

## ENERGY AND ENVIRONMENTAL ECONOMICS, INC.

San Francisco, CA

*Senior Director*

Mr. Moore is a Senior Director helping lead E3's Market Analysis practice, which examines how changes in policy, technology, and market design affect electricity prices, trading, and operations. He has led recent studies for 26 utilities in the Western Market Exploratory Group (WMEG) to evaluate the production cost benefits of forming different footprints of CAISO EDAM or SPP Markets+ day ahead markets in the West. For ERCOT's development of a transmission consumer benefits test, he has also examined the transmission economic benefit methodologies currently in use in jurisdictions across North America, as well as Australia and Ireland. Has also led studies for over fifteen utilities and public power agencies to quantify the potential impact of participating in real time markets including the Western Energy Imbalance Market (EIM) and Western Energy Imbalance Service (EIS), as well as a study of the potential opportunities of developing an extended Day Ahead Market (EDAM). A highly capable modeler who can dive deeply into large-scale simulation analysis, Mr. Moore does not lose sight of the practical value of his analysis when providing expert advice to clients. Over the last decade at E3, Mr. Moore has evaluated the benefits of proposed transmission projects across the U.S., Canada, and in Mexico. He has also helped develop E3's market price forecast service, which offers clients insight into how California's increasing renewable resource buildout and trading operations will impact long-term market price fundamentals at major Western hubs and in ERCOT.

Mr. Moore earned his M.S. in Management Science and Engineering and B.A. in Economics from Stanford University. His recent projects include:

- **Western Market Exploratory Group (WMEG) - Day Ahead Market Study (2022-2023).** For a group of 26 Western utilities, led E3's team in evaluating the potential production cost savings from formation of a new day-ahead markets within WECC. E3 developed a multi-stage WECC-wide production cost model using PLEXOS to simulate day-ahead scheduling and subsequent real-time dispatch for all generators across WECC. E3 used this model to compare different footprints of CAISO's EDAM and SPP's Markets+ day-ahead energy markets within WECC—both at a system wide savings level and at an individual member level --and to explore the impact of features of each day-ahead market such as fast start pricing, imbalance reserves and GHG pricing. E3's team worked closely with WMEG task force participants to define and gain agreement on key model assumptions, and worked with each WMEG member to validated and refined data and review subsequent results.
- **ERCOT Transmission Consumer Benefits Test Evaluation (2023).** For ERCOT, led E3's team to determine options and recommend the best approach for a consumer benefit test used to determine approval for economic transmission projects in the ERCOT market. As part of this engagement, conducted a jurisdictional survey of transmission evaluation methods and benefits tests in markets across North America as well as key international markets to understand the formulation of these tests and their impact on transmission project development. Explored the implication for transmission benefit economics of transmission congestion revenue allocation,

system-wide versus zonal transmission cost allocation, and utility-owned generation. Compared production simulation models used and a wide range of approaches for estimating transmission benefits.

- **WECC 20-Year Base Case and Extreme Weather Study Support (2023).** Advised WECC staff in development of a 20-year base case in GridView, as well as sensitivity studies to test the impact of high electrification and extreme summer and winter weather conditions. Discussed and recommended assumptions for use in load and new generation additions for WECC. Reviewed results of iterative GridView cases with WECC staff and collaborated on solutions to refine results and address anomalies.
- **Vistra Moss Landing Congestion Analysis (2021).** Using the GridView production simulation model, led a detailed congestion assessment on the lines serving the 400 MW/1600MWh Moss Landing Battery Storage system on behalf of the Vistra Corporation. The purpose of this effort was to evaluate the scale of local congestion and its impact on the economic cycling of the storage system and identify potential transmission solutions that could alleviate this congestion. Key findings from this work were incorporated assumptions use for CAISO's modeling for the 2021-2022 transmission plan, which led to the approval of an economic upgrade on the 230 kV Moss Landing – Las Aguilas line.
- **Western Market Price Forecast Development (2017-23).** For public and investor-owned utilities and generation developers, designed and led WECC-Wide modeling in modeling to forecast energy and capacity market prices for key Western trading hubs over a 30-year horizon, creating scenarios to identify the impact of different renewable resource build projects, rooftop PV and electric vehicle (EV) adoption estimates, transmission transfer capabilities between regions, and fuel and hydro conditions. Results forecast model, together with expertise from E3 assessment of sensitivities informed long-term procurement and resource planning decisions for those entities.

