To: The Coalition of California Utility Employees

From: Robert Earle, Ph.D

Date: February 28, 2023

Re: Solar Industry Job Loss Due to AB 538

I. Summary

Approximately 53,000 MW of new solar power will be needed to meet the goals of SB 100 for electricity consumption of 60 percent renewables by 2030 and 100 percent renewables or carbon free by 2045. The creation of a west-wide RTO as proposed in AB 538 would result in much of the 53,000 MW of new solar being constructed in other states rather than California. The resulting job loss in California would be approximately 1.1 million jobs through 2040.

II. Introduction

SB 100 established a policy that 60 percent and 100 percent of the electricity supplied to retail consumers and state agencies will be renewable and zero-carbon by 2030 and 2045, respectively. According to the CAISO, in order to achieve this goal, approximately 53,000 MW of new utility-scale solar will be needed.[1]

Where the needed solar power is built depends on several factors including whether it qualifies as Product Content Category 1 renewable power under California's RPS statute. An expanded west-wide RTO as contemplated in AB 538 would allow much more out-of-state renewables to qualify as PCC 1 than under the current regime or an expanded market under CAISO control (as contemplated under the Expanded Day-Ahead Market – "EDAM" or as analyzed for SB 350 by the CAISO). A west-wide RTO would result in a significant amount of solar being built outside California where land, permitting and labor costs are lower. The

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[1] CAISO, 20 Year Transmission Outlook (May 2022), http://www.caiso.com/InitiativeDocuments/20-YearTransmissionOutlook-May2022.pdf, PDF p.19.

effect would be to transfer future jobs in the development, construction, and operation of renewable facilities from California to other states.

As detailed in the next section, the CAISO analyzed the impacts of SB 350 on the California economy including jobs impacts.[2] CAISO concluded that SB 350 which had a 50 percent renewables goal by 2030 would create a significant number of jobs in California under the alternatives of an expanded CAISO versus a west-wide RTO.

This report builds on the CAISO SB 350 Study to analyze the number of solar jobs lost under AB 538. The resulting job loss in California would be approximately 1.1 million jobs. The next section of this report discusses the CAISO SB 350 Study followed by an application of that analysis to AB 538.

III. The SB 350 Analysis

SB 350, signed into law in 2015, established targets to increase retail sales of qualified renewable electricity to at least 50 percent by 2030. The CAISO SB 350 Study performed a variety of analyses to evaluate the impacts of a Regional ISO concerning:[3]

- Overall benefits to California ratepayers;
- Emissions of greenhouse gases and other air pollutants;
- The creation or retention of jobs and other benefits to the California economy;
- Environmental impacts in California and elsewhere;
- Impacts in disadvantaged communities in California; and
- Reliability and integration of renewable energy resources.

The CAISO SB 350 Study examined several scenarios including:[4]

- 2030 Current Practice using the business-as-usual, in-state procurement focus;

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[2] "Senate Bill 350 Study," California Independent System Operator, July 8, 2016.
[3] CAISO SB 350 Study, p. I-1.
[4] CAISO SB 350 Study, p. I-4 – I-5.

- 2030 Expanded Regional ISO (Regional 2) – continued, but not exclusive, in-state renewables procurement focus; and
- 2030 Expanded Regional ISO (Regional 3) – expanded out-of-state procurement focus than in Regional 2.

The Regional 3 scenario corresponds to the AB 538 proposal, while the Regional 2 scenario corresponds to an expanded reach of the CAISO footprint such as under the Expanded Day-Ahead Market (EDAM) but without ceding RTO control to a west-wide entity.

The CAISO SB 350 Study found that under the Regional 3 approach and the requirements of SB 350, approximately 16,000 jobs[5] from solar buildout in California would be lost under the type of west-wide RTO structure under AB 538 in just the year 2030.[6] Because the investment stream to meet the 50 percent target was fairly smooth, the 16,000 solar buildout jobs lost would amount to approximately 160,000 solar buildout jobs lost over the decade of development from 2021 to 2030.[7]

IV. Lost Jobs Due to AB 538

The CAISO SB 350 Study provides a useful basis for analyzing the impacts of AB 538 on the solar buildout jobs in California. Many factors have changed with the two most important being 1) the increase in renewables requirements under SB 100 to have renewable and zero-carbon resources supply 60 percent by 2030 percent and 100 percent by 2045 of retail electric sales and electricity procured to serve state agencies. 2) The increase in projected electricity demand due to the electrification of the other sectors in California such as transportation and buildings. According to the CAISO, electrification may increase load in

