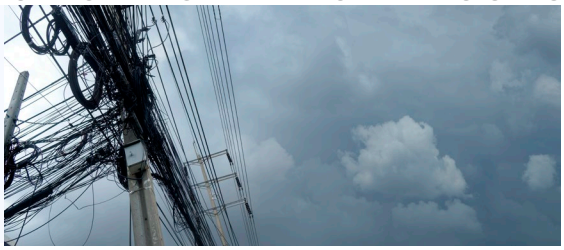
NATIONAL ACADEMIES Sciences Engineering Medicine

BOARD ON ENERGY AND ENVIRONMENTAL SYSTEMS

Electricity System Operability and Reliability under Increasing Complexity

A Workshop



National Academy of Sciences Building
2101 Constitution Ave., N.W.
Washington, DC 20418

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PURPOSE

The key focus of this workshop is to understand how to maintain and improve the operational integrity of the United States' electricity grid while it integrates increasing quantities of distributed, complex elements.

Workshop sessions will consider advances in technologies, energy equity and affordability imperatives, market mechanisms, as well as policy and regulatory frameworks as they pertain to supporting the electricity system's operational integrity.

This workshop will convene leaders from government, industry, academia, and nongovernmental organizations with the aim of forging relationships and opening communication channels for collaborative work towards building a more robust and flexible electricity system in the face of these challenges. A written proceedings will be produced, published, and disseminated to document and distribute the ideas presented during this workshop.

MONDAY, JUNE 17, 2024

Purpose

- Outline major technical changes occurring across the electricity system – load is increasingly uncertain, generation increasingly intermittent, the system is growing increasingly distributed and complex.
- Explore the changing electricity system landscape from market adoption, consumer, and equity perspectives.

All times are Eastern Daylight Time

8:30 **Welcome**

Lecture Room

Brent Heard, *Board on Energy and Environmental Systems, National Academies*

Anu Annaswamy, Planning Committee Chair, *Massachusetts Institute of Technology*

8:35–10:30 **Session 1: What Keeps Grid Operators Up at Night?**

Lecture Room

Keynote: Gene Rodrigues, *Department of Energy*

Panel presentations followed by moderated discussion with Mark Lauby, *North American Electric Reliability Corporation*

- Karen Onaran, *Electricity Consumers Resource Council*
- Julieta Giráldez, *Electric Power Engineers*
- Venkat Banunarayanan, *National Rural Electric Cooperative Association*

- Gordon Van Welie, *ISO-New England*
- Katie Dykes, *Connecticut Department of Energy & Environmental Protection*

10:40–11:00 **Mid-Morning Coffee Break**
East Court

11:00–1:00 **Session 2: How do we compensate DERs and keep the lights on? Markets, equity, and consumer adoption lenses**
Lecture Room

Keynote: Sue Tierney, *Analysis Group*

Panel presentations followed by moderated discussion with Anu Annaswamy, Planning Committee Chair, *Massachusetts Institute of Technology*

- Anne Hoskins, *Generac*
- Utopia Hill, *Reactivate*
- Lauren Shwisberg, *RMI*
- JP Carvallo, *Lawrence Berkeley National Laboratory*

1:00–2:00 **Lunch**
East Court

2:00–3:30 **Session 3 (pt. 1): Moderated Breakout Sessions & Conversations**

Breakout Topic	Moderator	Room Number	Zoom Link
Future grid as an ecosystem: challenges and opportunities	Deepak Divan	118	https://nasem.zoom.us/j/92374901052
Managing load growth on an increasingly complex electricity system	Julieta Giráldez	250	https://nasem.zoom.us/j/96214453091
Just, equitable, and inclusive planning practices for the future electricity system	Shay Banton	280	https://nasem.zoom.us/j/97491775582
Cyber & physical security needs for an increasingly distributed and IOT-heavy electricity system	Jeff Dagle	114	https://nasem.zoom.us/j/97753844165

3:30–4:00 **Afternoon Break**
East Court

4:00–5:30 **Session 3 (pt. 2): Reconvene and Report-Out Key Insights from Breakouts**
Lecture Room

5:30 **Reception**
East Court

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TUESDAY, JUNE 18, 2024

Purpose

- Discuss navigating varied policy realities, regulatory jurisdictions, and legal considerations across the electricity system.

