

ENERGY AND ENVIRONMENTAL ECONOMICS, INC.

San Francisco, CA

Partner

Mr. Schlag has over 15 years of experience in energy analysis. He currently leads E3's Integrated System Planning practice area, where his principal areas of expertise are in resource adequacy & reliability, long-term electricity resource planning under deep decarbonization, and utility strategy. Mr. Schlag has led a number of E3's recent engagements to support utilities in their IRP analyses, including (1) Arizona Public Service, where E3 facilitated stakeholder workshops, provided independent modeling to provide stakeholders access to technical resources, and advised on the narrative development for the 2023 IRP; (2) Salt River Project, where E3 supported a first-of-its-kind integrated system planning process from conceptualization to completion; (3) Public Service Company of New Mexico, where Mr. Schlag provided strategic support to guide the development of the 2023 IRP, identifying resources needed to maintain near-term resource adequacy while positioning PNM for its eventual transition to a carbon-free electricity system; and (4) Xcel Energy, where E3 was asked to provide an independent third-party study of Xcel's long-term plan to decarbonize its electricity supply, an analysis that supported Xcel's recent decisions to commit to early coal plant retirement and nuclear relicensing. Mr. Schlag holds a Master of Science in Civil and Environmental Engineering (Atmosphere and Energy) and a Bachelor of Science in Earth Systems, both from Stanford University.

Mr. Schlag's previous clients include the Balancing Authority of Northern California, Bonneville Power Administration, the California Public Utilities Commission, the California Independent System Operator, Los Angeles Department of Water and Power, Portland General Electric, Public Generating Pool, Seattle City Light, Tucson Electric Power, the Western Electricity Coordinating Council, and the Western Interstate Energy Board. Select E3 projects include:

- **Arizona Public Service, Integrated Resource Planning Support, 2019-present.** Mr. Schlag led an engagement to provide strategic and technical support to APS culminating in the development of its 2020 Integrated Resource Plan. Mr. Schlag oversaw an effort to develop a simplified IRP portfolio model used to facilitate dialog with stakeholders through a series of workshops exploring the impacts of different potential future portfolios and ultimately presented key findings from the effort to the Arizona Corporation Commission. More recently, Mr. Schlag and the E3 team also provided support to APS to assist in the development of its 2023 IRP filing.
- **Salt River Project, Integrated System Plan Scoping & Support, 2021-present.** Mr. Schlag contributed to E3's efforts to support SRP in the initial scoping and development of an analysis plan for its inaugural Integrated System Plan (ISP), a broad effort to coordinate planning functions including integrated resource planning, transmission planning, distribution planning, and customer planning. Mr. Schlag led the development of a scenario analysis approach and also served as a lead liaison with the public advisory group of stakeholders.
- **NV Energy, Integrated Resource Planning Support, 2020-present.** Mr. Schlag has led multiple studies of resource adequacy for NV Energy using a loss-of-load-probability modeling framework. These studies include an analysis of the effective load carrying capability of renewables and

storage (filed in NV Energy's Fourth Amendment to the 2018 Joint IRP) and a quantification of the Planning Reserve Margin requirement needed to achieve a "one-day-in-ten-years" standard for resource adequacy (filed in NV Energy's 2021 Joint IRP). In support of both studies, Mr. Schlag provided expert testimony before the Public Utilities Commission of Nevada. Mr. Schlag has also overseen several studies examining the challenges NV Energy will face in its pursuit of the state's goal to decarbonize the electricity portfolio, including the development of cost-optimized portfolios to meet a range of levels of carbon reductions using the PLEXOS LT capacity expansion model. Mr. Schlag is currently supporting NV Energy with a study to update their PRM and ELCC assumptions for the 2024 Joint IRP.