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[5] Jobs are job-years or 2,080 hours of work.
[6] CAISO SB 350 Study, p. VIII-17. The graph compares the changes in jobs from the Current Practice Scenario to the Regional 2 and Regional 3 scenarios. The jobs lost under the Regional 3 scenario compared to the Regional 2 scenario is the job jobs lost under the Regional 3 scenario
[7] CAISO SB 350 Study, Meeting May 24 – 25, 2016. https://www.caiso.com/Pages/DocumentsByGroup.aspx?GroupID=4C17574F-73AE-40E3-942C-59C3A13BBDF1

California by 2031 by 28.5 percent.[8] The result of these two factors is that approximately 53,000 MW of new solar power will be needed to meet the goals of SB 100.[9]

Comparing the CAISO SB 350 Study's results for solar buildout shows that under the Regional 2 scenario 7,804 MW of solar would be built in California, while under the AB 538 style scenario of Regional 3, only 3,440 MW of solar would be built in California.[10] In other words, AB 538 results in a 56% decline in solar MW being built in California. Applying the 56% decline in solar MW built in California to the estimated need of 53,000 MW results in approximately 30,000 MW less solar built in California under AB 538.[11]

Scaling up the MW built from the SB 350 Study Regional 2 scenario results in a 6.8 fold increase in the number of jobs lost under the AB 538 style scenario of Regional 3, or 1.1 million jobs lost through 2040.[12]

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[8] CAISO, 20 Year Transmission Outlook (May 2022), http://www.caiso.com/InitiativeDocuments/20-YearTransmissionOutlook-May2022.pdf , p.1 (PDF p.5).
[9] Ibid, p. 19 (PDF p.23).
[10] CAISO SB 350 Study, Technical Appendix, Table 29, p. 60 (pdf p. 192).
[11] 53,000 MW times 56 percent.
[12] 53,000 MW/7804 MW = 6.81

ROBERT EARLE, PH.D.

Dr. Earle is an economist with extensive experience in the energy, telecomm, and finance sectors including valuation, environmental mitigation methods and costs, and regulatory economics. Having worked as a consultant as well as an industry manager, he currently supports clients in analyzing market opportunities, strategy, regulatory issues, and litigation. His areas of expertise include electric power sector modeling, economics of environmental mitigation, electric power and gas markets, regulatory policy and ratemaking, demand response, and system optimization.

Dr. Earle has also worked extensively on tariff and market design, including as an expert witness before a number of regulatory commissions. He was the architect of an economic model used to evaluate alternative methods for environmental mitigation including BPM/BACT technology, incentives, and markets. Results from this work were used in numerous studies for investment decisions, policy studies, and litigation. He also served as part of the study team and report writing groups for the National Petroleum Council study on the development of natural gas resources.

Dr. Earle was manager of economic analysis at the California Power Exchange where his responsibilities included developing an overall analytic infrastructure for market analysis, analysis of new products, and briefing regulatory and legislative bodies. Dr. Earle holds Ph.D. and M.S. degrees in Operations Research, both from Stanford University.

EDUCATION

Ph.D. Operations Research, Stanford University

M.S. Operations Research, Stanford University

A.B. Mathematics, the College of William & Mary

REPRESENTATIVE PAST EXPERIENCE

Electricity Sector Structure and Regulation

- Advised in the development of transmission strategy for several renewables companies in the United States and Canada (wind and biomass) including analysis of transmission access, planning, cost allocation and siting conditions in regions in North America.
- Developed transmission pricing structure for Saudi Electric Company.
- Advised clients in Canada, the Middle East, and the United States on transmission pricing structures.
- Conducted numerous demand response potential and valuation studies for utilities across the United States.
- Analyzed energy efficiency potential in the Southeast for environmental and ratepayer advocates.
- Provided expert testimony on energy efficiency incentives for Oklahoma Gas & Electric.
- Led analysis for Midwest ISO of wholesale market interface with demand response.

Bidding/Auction Design and Analysis, Market Modeling

- Conducted detailed studies of participant bidding behavior for the purpose of product development, policy changes, and investigations. The results of these studies were used to establish standard methodologies for staff to use. In addition, Dr. Earle invented new techniques for characterizing bids to examine product ideas and various alternative market structures.
- Led the development of a new type of multivariate statistical model to track market changes and rigorously assess auction participant behavior. Reflecting the auction structure, this model uniquely codetermined all prices at the same time. To do this, a number of new statistical techniques were created.
- Advised two merging companies needing advice on divestiture of their generation assets with respect to both asset value and issues of strategic behavior. For this purpose, Dr. Earle designed and implemented an oligopoly simulation of the market. This game theoretic model explicitly represents company strategies and interactions in the marketplace. Dr. Earle's findings were used to shape the decisions of the investment bank in selling the merged companies' assets and win regulatory approval.