Additional E3 project experience includes:

- For public and investor-owned utilities, designed and led modeling to forecast energy and capacity market prices for key Western trading hubs over a 25-year horizon, creating scenarios to identify the impact of different renewable resource build projects, rooftop PV and electric vehicle (EV) adoption estimates, transmission transfer capabilities between regions, and fuel and hydro conditions. Results forecast model, together with expertise from E3 assessment of sensitivities informed long-term procurement and resource planning decisions for those entities.
- Led more than fifteen separate studies for client utilities to analyze the potential economic impact to them of participation in the Western Energy Imbalance Market (EIM) operated by the California ISO on a 5-minute basis, including the initial evaluation of the economic benefits of the initial EIM formed between CAISO and PacifiCorp, as well as studying a Western Interconnection-wide analysis of the EIM for WECC. Created multiple production simulation cases and sensitivity analyses based on stakeholder input and used cases to analyze potential savings in generator production costs as a result of EIM participation.
- Led a study of the impact of developing an extended Day Ahead Market (EDAM) covering all or a portion of the footprint of currently participating EIM entities, with a focus on evaluating the potential flexibility reserve requirements that would be needed under future scenarios with more renewable generation and different market constructs.
- Led a planning and procurement study for El Paso Electric Company (EPE) to compare the capacity and energy value of different solar, wind, storage, and gas resource bids that EPE evaluated during a recent procurement.

- Forecasted long-term market prices for 2020 through 20250 for day-ahead and real-time energy, as well as ancillary services, for ERCOT, with emphasis on identifying the implications of different long-term market scenarios on the potential revenue for new battery storage development.
- Managed the analysis to estimate the impact of full integration of PacifiCorp and CAISO, including assessment of the impact on day-ahead market of joint dispatch and unit commitment, coordinated transmission planning for renewable development and peak capacity needs, and potential opportunities to manage trading to minimize renewable curtailment over the 2020 through 2030 period.
- Led a screening-level non-wires alternatives analysis of the potential for economic energy efficiency, demand response and distributed generation to defer the need for a 500-kV transmission project in the Pacific Northwest.
- Provided strategic transmission advice regarding siting and timing of upgrades for developer projects, including assessing curtailment risks and the cost of wheeling power.
- Assessed the potential savings for renewable energy procurement that could be enabled by long-distance multi-jurisdictional transmission lines for *Load-Resource Balance in the Western Interconnection: Towards 2020*, a study of west-wide infrastructure needs for achieving aggressive RPS and greenhouse gas reduction goals in 2020 for the Western Electric Industry Leaders (WEIL) Group, comprised of CEOs and executives from a number of utilities in the West
- Conducted studies of the potential benefits of long-distance transmission lines to connect to remote renewable energy zones for PG&E, BPA, and British Columbia Hydro and Power Authority
- Created renewable resource supply curves based on a standardized set of costing assumptions and public data and integrated supply curve modeling results into E3's Greenhouse Gas Calculator for the California PUC and California Energy Commission to assess the cost to comply with AB32, California's greenhouse gas compliance law.
- Assisted in California ISO evaluation of economic and reliability benefits provided by SDG&E's proposed Sunrise 500 kV Transmission line. Calculated value of the renewable resources that the project enables for development based on their contribution towards state RPS requirements, and assessed their renewable procurement benefits relative to other resource options.
- Provided research and visual presentations of energy information to assist the Idaho Legislative Council Interim Committee on Energy, Technology and the Environment in developing the 2007 Idaho Energy Plan.
- Designed optimized sensitivity analysis and user interface, and authored comprehensive user guide for EPRI-sponsored Energy Storage Valuation Tool (ESVT) software, which uses a multiple stakeholder perspective to assess the energy economics and system avoided costs enabled by the use of energy storage devices. Led case studies with multiple utilities to use the Tool to evaluate storage demonstration projects.

## **ELECTRIC POWER RESEARCH INSTITUTE**

*Graduate Student Researcher, Climate Team*

Palo Alto, CA

Summer 2009

- Modeled the impact and value that improved low-carbon generation technologies would create for U.S. and other regions to meet deep greenhouse gas mitigation targets using EPRI's MERGE (Model for Estimating the Regional and Global Effects of Greenhouse Gas Reductions) Model.
- Analyzed long-term economic effect and mitigation costs dynamics that would result from China, India, and other developing nations joining a regime to mitigate climate change on an accelerated or delayed timetable.