8:45 AM **Welcome**

Lecture Room

Brent Heard, *Board on Energy and Environmental Systems, National Academies*

Anu Annaswamy, Planning Committee Chair, *Massachusetts Institute of Technology*

8:55–10:30 **Session 4: How do we regulate a complex electricity system with increasing distributed energy resources?**

Lecture Room

Panel presentations followed by moderated discussion with Janet Gail Besser

- Ann E. Rendahl, *Washington Utilities and Transportation Commission; Second Vice President, NARUC*
- Dede Subakti, *California ISO*
- Ryan Katofsky, *Advanced Energy United*
- David Brown, *University of Alberta*
- Erica S. McConnell, *Environmental Law & Policy Center*
- Richard Glick, *GQ New Energy Strategies (former FERC commissioner)*

10:30–11:00 **Mid-Morning Coffee Break**

East Court

11:00–12:30 **Session 5 (pt. 1): Moderated Breakout Sessions & Conversations**

Breakout Topic	Moderator	Room Number	Zoom Link
Role for virtual power plants	Debbie Lew	280	https://nasem.zoom.us/j/98988803702
Grid planning needs & technical architectures	Anjan Bose	114	https://nasem.zoom.us/j/92510312078
Opportunities for munis and coops to try new technologies	Murali Baggu	118	https://nasem.zoom.us/j/95405709400
How can we build a more resilient electricity system that serves our communities equitably?	Elizabeth Stein	250	https://nasem.zoom.us/j/91550971165

12:30–1:30 **Lunch**
East Court

1:30–2:45 **Session 5 (pt. 2): Reconvene and Report-Out Key Insights from Breakouts**
Lecture Room

2:45–3:00 **Closing Remarks**
Lecture Room
Brent Heard, *Board on Energy and Environmental Systems, National Academies*
Anu Annaswamy, *Massachusetts Institute of Technology*

3:00 **Adjourn Workshop**

PLANNING COMMITTEE BIOGRAPHIES

CHAIR

Anuradha M. Annaswamy, Massachusetts Institute of Technology

Dr. Anuradha Annaswamy is the Founder and Director of the Active-Adaptive Control Laboratory in the Department of Mechanical Engineering at MIT. Her research interests span adaptive control theory and its applications to aerospace, automotive, propulsion, and energy systems as well as cyber-physical systems such as Smart Grids, Smart Cities, and Smart Infrastructures. She has received best paper awards (Axelby; CSM), as well as Distinguished Member and Distinguished Lecturer awards from the IEEE Control Systems Society (CSS) and a Presidential Young Investigator award from NSF. She is a Fellow of IEEE and the International Federation of Automatic Control. She is the recipient of the Distinguished Alumni Award from Indian Institute of Science for 2021. Anu Annaswamy received her Ph.D. in Electrical Engineering from Yale University in 1985. She has served as a faculty member at Yale, Boston University, and MIT. She is the author of a graduate textbook on adaptive control, co-editor of two vision documents on smart grids as well as two editions of the Impact of Control Technology report, author of several journals and conference publications, and a member of the National Academy of Sciences Committee study that published a report on the Future of Electric Power in the United States in 2021. She served as the President of CSS in 2020. She has been serving as a Faculty Lead in the Electric Power Systems workstream in the MIT Future Energy Systems Center since September 2021.

MEMBERS

Murali Mohan Baggu, National Renewable Energy Laboratory

Dr. Murali Baggu is Laboratory Program Manager for grid integration at the National Renewable Energy Laboratory (NREL). In his current capacity, he holds a pivotal role in overseeing various programs critical to advancing grid integration, including the Department of Energy Office of Electricity, Grid Deployment Office, and Grid Modernization Laboratory Consortium initiatives at NREL. Notably, Baggu spearheads NREL’s groundbreaking research in Advanced Distribution Management Systems (ADMS) and plays a pivotal role in the Puerto Rico Grid Recovery and Resilience endeavor. He is also a Co-Principal Investigator of PR100: Puerto Rico Grid Resilience and transition to 100% Renewable Energy Study. Dr. Baggu's research interests are anchored in the fields of grid integration of renewable energy systems, encompassing both wind and photovoltaic sources, energy storage system integration, and the intricate domains of distribution automation and grid operations and control. His noteworthy accomplishments are reflected in his portfolio, which includes an array of five patents and more than eighty publications that have significantly contributed to the advancement of these research areas. Baggu has a Ph.D. in Power Engineering from Missouri S&T.