Environment

- Architect of economic model used to evaluate alternative methods for environmental mitigation including BPM/BACT technology, incentives, and markets. Results from this work were used in numerous studies for investment decisions, policy studies, and litigation.
- Advised clients on approaches to environmental mitigation in the oil, electric power, and water sectors.
- Managed a 2-year project to develop a carbon mitigation strategy for a major country in the Middle East.
- Managed a successful water privatization for a city of five million where environmental concerns formed a key part of the privatization effort.

Valuation of Assets, Market Strategies

- For the Electric Power Research Institute (EPRI), developed a methodology for the valuation of alternative market strategies for hydroelectric power plants using stochastic dynamic programming. The changing dynamics of the electricity market, in particular the structure of electricity prices, may have significant implications for the value of a technology that can store energy and release it according to market conditions, thereby leading to a premium value for such resources. The methodology Dr. Earle developed was published in an EPRI report.
- Assessed the impact of market structure changes on plant value that resulted in the restructuring of a bid for generation assets.
- As a result of reorganization, a utility company needed help in valuation of its load management technology and program. At the time, its program was one of the top five in the United States. Dr. Earle directed a team to conduct market research on this technology and teach a class on its current status. As a follow-on, Dr. Earle acted as a facilitator to the client in their development of a valuation methodology. This project resulted in the client deciding to phase-out its efforts in this area.

Corporate Strategy

- In preparation for deregulation of the generation sector in the power industry, Dr. Earle co-led a team to formulate valuation and corporate asset deployment strategies for a $5 billion southeastern utility. The various options considered included: asset spin-off, divestiture, mergers, and acquisitions.

Different scenarios implied different trade-offs among the business units of the company. This required extensive financial modeling of the various options and sensitivity to the client's cultural issues in order to reach a unified decision. These recommendations were adopted by the board as the basis for ongoing company strategy.

- Conducted market research for a company that was considering starting an energy brokerage in California. Key issues investigated were market size and structure, first mover advantage, and risk. As a result of this work, the company selected an effective start-up strategy for its new operation in California.

- Reporting to the CEO, co-negotiated a settlement calculation involving a billion dollars. Co-wrote the filing implementing the settlement and then coordinated its implementation through the IT and settlements process.

EXPERT TESTIMONY

- Before the California Public Utilities Commission, on behalf of the Coalition of California Utility Employees, concerning the Pacific Gas & Electric 2023 General Rate Case.
- Before the Washington Utilities and Transportation Commission, on behalf of the Attorney General of the State of Washington, concerning the Avista 2023 General Rate Case.
- Before the Washington Utilities and Transportation Commission, on behalf of the Attorney General of the State of Washington, concerning the Puget Sound Energy 2023 General Rate Case.
- Before the California Public Utilities Commission, on behalf of the Coalition of California Utility Employees, concerning Major Updates to the 2022 Avoided Cost Calculator.
- Before the California Public Utilities Commission, on behalf of the Coalition of California Utility Employees, concerning the rulemaking to revisit net energy metering tariffs.
- Before the California Public Utilities Commission, on behalf of the Coalition of California Utility Employees, concerning the issuance of recovery bonds for Pacific Gas & Electric.
- Before the California Public Utilities Commission, on behalf of the Coalition of California Utility Employees, concerning Southern California Edison's Application for Wildfire Cost Securitization.
- Before the Washington Utilities and Transportation Commission, on behalf of the Attorney General of the State of Washington, concerning power costs and interjurisdictional allocation in the PacifiCorp 2021 General Rate Case.
- Before the California Public Utilities Commission, on behalf of the Coalition of California Utility Employees, concerning the Southern California Edison 2021 General Rate Case.
- Before the California Public Utilities Commission, on behalf of the Coalition of California Utility Employees, concerning Major Updates to the 2020 Avoided Cost Calculator.
- Before the California Public Utilities Commission, on behalf of the Coalition of California Utility Employees, concerning the Pacific Gas & Electric Gas 2020 General Rate Case.
- Before the California Public Utilities Commission, on behalf of the Coalition of California Utility Employees, concerning the Pacific Gas & Electric Gas Transmission and Storage Rate Case.
- Before the California Public Utilities Commission, on behalf of the Coalition of California Utility Employees, concerning the Power Charge Indifference Adjustment.
- Before the Ohio Public Utilities Commission, on behalf of FirstEnergy, concerning the market for renewable energy credits.

