without the Proposed Project. In conducting this analysis, the production cost model considers transmission and generator ownership to properly attribute costs and benefits to CAISO ratepayers. Certain transmission revenues and generator profits are counted as an offset to ratepayer net load payments because the underlying resources are owned (or contracted for) and operated on behalf of ratepayers (*i.e.*, utility-owned generation).

[3] http://www.caiso.com/Documents/TransmissionEconomicAssessmentMethodology-Nov2_2017.pdf

Generally, the CAISO calculates the net load payment based on the following equation.

Net load payment = *CAISO's Gross load payment – CAISO's Generator profit – CAISO's Transmission revenue*

CAISO Load Payment = $\sum$*(Load X LMP)*

Generator profit = $\sum$*(Generator revenue – Generator cost)*

Transmission revenue = $\sum$*(Congestion cost + Export wheeling cost)*

Based on the CAISO's updated analysis, the Proposed Project provides ratepayer production cost benefits (or a reduction in the CAISO net load payment) equal to $33.6M annually. The CAISO provides detailed results of the production cost modeling benefits in Table 1.

Table 1
Baseline Study Annual Production Cost Benefits

	Without Ten West ($M)	With Ten West ($M)	Production Cost Benefits ($M)
CAISO Load Payment	7,886.5	7,877.2	9.4
CAISO generator net revenue benefitting ratepayers	3,598.9	3,630.0	31.1
CAISO transmission revenue benefitting ratepayers	170.4	163.6	-6.9
CAISO Net payment	4,117.2	4,083.6	33.6

Q10. Please describe any additional production cost simulation sensitivities conducted by the CAISO to assess the need for the Proposed Project.

A10. The CAISO performed an additional production cost simulation sensitivity using the CEC's preliminary natural gas price forecast[4] and preliminary carbon dioxide (CO2) price forecast[5] in the 2019 Integrated Energy Policy Report (IEPR). The CEC's IEPR

[4] https://ww2.energy.ca.gov/assessments/ng_burner_tip.html.
[5] 2019 IEPR Preliminary Carbon Allowance Price Scenarios.

forecasts increased natural gas prices in California and decreased natural gas prices in other states, especially Arizona, compared with the price forecasts in the 2018 IEPR. The preliminary CO2 price forecast showed that the CO2 prices increased compared with the 2018 IEPR.

In the sensitivity study, the Proposed Project provide $46.6M annual production costs benefit for CAISO ratepayers, which is significantly higher than the $33.6M calculated in the baseline study. The CAISO provides the sensitivity study production cost benefit results in Table 2.

Table 2
2019 IEPR Preliminary Forecast Sensitivity Annual Production Cost Benefits

	Without Ten West ($M)	With Ten West ($M)	Production Cost Benefits ($M)
CAISO Load Payment	7,753.7	7,748.3	5.3
CAISO generator net revenue benefitting ratepayers	3,522.2	3,574.0	51.8
CAISO transmission revenue benefitting ratepayers	200.4	189.9	-10.5
CAISO Net payment	4,031.1	3,984.5	46.6

V. BENEFIT TO COST RATIO ANALYSIS

Q11. Please provide the updated cost estimate for the Proposed Project.

A11. The CAISO provides an updated the total cost estimate for the Proposed Project in Table 3, below, based on information provided by DCRT,[6] the Approved Project Sponsor for the Proposed Project. DCRT provided the capital cost and net present value of annual revenue requirements in 2021 dollars and the CAISO converted these costs to 2018 real dollars for consistency with its benefit-to-cost ratio calculation. The CAISO converted the capital costs and net present value based on the inflation ratio provided in the preliminary natural gas price forecast for the 2019 IEPR.[7]

Table 3
Updated Cost Estimates for the Proposed Project

	Capital Cost ($M)	Present value based on 7% discount rate ($M)	Present value based on 5% discount rate ($M)
DCRT Provided Values (2021 dollars)	389	622	766
CAISO Benefit-to-Cost Ratio Values (2018 dollars)	365	584	720

Q12. Please provide the CAISO's updated benefit-to-cost ratio for the Proposed Project.