Shay Banton, Interstate Renewable Energy Council

Shay Banton (they/them) is an energy systems and policy specialist and M.S. candidate in Energy Policy and Climate at Johns Hopkins University. They currently serve as a Regulatory Program Engineer and Energy Justice Policy Advocate for the Interstate Renewable Energy Council, where they lead the development of regulatory frameworks for evaluating inequities within DER interconnection processes and are co-authoring an innovative integrated distribution planning guidebook for prioritizing equity-centered, climate-resilient distribution system investments. They also consult for the non-profit Just Solutions, where they are researching resilience applications for long-duration energy storage systems in enabling economical and climate-resilient microgrids for frontline communities. One of Shay's most significant career accomplishments was during their time with the Department of Energy's Solar Energy Technologies Office, where they co-led the development of one of the agency's most ambitious interagency programs aimed at addressing nationwide interconnection challenges, the Interconnection Innovation eXchange. Shay holds a B.S. in Systems Science and Engineering from Washington University in St. Louis.

Janet Gail Besser

Janet Gail Besser is a nationally recognized energy policy and regulatory strategy expert, with experience as a regulator, clean energy business association leader, utility executive, developer, consultant, and consumer advocate. She is currently moderating the New England Electricity Restructuring Roundtable and undertaking other select projects. Previously, Janet was VP of Regulatory and Business Innovation at the Smart Electric Power Alliance; EVP of the Northeast Clean Energy Council; VP, Regulatory Strategy and Policy at National Grid; Chair and Commissioner of the Massachusetts Department of Public Utilities; and an executive and expert at Analysis Group and Lexecon. She held senior staff roles at the Massachusetts Energy Office and New Hampshire Public Utilities Commission, was policy director for a national IPP association, and worked for a small hydro developer and low-income consumer advocate. In 2022-23, Janet chaired the National Academies of Science, Engineering and Medicine (NASEM) Committee on the role of net metering in the evolving electricity system. She is the chair of the Power Options Board and serves on the VEIC Board where she chairs the Impact and Evaluation Committee. She has an MPP from the Kennedy School of Government, Harvard University and a B.A., magna cum laude, from Williams College.

Jeffery Dagle

Jeff Dagle has worked at the Pacific Northwest National Laboratory in Richland Washington, operated by Battelle for the U.S. Department of Energy (DOE), since 1989. He has expertise in power system modeling, analysis, and advanced measurements, supporting or leading numerous projects in the areas of transmission reliability and security. Recent project highlights include leading the North American SynchroPhasor Initiative and serving on the leadership team of the DOE Grid Modernization Laboratory Consortium, leading the multi-laboratory system operations and control technical area. Mr. Dagle is the co-director of the Advanced Grid Institute, a joint institute with Washington State University. He is a Senior Member of the IEEE and currently serves as the vice president for the eastern region of the Washington Society of Professional Engineers. He received B.S. and M.S. degrees in Electrical Engineering from Washington State University in 1989 and 1994, respectively, and is a registered professional engineer in the State of Washington.

Debra Lew

Dr. Lew is the Associate Director of the Energy Systems Integration Group (ESIG) which is an educational, member-driven organization that provides peer learning on state-of-the-art issues in electricity and energy systems integration. She has expertise in wind, solar, and distributed energy resources integration and a focus on 100% clean energy systems. She is a Past Chair of the IEEE PES Renewables Systems Integration Coordinating Committee, member of IEEE Standards Committee 21

that focuses on DER standards including IEEE 1547, and a member of the IEA Wind Task 25. She has written numerous papers and speaks globally on issues of energy systems integration. She previously worked at the National Renewable Energy Laboratory, GE, the International Institute for Energy Conservation, Princeton University, and was seconded to Hawaiian Electric Company during 2009-2010. She has a PhD and MS in Applied Physics from Stanford and BS degrees in Electrical Engineering and Physics from MIT.