- Before the District Court in Dallas, Texas, on behalf of O Mart, submitted an expert affidavit concerning the appropriate method to value a breach of an electric power purchase contract.
- Before the Superior Court of California in Los Angeles County, on behalf of several municipal utilities, submitted two expert reports on the structure of California electricity markets and on certain transactions in the California electricity marketplace.
- Before the Oklahoma Corporation Commission, on behalf of Oklahoma Gas & Electric, concerning cost recovery and shareholder incentives for DSM programs.
- Before the Public Utilities Commission of Texas, on behalf of El Paso Electric, concerning the capacity value of certain electric power contracts in a fuel cost reconciliation proceeding.
- Before the Federal Energy Regulatory Commission, on behalf of El Paso Electric, concerning the effect of certain power market transactions on California and western markets and the effect of information sharing on California markets.
- Before the New Brunswick Public Utilities Board, on behalf of J.D. Irving, Ltd. and the Canadian Manufacturers and Exporters, concerning the transmission tariff application by New Brunswick Power.

PUBLICATIONS AND PRESENTED PAPERS

"Tail of the Corona Virus?: High Stakes Decisions with Little Information – A Case Examining Data Leadership," with Jung Park and Karl Schmedders, February 2021.

"Attack of zombie companies: don't let them eat bailouts that are vital to restore the economy," with Jung Park and Karl Schmedders, *the Conversation*, June 2, 2020, republished in *The National Interest.*

"Coronavirus: the economic recovery won't only be U-shaped – it'll look like a wheelbarrow," with Jung Park and Karl Schmedders, *the Conversation*, April 14, 2020, republished in *World Economic Forum Agenda* and *The National Interest*.

"Spectrum Auctions Around the World: An Assessment of International Experiences with Auction Restrictions", with David W. Sosa, July 2013, prepared for Mobile Future.

"Hydraulic Fracturing: the regulatory year in review," *Oil and Gas Financial Journal*, January 2012, Vol. 9, No. 1.

"How not to improve surface water quality," with Virginia Perry-Failor, *Regulation*, Fall 2010, Cato Institute Press.

"The Costs of Compliance to EPA's Advance Notice of Proposed Rulemaking on the PCB Use Authorization for Interstate Natural Gas Pipelines," with Susan Tierney, prepared on behalf of the Interstate Natural Gas Association of America ("INGAA"), September 10, 2010.

"Demand Response on Steroids: Extra Value from using the Smart Grid?," *Natural Gas and Electricity*, February 2010.

"Measuring the Capacity Impacts of Demand Response," with Ed Kahn and Edo Macan, *Electricity Journal*, June 2009.

"Ethanol 2.0," with Ahmad Faruqui, *Regulation*, Winter 2008, Cato Institute Press.

"Fostering Economic Demand Response in the Midwest ISO," with Sam Newell, Ahmad Faruqui, Attila Hajos, and Ryan Hledik, prepared for the Midwest ISO, December 30, 2008.

"Transforming America's Power Industry: The Investment Challenge 2010-2030," with Mark Chupka, Peter Fox-Penner, and Ryan Hledik, prepared for the Edison Foundation, November 2008.

"The Role of Expectations in Modeling Costs of Climate Change Policies," with Paul Bernstein and David Montgomery, to appear in *Integrated Assessment of Human-induced Climate Change*, Cambridge University Press, 2007.

"On Price Caps under Uncertainty," with Karl Schmedders and Tymon Tatur, *Review of Economic Studies*, January 2007.

"Demand Response and Advance Metering," with Ahmad Faruqui, *Regulation*, The Cato Institute, Spring 2006.

"Toward a New Paradigm for Valuing Demand Response," with Ahmad Faruqui, *The Electricity Journal*, May 2006.

"Rate Case Mania," with Ahmad Faruqui, *Public Utilities Fortnightly*, February 2006.

"Controlling the Thirst for Demand," with Anees Azzouni and Ahmad Faruqui, *Middle East Economic Digest*, December 2, 2005.

"Reforming Electricity Pricing in the Middle East," with Anees Azzouni and Ahmad Faruqui, *Middle East Economic Survey*, December 5, 2005.

"Ontario Demand-Supply Balance Update: Where will the hot trading occur?," Interjurisdictional Power Transaction Conference, The Canadian Institute, Toronto, invited talk, April 8, 2002.

"Price Caps and Uncertain Demand," with Karl Schmedders and Tymon Tatur, Discussion Paper #1340, CMS-EMS: The Center for Mathematical Studies in Economics and Management Sciences, Kellogg School of Management, Northwestern University, March 6, 2002.