- **Black Hills Energy, Colorado Electricity Resource Plan Support, 2020-present.** Mr. Schlag led E3's efforts to support Black Hills Energy through multiple phases of its 2022 Energy Resource Plan and Clean Energy Plan filings. In Phase 1, E3 conducted a number of analyses to inform the development of a long-term resource plan consistent with the state of Colorado's aggressive clean energy goals, including loss-of-load-probability modeling, capacity expansion modeling, and production simulation modeling. These plans were developed to meet (or exceed) requirements for 80% greenhouse gas emissions reductions by 2030 and 100% by 2050 and reflected Colorado's social costs of carbon and methane while maintaining system reliability. In Phase 2, E3 conducted detailed bid evaluation analysis using the same tools to support BHE in identifying specific projects to bring forward to the Commission for approval.
- **Public Service Company of New Mexico, Integrated Resource Planning Support, 2019-present.** Mr. Schlag has led E3's team in providing technical and strategic support to PNM through multiple IRP cycles and related processes. In 2020, Mr. Schlag led the development of the IRP report and narrative, which lays out a pathway for the utility to transition to 100% carbon-free energy by 2040. Subsequently, Mr. Schlag provided additional support PNM through a number of regulatory filings related to the IRP Action Plan, which included providing direct testimony regarding the implications of PNM's objective to achieve its goal of 100% carbon-free energy for its ability to maintain resource adequacy. In 2023, Mr. Schlag reprised his role in leading the development of the narrative for PNM's 2023 IRP, which focuses on identifying resources needed to maintain near-term resource adequacy while positioning PNM for its eventual transition to a carbon-free electricity system.
- **Pasadena Water & Power, System Planning Support, 2023-present.** In 2023, under Mr. Schlag's direction, E3 conducted an independent review of PWP's IRP modeling and narrative. Mr. Schlag presented results of this review, which found PWP's IRP to be generally aligned with industry standard practices, to Pasadena City Council at a public meeting. Subsequently, the City of Pasadena hired E3 to work with PWP to develop an Optimized Strategic Plan that would allow the city to meet its goal of sourcing all electricity from carbon-free sources by the end of 2030. Mr. Schlag is currently leading this study, which involves technical analysis of generation, transmission and distribution, and customer programs.
- **Various utilities, Southwest Resource Adequacy Study, 2021-2022.** Mr. Schlag led a study funded by a coalition of utilities to investigate resource adequacy challenges facing the Desert Southwest region in the coming decade; the study's sponsors included Arizona Public Service, Arizona Electric Power Cooperative, El Paso Electric, Public Service Company of New Mexico, Salt River Project, and Tucson Electric Power. The study used on state-of-the-art loss-of-load-probability modeling to assess reliability risks in light of rapidly growing loads, planned resource retirements, the transition towards renewables and storage, and increasing climatic uncertainty. The analysis highlighted a dire need for new capacity within the region to address a rapidly increasing shortfall and explored the possible roles of renewables, storage, and other resources to satisfy these needs.

- **Electric Reliability Council of Texas, Performance Credit Mechanism Implementation, 2023-present.** Mr. Schlag is currently advising E3's team in assisting ERCOT in efforts to implement a "Performance Credit Mechanism" (PCM) to improve system reliability in Texas. The PCM design, adopted by the Public Utilities Commission of Texas following an extensive market redesign process, represents an innovative market-based construct to provide financial incentives to generators to be available during periods of system scarcity. E3's advisory support in this effort spans all aspects of market design, including both technical and administrative elements of the design.
- **Public Utilities Commission of Texas, Assessment of Market Reform Options to Enhance Reliability of the ERCOT System, 2022-2023.** Mr. Schlag oversaw a study to analyze potential market reforms with the objective of improving the reliability of the ERCOT region. Using loss of load probability modeling, E3's analysis evaluated the impacts of various market reforms upon cost, reliability, and impacts on new investment. The study prompted the PUCT to recommend and ultimately adopt an innovative "Performance Credit Mechanism" (PCM) designed to reward generators for their ability to generate during the highest risk periods of the year, providing an additional economic incentive to encourage investment in the types of resources needed to ensure reliability.
- **Tucson Electric Power, Effective Load Carrying Capability Study of Renewables and Storage, 2022-2023.** Mr. Schlag led E3's study to calculate ELCCs for solar, wind, and energy storage to develop inputs for TEP's 2023 IRP. Using E3's RECAP loss-of-load-probability model, Mr. Schlag directed a team that examined how the marginal capacity value of different types of renewables and energy storage resources changed as a function of penetration. The results of E3's study served as direct inputs into TEP's 2023 IRP.
- **Arizona Electric Power Cooperative, Resource Adequacy Study, 2022.** Under Mr. Schlag's direction, E3 worked closely with AEPSCO to apply LOLP modeling techniques to calculate a planning reserve margin requirement and effective load carrying capability values. E3 also worked closely with AEPSCO to devise reasonable methods to apply the results of this analysis to its members in a manner that was both equitable and efficient given differences in load and electric resource portfolios.
- **California Energy Commission, SB100 Implementation Study, 2020.** Mr. Schlag contributed in an advisory capacity to the development of a study examining the investments needed to achieve a California's 100% goal for carbon-free power in 2050. The analysis builds off Mr. Schlag's prior experience working with California state agencies to develop an optimization-based approach to resource planning in the state using E3's RESOLVE model.
- **Xcel Energy, Upper Midwest Integrated Resource Plan Technical Support, 2018-2019.** Mr. Schlag led analysis of the impact of deep decarbonization scenarios on Xcel Energy's Upper Midwest System over the 2020-2034 planning period to support Xcel's IRP filing before the Minnesota Public Utilities Commission. Using E3's RESOLVE and RECAP models, Mr. Schlag identified optimal resource investment portfolios that met resource adequacy needs in the context of state and corporate long-term greenhouse gas reduction targets.
- **Sacramento Municipal Utilities District, Integrated Resource Planning Support, 2018-2023.** In a project evaluating long-term clean energy and greenhouse gas reduction goals in the context of vehicle and building electrification, Mr. Schlag customized E3's RESOLVE model to SMUD's system to develop optimal portfolios of renewable, conventional, and energy storage resources to meet SMUD's electric energy and reliability needs while achieving 90-100% carbon emissions reductions by 2040. More recently, Mr. Schlag directed technical analysis exploring various pathways to achieve a net-zero emissions target by 2030 in response to the SMUD Board's Climate