INVITED SPEAKERS, PANELISTS, AND BREAKOUT MODERATOR BIOGRAPHIES | ALPHABETICAL ORDER

Venkat Banunarayanan, *National Rural Electric Cooperative Association*

Venkat Banunarayanan is the Vice President of Integrated Grid NRECA's Business & Technology Strategies unit. He has 22 years of experience leading and executing energy-related projects involving power system analysis, data analytics, grid optimization, renewables integration, techno-economic feasibility and benefit-cost studies. At NRECA, his role is to lead the development of tools, resources and partnerships for member cooperatives to successfully evaluate opportunities for distribution grid optimization and value extraction, enabling reliable and cost-effective grid operations with high penetration of distributed energy, and business models for cooperatives to function as the trusted energy advisor for their communities. Venkat holds a doctorate in Electrical Engineering and an M.B.A in Finance, is certified as a Project Management Professional (PMP®), has worked previously at the United States Department of Energy, ICF International, and General Electric's Energy division.

Anjan Bose*, Washington State University*

Dr. Anjan Bose (NAE) has over forty years of experience in industry and academia, as an engineer, educator, and administrator. He is well known as a technical leader in the power grid control industry, a researcher in electric power engineering, an educator in engineering, and an administrator in higher education. He is a Regents Professor at Washington State University (WSU), where he also served as the Dean of Engineering and Architecture (1998-2005) and in 2012-13 served as a Senior Advisor to the US Department of Energy (DOE) in the Obama administration. Dr. Bose is a Member of the US National Academy of Engineering (2003) and has served on many National Academy Committees. He is a founding Member of the Washington State Academy of Sciences and has been elected as its President. He is also a Foreign Fellow of the Indian National Academy of Engineering. He is a Fellow of the IEEE and is active in several international professional societies. He was the recipient of the Outstanding Power Engineering Educator Award (1994), the Third Millenium Medal (2000) and the Herman Halperin Electric Transmission & Distribution Award (2006), from the IEEE. He has been recognized as a distinguished alumnus of the Indian Institute of Technology, Kharagpur (2005) and the College of Engineering at Iowa State University (1993). At Washington State University, Dr. Bose is Regents Professor in the School of Electrical Engineering and Computer Science, holds the endowed Distinguished Professorship in Power Engineering, and is the Site Director of the NSF sponsored Power System Engineering Research Center. In Fall 2005, he served as a Senior Advisor to the Federal Energy Regulatory Commission in Washington, DC on leave from the university. From 1998 to 2005 he served as the Dean of the College of Engineering and Architecture and before that, from 1993 to 1998, he was the Director of the School of Electrical Engineering and Computer Science. Before joining WSU, Dr. Bose was on the faculty of Arizona State University (ASU), where he directed the Electric Power Research Laboratory that he helped establish in 1982. In addition, his own research group became internationally known for applying computation technology to the control and analysis of large power grids. In 1988-89, he was on leave from the university to manage the Program on Engineering Systems (Power) at the National Science Foundation. Before ASU, Dr. Bose worked for Control Data Corporation in their Energy Management Systems Division (now Siemens Energy Management & Information Systems). He administered a research group of over a dozen professionals and played a crucial role in the technical leadership of the division ($50 million yearly revenue), which became the leading vendor of power system

control centers during this time. Major breakthroughs in power system control technology under his leadership are industrial practice today. He has continued to be a technical leader in this industry and a prominent consultant. He has served on several editorial boards of IEEE publications and the McGraw-Hill Encyclopedia of Science & Technology. He has also served, some as chair, on several international technical committees and conference organizations. He was appointed by the governor to the board of the Washington Technology Center (served as Vice-Chair for three years), and by the US Secretary of Energy on the committees to study the 1999 and 2003 power blackouts. He has consulted for the electric power industry throughout the world and has been an advisor to several governments on grid related issues.

David Brown, *University of Alberta*

David Brown is a Professor in the Department of Economics at the University of Alberta where he holds a Canada Research Chair in Energy Economics & Policy. His research lies at the intersection of energy economics, industrial organization, and regulatory policy. David's recent work considers questions in the electricity sector ranging from market design, market power, and pricing mechanisms for demand-side management and emerging technology adoption such as rooftop solar, battery storage, and electric vehicles. The objective of his work is to design regulatory policies to improve the operation of electricity markets. David is the President of the Canadian Association for Energy Economists, Faculty Affiliate at Stanford University's Program on Energy and Sustainable Development, and serves as a Co-Editor at *Resource and Energy Economics*, Senior Associate Editor of *The Electricity Journal*, and on the Editorial Boards of *Utilities Policy* and *Competition and Regulation in Network Industries*.