"Demand Uncertainty and Risk-Aversion: Why Price Caps May Lead to Higher Prices," with Karl Schmedders, Discussion Paper #1330, CMS-EMS: The Center for Mathematical Studies in Economics and Management Sciences, Kellogg School of Management, Northwestern University, October 2, 2001.

"Demand Elasticity in the California Day-Ahead Market," *Electricity Journal*, October 2000.

"Electric Power Deregulation and Market Monitoring," with Philip Q. Hanser and James D. Reitzes, *Electricity Journal*, October 2000.

"How Many Firms Are Enough?—Deregulating Electric Generation," with Philip Q. Hanser and James D. Reitzes, Western Economic Association Conference, Vancouver, B.C., July 2000.

"Review of Price Behavior in the California Power Exchange," Western Power Trading Forum, invited talk, May 2000.

"Electric Power Restructuring: Industrial Organization," Department of Management and Strategy, Kellogg School of Management, Northwestern University, invited talk, April 26, 2000.

"Reply to Borenstein and Bushnell," with Philip Q. Hanser and James D. Reitzes, *Electricity Journal*, March 2000.

"Market Power Basics," IEEE Los Angeles Chapter, invited talk, March 14, 2000.

"Lessons from the Early Days of Competition in California," with Philip Q. Hanser, Weldon C. Johnson, and James D. Reitzes, *Electricity Journal*, October 1999.

"Optionality in Energy and Ancillary Services Markets," with Jason A. Hicks, Deregulation Progress Report: Issues and Insights Conference, invited talk, August 4, 1999.

"Measuring Market Power: Back to the Basics," with Jason A. Hicks, invited talk, Deregulation Progress Report: Issues and Insights Conference, August 4, 1999.

Mechanisms for Evaluating the Role of Hydroelectric Generation in Ancillary Services Markets, with R.P. Broehm, F.C. Graves, T.J. Jenkin, and D.M. Murphy, EPRI, Palo Alto, CA: 1998. Report TR-111707.

"Power Market Price Forecasting: Pitfalls and Unresolved Issues," with Frank C. Graves and Philip Q. Hanser, *USAEE/IAEE Annual North American Conference Proceedings*, October 1998.

"Capacity Expansion/Investment Dynamics: Price Forecasting in Deregulated Electric Power Markets," presentation to Market Price Forecasting Conference, Baltimore, Maryland, August 25, 1998.

"Planning Reserve Requirements in a Deregulated Industry: One-Part vs. Two-Part Pricing -or- How I Learned to Stop Worrying and Love Regulation," with Frank C. Graves and Philip Q. Hanser, presentation to ISO Operations, Planning, and Design: An MIT Energy Laboratory, Massachusetts Institute of Technology, June 10, 1998.

"One-Part Markets for Electric Power: Ensuring the Benefits of Competition," with Frank C. Graves, Philip Q. Hanser, and E. Grant Read, in *Power Systems Restructuring: Engineering and Economics*, Marija Ilic, Francisco Galiana, and Lester Fink, eds., Kluwer Academic Publishers, Boston, 1998.

"Computation of Electric Power Production Cost with Transmission Constraints," Energy Modeling Forum, Stanford University, EMF-SR6, December 1996.

TEACHING

Guest lecturer for Master's level seminars, Department of Quantitative Business Administration, University of Zurich

o Reinforcement Learning	Autumn 2017, 2018, 2019, 2020
o Neural Networks and Deep Learning	Spring 2017, 2019, 2020, 2021
o Machine Learning for Managers	Autumn 2016, Spring 2018
o Methods in Economic Consulting	Autumn 2015

Master's Theses Supervised:

- "Use of a Reinforcement Learning Algorithm to Search Trading Strategies for the Management of a Multi-Asset Portfolio", Master of Arts in Banking and Finance, Colin Grab, 2018.
- "A Reinforcement Learning Approach for Airline Revenue Management," Master of Arts in Banking and Finance, Marco Kiener, 2021 (*forthcoming*).

OTHER PROFESSIONAL ACTIVITIES

- Referee for *Journal of Regulatory Economics*, *Energy Journal.*
- Center for Research in Regulated Industries, Rutgers University, member of organizing committee for annual Western Conference, 2005 – 2015.

POSITIONS HELD

2015-present Alea IE, LLC, Owner

2009-2015 Analysis Group, Vice President

2007-2009	Brattle Group, Principal and San Francisco Office Director
2001-2007	Charles River Associates, Principal
1999-2001	California Power Exchange, Manager of Economic Analysis
1997-1999	Brattle Group, Associate