Emergency Declaration. The results of this analysis served as the basis for SMUD's recent 2030 Zero Carbon Plan.

- **California Public Utilities Commission, Integrated Resource Planning Implementation Support, 2016-present.** Mr. Schlag worked closely with the CPUC in its rollout of a framework and process for integrated resource planning. Mr. Schlag helped design the analytical framework currently in use in the 2017 IRP and managed an E3 team working to develop a "Preferred System Plan"—an optimal resource portfolio consistent with the state of California's long-term greenhouse gas reduction goals—using RESOLVE, E3's in-house capacity expansion model designed for use on high-penetration renewable systems. Mr. Schlag continues to advise E3's team in an ongoing engagement to provide technical support to the IRP process.
- **Public Generating Pool, Pacific Northwest Low Carbon Scenario Analysis, 2017.** Mr. Schlag led a study examining the most effective policy mechanisms to facilitate greenhouse gas reductions in the electric sector in the Pacific Northwest. The study relied on E3's RESOLVE model to compare the relative impacts of expanded RPS goals, carbon caps, carbon taxes, and a prohibition on new gas generation, highlighting the different cost and emissions impacts of each on ratepayers in the Northwest.
- **Los Angeles Department of Water and Power, 100% Clean Energy Study, 2017.** Working directly with LADWP staff, Mr. Schlag designed a work plan for LADWP's 100% Clean Energy Study to be executed over a period of several years. This effort included scoping of a public outreach program, development of potential research partnerships, and preliminary data gathering and validation.
- **California Public Utilities Commission, RPS Program Evaluation Support, 2012-2017.** Mr. Schlag managed an E3 team including four subcontractors to provide multiple services to the CPUC over a five-year period. Foremost among these was the redesign, development, and maintenance of an updated RPS Calculator—tailored specifically to highlight renewable integration challenges at high penetrations—which was used as a key source of inputs in both the CAISO's Transmission Planning Process (TPP) and the CPUC's Long-Term Procurement Proceeding (LTPP). Additional support tasks included development and maintenance of a database of the renewable contracts of the three investor-owned utilities and an assessment of renewable cost, potential, and performance in California and throughout the Western U.S.
- **Northwestern Energy, EIM Benefits Analysis, 2016-2017.** Mr. Schlag led E3's study of the benefits to NWE of participating in the Western EIM. The E3 team worked closely NWE staff to model the effect of NWE's EIM participation on system operations using PLEXOS production simulation software, providing a clear illustration of the EIM value proposition.
- **Balancing Authority of Northern California, EIM Benefits Analysis, 2016.** Mr. Schlag led E3's study of the benefits to BANC members of participating in the Western EIM. The E3 team worked closely with representatives from all BANC members to model the operations of their respective electric systems accurately using PLEXOS production simulation software, providing a clear illustration of the EIM value proposition for each BANC member.
- **Seattle City Light, EIM Benefits Analysis, 2016.** Mr. Schlag led the assessment of Seattle City Light's prospective benefits of participation in the Western EIM. E3's analysis for SCL was designed specifically to highlight the value of Seattle's flexible hydroelectric generation fleet in the EIM's 15- and 5-minute markets, using dispatch optimization software and historical market prices to quantify the value of arbitrage opportunities.
- **California Independent System Operator, SB350 Regionalization Study, 2015-2016.** Mr. Schlag contributed to E3's work as part of a consulting team studying the benefits of expanding the CAISO to a broader regional entity in accordance with California's Senate Bill 350. Using RESOLVE, Nick helped to design the alternative portfolios used as the basis for identifying the potential infrastructure impacts (and associated fixed cost savings) of ISO expansion.