JP Carvallo, *Lawrence Berkeley National Laboratory*

Juan Pablo Carvallo is a Research Scientist in the Energy Markets and Policy department at Lawrence Berkeley National Laboratory. His research areas at the Lab focus on long-term power system planning, integration and planning of distributed energy resources and electric vehicles, and reliability and resilience valuation. Dr. Carvallo holds Ph.D. and M.S. degrees in Energy and Resources from the University of California, Berkeley, as well as P.E. and B.S. degrees in Electronics Engineering from Universidad Técnica Federico Santa Maria, Chile.

Deepak Divan, *Georgia Tech*

Dr. Deepak Divan is Professor, John E Pippin Chair, GRA Eminent Scholar, and Director of the Center for Distributed Energy at the Georgia Institute of Technology in Atlanta, GA. His field of research is in the areas of power electronics, power systems, smart grids, and distributed control of power systems. He works closely with utilities, industry and is actively involved in research, teaching, entrepreneurship and starting new ventures. Dr. Divan also serves as Founder and Chief Scientist at Varentec, in Santa Clara, CA, and was President and CTO from 2011-14, leading the company as it developed its suite of innovative distributed real-time grid control technologies. Varentec is funded by leading green-tech Venture Capital firm Khosla Ventures and renowned investor Bill Gates. Dr. Divan is an elected Member of the US National Academy of Engineering, member of the National Academies Board on Energy and Environmental Systems, a Fellow of the IEEE, past President of the IEEE Power Electronics Society, and is a recipient of the IEEE William E Newell Field Medal. He has 40 years of academic and industrial experience, 65 issued and pending patents, and over 400 refereed publications. He has founded or seeded several new ventures including Soft Switching Technologies, Innovolt, Varentec and Smart Wires, which together have raised >$160M in venture funding. He received his B. Tech from IIT Kanpur, and his M.S. and Ph.D. degrees from the University of Calgary, Canada.

Katie Dykes, *Connecticut Department of Energy & Environmental Protection*

Katie Dykes is the Commissioner of Connecticut’s Department of Energy & Environmental Protection (DEEP). She has served since 2019, when she was first nominated by Governor Ned Lamont, and was

re-confirmed in February 2023 to serve in Governor Lamont's second term. Katie previously served as Chair of the Connecticut Public Utilities Regulatory Authority (PURA) from 2015-2018, and as Deputy Commissioner for Energy at Connecticut DEEP from 2012-2015. Katie also serves as the Chair of the Board of Directors of the Regional Greenhouse Gas Initiative, Inc. (RGGI). Katie joined CT DEEP in March 2012 after prior service in the White House Council on Environmental Quality and the U.S. Department of Energy. She is a graduate of Yale College and the Yale Law School.

Julieta Giráldez, *Julieta Energy*

A leader in the renewable energy sector, Julieta Giráldez focuses on solving integrated grid planning challenges and the way DERs interact with the grid. Prior to starting her independent consulting firm, Dr. Giráldez was a Principal of Customer Solutions at Kevala, a grid-intelligence-focused data and analytics company. Before Kevala, Dr. Giráldez worked for the National Renewable Energy Laboratory (NREL) where she led Distributed Energy Resources (DER) grid integration related projects. She brings a holistic view of grid integration related issues, acknowledging the importance of including multiple perspectives in the evaluation of new emerging technologies, from developers and customers to technology providers, regulators and utilities. Dr. Giráldez holds a P.h.D. in Systems Engineering from Colorado State University, an M.S. in Electrical Engineering from the Colorado School of Mines and a B.S in Technical Mining and Energy Resources from the Polytechnic University of Madrid, Spain.