A12. The CAISO's benefit-to-cost ratio analysis considers both the production cost benefit calculated in Tables 1 and 2 and capacity benefits calculated by Mr. Yimer. The production cost benefits of the Proposed Project are based on the baseline and sensitivity production cost simulations as described in this testimony. Mr. Yimer's testimony calculates the capacity benefit of the Proposed Project by valuing the avoided capacity costs for battery storage and the locational renewable capacity cost savings. Mr. Yimer's testimony also explains the CAISO's basis for discounting the capacity benefits to consider potential future reductions in solar resource adequacy capacity. For the purpose of the benefit-to-cost ratio calculations presented in the tables below, the CAISO reduced

[6] *See* Mr. Millar's concurrently filed testimony, Section VI, for an explanation of the CAISO's basis for the Proposed Project costs.
[7] https://ww2.energy.ca.gov/assessments/ng_burner_tip.html

Mr. Yimer's calculated capacity benefits to conservatively estimate the capacity benefits provided by the Proposed Project. Tables 4 through 7, below, provide benefit-to-cost ratios with the capacity benefits reduced to (1) 33%, (2) 50%, and (3) 66% of the full capacity benefit calculated by Mr. Yimer.

The CAISO also estimated the present value of the revenue requirement of the Proposed Project using both a 7% and 5% discount rate, which is consistent with the CAISO's transmission planning economic assessment practice. The present value of revenue requirement provides an apples-to-apples comparison of Proposed Project costs with the benefits calculated by the CAISO.

The CAISO's results show that the Proposed Project has benefit-to-cost ratios higher than 1.0 for all scenarios in the updated analysis, which confirms the economic need for the Proposed Project. Table 4 to Table 7 provide the benefit-to-cost ratio calculations with different combinations of production cost benefits, capacity benefits, and discount rates. All benefit and cost values are in 2018 real dollars.

Table 4 shows the benefit-to-cost ratios for the Proposed Project based on the baseline production cost modeling simulation and valuing the capacity benefits based on the avoided costs of battery storage.

Table 4
Baseline Study Benefit-to-Cost Ratio Calculation
Capacity Benefit Based on Avoided Battery Storage Costs

Capital Cost ($M)	365					
Production cost benefit ($M/year)	34					
Capacity benefit ($M/year)	36					
	7% discount rate			**5% discount rate**		
Total Project Cost (Present Value of Revenue Requirement) ($M)	584			720		
Present Value of Production Cost Benefits ($M)	496			644		
Present Value of Capacity Benefits ($M)	536			696		
Capacity Benefit Discount Level	**33%**	**50%**	**66%**	**33%**	**50%**	**66%**
Discounted Net Present Value of Capacity Benefits ($M)	179	268	357	232	348	464
Total benefit ($M)	675	764	854	876	992	1,108
Benefit-to-Cost Ratio	1.16	1.31	1.46	1.22	1.38	1.54

Table 5 shows the benefit-to-cost ratios based on the 2019 IEPR preliminary forecast production cost modeling simulation and valuing the capacity benefits based on the avoided costs of battery storage.

Table 5
2019 IEPR Preliminary Forecast Sensitivity Benefit-to-Cost Ratio Calculation
Capacity Benefit Based on Avoided Battery Storage Cost

Capital Cost ($M)	365					
Production cost benefit ($M/year)	47					
Capacity benefit ($M/year)	36					
	7% discount rate			**5% discount rate**		
Total Project Cost (Present Value of Revenue Requirement) ($M)	584			720		
Present Value of Production Cost Benefits ($M)	688			893		
Present Value of Capacity Benefits ($M)	536			696		
Capacity Benefit Discount Level	**33%**	**50%**	**66%**	**33%**	**50%**	**66%**
Discounted Net Present Value of Capacity Benefits ($M)	179	268	357	232	348	464
Total benefit ($M)	867	956	1,045	1,125	1,241	1,357
Benefit-to-Cost Ratio	1.48	1.64	1.79	1.56	1.72	1.89

Table 6 shows the benefit-to-cost ratios based on the baseline production cost modeling simulation and valuing the capacity benefits based on the locational renewable cost savings.