- **Western Electricity Coordinating Council & Western Interstate Energy Board, Western Interconnection Flexibility Assessment, 2014-2016.** Working in partnership with the National Renewable Energy Laboratory, an E3 team managed by Mr. Schlag completed a thorough examination of the flexibility of the generation fleet of the Western Interconnection and its ability to integrate high penetrations of renewable generation. The study identified both operational challenges as well as institutional and physical solutions to facilitate renewable integration across the region.
- **Western Interstate Energy Board, Western Gas-Electric Study, 2013-2014.** Mr. Schlag managed a two-phase study of gas-electric coordination in the Western Interconnection to investigate whether the natural gas infrastructure in the West would be sufficient to meet future needs of the electric sector, considering both the anticipated retirements of a sizeable portion of the Western coal fleet as well as the increasing penetrations of intermittent renewable resources.
- **PG&E, SCE, SDG&E, LADWP & SMUD, Investigating a Higher Renewables Portfolio Standard for California, 2013.** As part of the E3 team, Mr. Schlag helped to design and analyze a range of renewable portfolios to meet a 50% Renewables Portfolio Standard, using production simulation to evaluate integration challenges and calculating the corresponding rate impacts for California ratepayers.
- **Portland General Electric, Low Carbon Portfolio Development, 2012.** Mr. Schlag worked with PGE staff and a group of environmental stakeholders to create a low carbon portfolio for analysis in PGE's 2012 Integrated Resource Plan. The portfolio was designed to include higher penetrations of renewable generation and accelerated achievement of efficiency goals.
- **Western Electricity Coordinating Council, Cost and Performance Review of Generation Technologies, 2012.** Mr. Schlag led E3's literature review of the cost and performance of new electric generation technologies, which culminated in a report to WECC staff with recommended assumptions for use in its 10- and 20-year study processes.

STANFORD UNIVERSITY

Teaching Assistant

Palo Alto, CA

2008-2009

- Assisted students with coursework in engineering classes related to energy efficiency, electric power, and meteorology; facilitated students' experiments in the Renewable Energy Laboratory

ROCKY MOUNTAIN INSTITUTE

MAP Sustainable Energy Fellow

Boulder, CO

Summer 2008

- Awarded three-month MAP Sustainable Energy Fellowship sponsored by MAP Royalty, Inc. to conduct research on the energy efficiency potential in residential, commercial, and industrial sectors of the United States as part of RMI's Next Generation Utilities project

STOCKHOLM ENVIRONMENT INSTITUTE

Donald Kennedy Environmental Fellow

Stockholm, Sweden

Summer 2007

- Awarded Donald Kennedy Environmental Fellowship through Stanford in Government to study benefits of clean cooking fuels in Sub-Saharan Africa, research that culminated with a working paper on the market barriers to clean cooking fuel adoption

Education

Stanford University
M.S., Atmosphere and Energy (Civil & Environmental Engineering)

Palo Alto, CA
2009

Stanford University
B.A., Earth Systems (Energy Science and Technology)