Richard Glick, *GQ New Energy Strategies*

Rich Glick is a Principal with GQ New Energy Strategies – a consulting firm he co-founded with Pamela Quinlan. He recently completed a five-year term as a Commissioner with the Federal Energy Regulatory Commission (FERC) where he chaired the Commission between January 21, 2021 and January 3, 2023. As Chairman, Mr. Glick initiated a number of key initiatives, including proposals to reform the planning and cost allocation process for electric transmission; expedite and enhance the generator interconnection process; improve the operation of organized electric capacity markets; and protect the reliability of the electric grid against weather-related, cybersecurity, and physical attack threats. Prior to serving at FERC, Mr. Glick was the General Counsel for the Democrats on the Senate Energy and Natural Resources Committee, serving as a senior policy advisor on numerous issues, including electricity and renewable energy. Prior to that, he was Vice President of Government Affairs for Iberdrola's renewable energy, natural gas storage, and electric and gas utility businesses in the United States. He ran the Company's Washington, D.C. office and was responsible for developing and implementing the U.S. businesses' federal legislative and regulatory policy advocacy strategies. Mr. Glick previously served as a Director of Government Affairs for PPM Energy and prior to that he held the same position with PacifiCorp. He also served as a Senior Policy Advisor to U.S. Energy Secretary Bill Richardson, and before that was the Legislative Director and Chief Counsel to U.S. Senator Dale Bumpers, of Arkansas. From 1988-1992, he was an Associate with the law firm of Verner, Liipfert, Bernhard, McPherson and Hand. Mr. Glick is a graduate of George Washington University and Georgetown Law.

Utopia Hill, *Reactivate*

Utopia Hill is the Chief Executive Officer at Reactivate. Utopia provides leadership and strategic direction to a diverse, rapidly growing, innovative team. In her role, she manages and fosters relationships with industry partners, businesses, and communities, while also growing the company to ensure positive environmental and social impacts to the communities served by Reactivate projects. Utopia previously served as Head of Engineering, Procurement, and Construction (EPC) at Reactivate and as Vice President of Renewables Construction for Invenergy. After beginning her career at General Electric, Utopia spent nearly two decades at Invenergy in roles within engineering, procurement, and construction. She has been involved in over10,000 MW of renewables projects including wind, solar and energy storage. Utopia has been recognized for her sharp intellect, detailed dedication to project execution, and ability to effectively collaborate with cross-functional teams. Utopia previously served as

the Board Vice-President for the Boys & Girls Club of West Cook County, where she actively worked to ensure STEM related programming was taught to the members, many from low-income and underrepresented communities. Utopia has a degree in Aerospace Engineering from the University of Illinois at Urbana-Champaign and has completed Executive Education coursework at Harvard Business School.

Anne Hoskins, *Generac*

Anne Hoskins is the Senior Vice President of Policy and Market Development at Generac Power Systems, where she serves on the Energy Technology leadership team. Generac is a leading energy technology company that provides back-up power systems for home and industrial use, solar/battery solutions and virtual power plant platforms. Anne advocates for regulatory and legislative initiatives to accelerate distributed clean energy deployment, modernize the electric grid and improve energy resiliency and reliability. She has almost two decades of regulatory, policy and strategy experience across multiple organizations in the energy and telecommunications industries, including serving as Chief Policy Officer of Sunrun, Commissioner on the Maryland Public Service Commission, Senior Vice President of Policy and Sustainability at Public Service Enterprise Group and Senior Counsel at Verizon Wireless. Anne has advanced regulatory innovation through serving on the Boards of Directors of the National Association of Regulatory Utility Commissioners (NARUC), the Interstate Renewables Energy Council and the Solar Energy Industries Association. Anne is a frequent public speaker on energy policy and served as the first visiting research scholar at the Andlinger Center for Energy and the Environment at Princeton University. She is a graduate of Harvard Law School, the Princeton School of Public and International Affairs (MPA), and Cornell University (BS, Applied Economics).

Ryan Katofsky, *Advanced Energy United*

Ryan Katofsky leads Advanced Energy United's industry and market analysis work in support of United's policy and regulatory engagement. He provides data-driven analysis, research, and thought leadership on the big cross-cutting issues affecting the entire industry as well as on more focused policy-specific matters. Prior to joining United in 2013, Ryan spent 20 years consulting the advanced energy industry, utilities, and the public sector at Arthur D. Little, Navigant Consulting, and as an independent consultant.