Table 6
Baseline Study Benefit-to-Cost Ratio Calculation
Capacity benefit Based on Locational Renewable Cost Saving

Capital Cost ($M)	365					
Production cost benefit ($M/year)	34					
Capacity benefit ($M/year)	18					
	7% discount rate			**5% discount rate**		
Total Project Cost (Present Value of Revenue Requirement) ($M)	584			720		
Present Value of Production Cost Benefits ($M)	496			644		
Present Value of Capacity Benefits ($M)	266			346		
Capacity Benefit Discount Level	**33%**	**50%**	**66%**	**33%**	**50%**	**66%**
Discounted Net Present Value of Capacity Benefits ($M)	89	133	178	115	173	230
Total benefit ($M)	585	629	674	759	817	874
Benefit-to-Cost Ratio	1.00	1.08	1.15	1.05	1.13	1.21

Table 7 shows the benefit-to-cost ratios based on the 2019 IEPR preliminary forecast production cost modeling simulation and valuing the capacity benefits based on the locational renewable cost savings.

Table 7
2019 IEPR Preliminary Forecast Sensitivity Benefit-to-Cost Ratio Calculation
Capacity Benefit Based on Locational Renewable Cost Saving

Capital Cost ($M)	365					
Production cost benefit ($M/year)	47					
Capacity benefit ($M/year)	18					
	7% discount rate			**5% discount rate**		
Total Project Cost (Present Value of Revenue Requirement) ($M)	584			720		
Present Value of Production Cost Benefits ($M)	688			893		
Present Value of Capacity Benefits ($M)	266			346		
Capacity Benefit Discount Level	**33%**	**50%**	**66%**	**33%**	**50%**	**66%**
Discounted Net Present Value of Capacity Benefits ($M)	89	133	178	115	173	230
Total benefit ($M)	777	821	866	1,008	1,066	1,124
Benefit-to-Cost Ratio	1.33	1.41	1.48	1.40	1.48	1.56

VI. CONCLUSION

Q13. Please summarize your conclusions.

A13. The CAISO's analysis demonstrates the Proposed Project continues to show benefits in excess of project costs under a variety of different sensitivities and capacity valuation approaches.

Q14. Does this conclude your testimony?

A14. Yes.

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ATTACHMENT A

SUMMARY OF KEY ASSUMPTIONS OF
2019~2020 TPP PRODUCTION COST MODEL DEVELOPMENT

The 2019-2020 TPP PCM development started from the last planning cycle's planning production cost model (PCM), which used the Anchor Data Set (ADS) PCM as a starting database. The validated changes in ADS PCM up to the ADS PCM Phase II v2.0 were incorporated into the CAISO planning PCM in 2019-2020 cycle. The CAISO's system network model was updated to be consistent with the 2019-2020 TPP reliability power flow case for 2029.

The California load data used the 2029 load forecast that was drawn from the California Energy Demand Forecast 2018-2030, Revised Electricity Forecast adopted by California Energy Commission (CEC) on January 9, 2019.

The forecasts of Natural Gas price and CO2 price were the same as in the ADS PCM, which are based on the CEC 2018 Integrated Energy Policy Report. The forecast of Coal prices were the same as in the ADS PCM. All prices are in 2018 real dollar.

Generator locations and installed capacities in the PCM are consistent with the 2019-2020 TPP reliability assessment power flow cases for 2029, including both conventional and renewable generators.

Transmission constraints were enforced in the PCM, including transmission line or transformer's ratings, path ratings or operation limits, critical contingencies identified in the CAISO's TPP studies, nomograms as modeled in the ADS PCM and the additional ones identified in the CAISO's operating procedures or TPP studies. Scheduled maintenance of transmission facilities was modeled based on historical data. Only the repeatable maintenances were considered. The corresponding derates on transmission capability were also modeled.