Palo Alto, CA
2008

Expert Witness Testimony

1. *Public Utilities Commission of Nevada, 2020, testified on behalf of NV Energy in its Fourth Amendment to 2018 Joint Triennial Integrated Resource Plan proceeding regarding the effective load carrying capability (ELCC) of renewable and energy storage resources and the value of diverse renewable resources in helping NV Energy meet Nevada’s goal of 100 percent zero-carbon energy by 2050*
2. *Public Utilities Commission of Nevada, 2021, testified on behalf of NV Energy in its 2021 Joint Triennial Integrated Resource Plan to support an update to NV Energy’s Planning Reserve Margin (PRM) requirement based on a loss of load probability analysis to identify the amount of capacity needed to meet a “one-day-in-ten-years” standard*
3. *New Mexico Public Regulation Commission, 2021, testified on behalf of Public Service Company of New Mexico in the company’s filing for the abandonment and replacement of leased shares of the Palo Verde Nuclear Generating Station regarding best practices in planning for resource adequacy and the challenges that the company will face in its transition to 100 percent carbon-free energy*
4. *Colorado Public Utilities Commission, 2021-2022, testified on behalf of Black Hills Energy in its Clean Energy Plan (CEP) filing as a technical expert supporting analysis of the utility’s future resource adequacy needs and optimization of portfolios to meet the greenhouse gas reduction targets of 80% below 1990 levels by 2030 and 100% clean energy by 2050*
5. *Public Utilities Commission of Nevada, 2023, testified on behalf of NV Energy in the Fifth Amendment to the 2021 Joint IRP supporting NV Energy’s continued use of E3’s PRM and ELCC analysis and providing commentary on evolving risks related to resource adequacy in the Western Interconnection*

Publications

1. Burdick, A., **N. Schlag**, A. Au, R. Go, Z. Ming, & A. Olson (2022). “Lighting a Reliable Path to 100% Clean Electricity.” IEEE Power and Energy Magazine, 20(4):30-43.
2. Stenclik, D., M. Ahlstrom, S. Awara, J. Bakke, A. Bloom, W. Cole, E. Delaney, A. Dobbie, S. Elsevier, A. Acevedo, B. Frew, E. Hart, W. Henson, E. Ibanez, J. Jin, W. Lamanna, C. Lau, J. Matevosyan, M. Milligan, K. Parks, R. Pungaliya, **N. Schlag**, J. Sharp, E. Smeloff, G. Stephen, A. Tuohy, M. Welch, P. Wong (2023). Ensuring Efficient Reliability: New Design Principles for Capacity Accreditation. A

Report of the Redefining Resource Adequacy Task Force. Reston, VA. <https://www.esig.energy/new-design-principles-for-capacity-accreditation>.

3. Stenclik, D., A. Bloom, W. Cole, G. Stephen, A. Acevedo, R. Gramlich, C. Dent, **N. Schlag**, & M. Milligan (2021). "Quantifying Risk in an Uncertain Future: The Evolution of Resource Adequacy," IEEE Power and Energy Magazine, 19(6): 29-36.
4. **Schlag, N.**, Z. Ming, A. Olson, L. Alagappan, B. Carron, K. Steinberger, & H. Jiang (2020). "Capacity and Reliability Planning in the Era of Decarbonization." <https://www.ethree.com/wp-content/uploads/2020/08/E3-Practical-Application-of-ELCC.pdf>.
5. **Schlag, N.**, Z. Ming, & A. Olson (September 2020). "Adding it all up: Counting the capacity contribution of variable and duration limited resources." Utility Dive. <https://www.utilitydive.com/news/adding-it-all-up-counting-the-capacity-contribution-of-variable-and-durati/584843/>.
6. **Schlag, N.**, D. Mullen, & K. Patel. (April 2019). "Moving beyond 'rules of thumb' for smart, cost-effective storage deployment." Utility Dive. <https://www.utilitydive.com/news/moving-beyond-rules-of-thumb-for-smart-cost-effective-storage-deployment/553674/>.
7. Woo, C.K., Y. Chen, A. Olson, J. Moore, **N. Schlag**, A. Ong, & T. Ho. (2017). "Electricity price behavior and carbon trading: New evidence from California," Applied Energy, Elsevier, vol. 204(C): 531-543.
8. Olson, A., C.K. Woo, **N. Schlag** & A. Ong (2016). "What Happens in California Does Not Always Stay in California: The Effect of California's Cap-and-Trade Program on Wholesale Electricity Prices in the Western Interconnection," The Electricity Journal, 29(7), 18-22.
9. Olson, A., E. Hart, J. Hargreaves, R. Jones, **N. Schlag**, G. Kwok, N. Ryan, R. Orans, & R. Frowd, "Halfway There: Can California Achieve a 50% Renewable Grid?," IEEE Power and Energy Magazine, 13(4): 41-52.
10. Woo, C.K., H. Liu, F. Kahrl, **N. Schlag**, J. Moore, & A. Olson (2012). "Assessing the economic value of transmission in Alberta's restructured electricity market." Electricity Journal, 25(3): 68-80.