Mark Lauby, *North American Electric Reliability Corporation*

Mark G. Lauby (NAE) is senior vice president and chief engineer at NERC. Mr. Lauby joined NERC in January 2007 and has held several positions, including vice president and director of Standards and vice president and director of Reliability Assessments and Performance Analysis. In 2012, Mr. Lauby was elected to the North American Energy Standards Board and was appointed to the Department of Energy's Electric Advisory Committee by the Secretary of Energy in 2014. Mr. Lauby has served as chair and is a life member of the International Electricity Research Exchange and served as chair of several Institute of Electrical and Electronics Engineers (IEEE) working groups. From 1999 to 2007, Mr. Lauby was an appointed member of the Board of Excellent Energy International Co., Ltd., an energy service company based in Thailand. He has been recognized for his technical achievements in many technical associations, including the 1992 IEEE Walter Fee Young Engineer of the Year Award. He was named a Fellow by IEEE in November 2011 for "leadership in the development and application of techniques for bulk power system reliability." In 2014, Mr. Lauby was awarded the IEEE Power and Energy Society's Roy Billinton Power System Reliability Award. In 2020, the National Academy of Engineering elected Mr. Lauby as a member, citing his development and application of techniques for electric grid reliability analysis. He is also a member of the IEEE Power & Energy Society (PES) Executive Advisory Committee, focused on providing strategic support to the PES Board of Directors. Prior to joining NERC, Mr. Lauby worked for the Electric Power Research Institute (EPRI) for 20 years, holding several senior positions, including: director, Power Delivery and Markets; managing director, Asia, EPRI International; and manager, Power System Engineering in the Power System Planning and Operations Program. Mr. Lauby

began his electric industry career in 1979 at the Mid-Continent Area Power Pool in Minneapolis, Minnesota. His responsibilities included transmission planning, power system reliability assessment, and probabilistic evaluation. Mr. Lauby is the author of more than 100 technical papers on the subjects of power system reliability, expert systems, transmission system planning, and power system numerical analysis techniques. He earned his bachelor's and master's degrees in Electrical Engineering from the University of Minnesota. In addition, Mr. Lauby attended the London Business School Accelerated Development Program as well as the Executive Leadership Program at Harvard Business School.

Erica S. McConnell, *Environmental Law & Policy Center*

Erica McConnell is a Staff Attorney at ELPC. She is based in Columbus and focuses on clean energy issues across the Midwest. Prior to joining ELPC, Erica was an attorney at Shute, Mihaly & Weinberger and, before that, Keyes & Fox. Among other clients, Erica represented the Interstate Renewable Energy Council (IREC) in regulatory proceedings across the United States. Her areas of expertise include shared/community renewable energy, net metering, solar permitting, grid modernization, interconnection, and renewables integration. Before law school, Erica was a Program Associate at the Consortium for Energy Efficiency, working on residential energy efficiency programs. Erica received her law degree from University of California, Berkeley, School of Law, a Master of Environmental Management degree from the Yale School of the Environment, and a bachelor's degree in Ethics, Politics & Economics from Yale University.

Karen Onaran, *Electricity Consumers Resource Council*

Karen Onaran is the Vice President of the Electricity Consumers Resource Council (ELCON) where she advocates for policies benefiting large industrial consumers of electric energy before the Federal Energy Regulatory Commission (FERC), the Department of Energy (DOE), the North American Reliability Corporation (NERC), and Congress. Prior to joining ELCON, Karen was the Director of Federal Regulatory Affairs at Edison Electric Institute (EEI) where she focused on federal electric transmission policy issues, supporting investor-owned utilities on transmission planning and investment issues, as well as wholesale market operations, to promote policies geared towards electric transmission's role in providing safe, reliable, cost-effective, and increasingly clean energy to consumers. Prior to her 10 years at EEI, Karen was a paralegal for 16 years in Washington D.C. focusing on energy project finance and federal regulatory compliance. Karen is a graduate of the University of Mary Washington and received her Master of Business Administration degree from Johns Hopkins University.