## **CORNERSTONE RESEARCH**

Menlo Park, CA

Senior Analyst

2003-2006

- Played key role on case teams which provided economic and financial analysis of liability and damage issues arising in commercial litigation to support experts, attorneys and their client companies. Tasks included: generation of ideas for conceptualization of research agenda, creation of trial presentations and expert report exhibits, and management of junior analysts.
- Provided thorough analysis of anti-trust and accounting-related commercial issues for industries including healthcare, real-estate, alternative fuels, software, and consumer products.
- Developed and executed activity-based costing model of consolidated real estate organization's profitability if it had been operating as multiple regional separate entities; model used to assess claims that firm overcharged customers for services provided.

**DYNEGY, INC.**

Houston, TX

Summer Intern

2001

Supported natural gas trading desk traders by implementing Excel macro-based tool to verify and track natural gas futures and options trades, and provided natural gas market data research.

## Education

Stanford University

Palo Alto, CA

*M.S., Management Science and Engineering*

2009

Stanford University

Palo Alto, CA

*B. A., Economics with Departmental Honors*

2003

*Anna Laura Myers Award for Outstanding Honors Thesis, "Long-Term Consequences of Youth Unemployment"*

## Refereed Papers

1. Williams, J.H., A. DeBenedictis, R. Ghanadan, A. Mahone, J. Moore, W. Morrow, S. Price, and M.S. Torn (2012). "The Technology Path to Deep Greenhouse Gas Emissions Cuts by 2050: The Pivotal Role of Electricity," *Science*, 335, 53-59.
2. Woo, C.K., I. Horowitz, J. Zarnikau, J. Moore, B. Schneiderman, T. Ho, and E. Leung (2016). "What Moves the Ex Post Variable Profit of Natural-Gas-Fired Generation in California?" *The Energy Journal*, 37(3), 29-57.
3. Orans, R., A. Olson, J. Moore, J. Hargreaves, R. Jones, G. Kwok, F. Kahrl and C.K. Woo (2013) "Energy Imbalance Market Benefits in the West: A Case Study of PacifiCorp and CAISO," *The Electricity Journal*, 26(5), 26-36.
4. Woo, C.K., H. Liu, F. Kahrl, N. Schlag, J. Moore, and A. Olson (2012) "Assessing the Economic Value of Transmission in Alberta's Restructured Electricity Market," *The Electricity Journal*, 25:3, 68-80.

5. Woo, C.K., I. Horowitz, J. Moore, and A. Pacheco (2011) "The impact of wind generation on the electricity spot-market price level and variance: The Texas experience," *Energy Policy*, 39:7, 3939-3944.
6. Woo, C.K., J. Zarnikau, J. Moore, and I. Horowitz (2011) "Wind generation and zonal-market price divergence: Evidence from Texas," *Energy Policy*, 39:7, 3928-3938.
7. DeBenedictis A., D. Miller, J. Moore, A. Olson, and C.K. Woo (2011) "How Big Is the Risk Premium in an Electricity Forward Price? Evidence from the Pacific Northwest," *Electricity Journal*, 24:3, 72-76.
8. Woo C.K., I. Horowitz, A. DeBenedictis, D. Miller, and J. Moore (2011) "Cross-Hedging and Forward-Pricing of Electricity in the Pacific Northwest," *Managerial and Decision Economics*, 32, 265-279.
9. Moore, J., C.K. Woo, B. Horii, S. Price, A. Olson (2010) "Estimating the Option Value of a Non-firm Electricity Tariff," *Energy*, 35, 1609-1614.
10. Olson A., R. Orans, D. Allen, J. Moore, and C.K. Woo (2009) "Renewable Portfolio Standards, Greenhouse Gas Reduction, and Long-line Transmission Investments in the WECC," *Electricity Journal*, 22:9, 38-46.
11. Orans, R., S. Price, J. Williams, C.K. Woo, and J. Moore (2007) "A Northern California-British Columbia partnership for renewable energy," *Energy Policy*, 35, 3979-3983.