Gene Rodrigues, *Department of Energy*

Gene Rodrigues is the Assistant Secretary for Electricity for the U.S. Department of Energy (DOE). The Office of Electricity drives technological and operational advancements in grid systems and components, grid controls and communications, and grid-scale energy storage to ensure that our nation's power grid remains reliable, resilient, secure, and affordable. Mr. Rodrigues also serves as DOE's senior official on the federal interagency working group for the White House Initiative on Asian Americans, Native Hawaiians, and Pacific Islanders. Mr. Rodrigues brings over three decades of industry experience to DOE as a nationally recognized expert in clean energy policy and programs. Prior to joining DOE, Mr. Rodrigues was Vice President in the Energy, Environment, and Infrastructure practice at ICF, a global advisory and digital services provider. Before that, he garnered 23 years of industry experience as an executive at Southern California Edison, one of the nation's largest electric utilities. Throughout his professional career, Mr. Rodrigues has held leadership positions in industry associations, including most recently as a member of the board of the American Council for an Energy-Efficient Economy, the chair of the board for the California Efficiency & Demand Management Council, and the chair of the outreach committee for the bipartisan Alliance to Save Energy's Active Efficiency initiative. Previously, he served as the chair of the board for the Consortium for Energy Efficiency and as a board member on the China-U.S. Energy Efficiency Alliance and California's Low-Income Oversight Board. In recognition of his industry leadership, in 2012 the U.S. Environmental Protection Agency presented Mr. Rodrigues with its Climate Leadership Award for individual leadership. In 2022, the Alliance to Save Energy presented Mr. Rodrigues with their Charles H. Percy Award for Public Service, which honors the late Senator's commitment to bipartisanship. Mr. Rodrigues received a J.D. from University of California Law, San Francisco (formerly U.C. Hastings College of the Law), and a B.S. degree from Northern Arizona University.

Lauren Shwisberg, *RMI*

Lauren is a Principal in RMI's Carbon-Free Electricity Practice, leading research and collaboration projects to support the rapid transition to a low-carbon electricity system. Specifically, Lauren's work examines the roles that renewable energy and distributed energy resources can play in grid planning and investment. Lauren has led research on solutions for serving low-income customers with clean energy and has supported utilities and regulators to engage disadvantaged communities in their decision-making processes. She has also coordinated engagements with cities, federal government agencies in the United States and Australia, large commercial & industrial customers, and utilities to support them in their procurement and deployment of renewable energy and advanced energy solutions such as microgrids and electric vehicles. Lauren has experience as a facilitator for RMI's Electricity Innovation Lab (e⁻Lab), an assembly of thought leaders and decision makers from across the US electricity sector focused collaborative innovation to address critical barriers to clean energy deployment. Prior to joining RMI, Lauren received her master's degree from Stanford University in Civil and Environmental Engineering, focused on Atmosphere and Energy. While in graduate school, Lauren worked at RMI as a Schneider Fellow with e⁻Lab Leap and focused on the identification and acceleration of business models that serve low-income customers with distributed energy resources. Lauren was also an intern at Tesla where she worked on the Powerpack product team, building models to assess large-scale energy storage applications. Before returning to graduate school, Lauren worked as a civilian engineer for the United States Navy. With Naval Sea Systems Command, Lauren primarily worked in program management on shipbuilding programs, and pursued her interest in renewable energy through execution of the energy efficiency portfolio for large amphibious ships, and energy and environmental policy at the Pentagon. While living in Washington D.C., Lauren was a fellow with the Clean Energy Leadership Institute.

Ann E. Rendahl, *Washington Utilities and Transportation Commission*

Ann was first appointed to serve as a commissioner of the Washington Utilities and Transportation Commission by Gov. Inslee in December 2014 for a six-year term that ended Jan. 1, 2021. Ann has been reappointed and confirmed to a second six-year term ending Jan. 1, 2027. Ann is a member of the National Association of Regulatory Utility Commissioners, or NARUC, Committees on Electricity and Critical Infrastructure, prior chair of the Committee on Electricity, a member of the Executive Committee, and serves on the Board of Directors. Ann serves as a member of the Body of State Regulators for the California ISO's Energy Imbalance Market. Ann also serves as a member of the Electric Power Research Institute's Advisory Council through August 2025, and as a member of the Advisory Council of the Center for Public Utilities at New Mexico State University. Ann previously served as the Director of Policy and Legislation for the UTC. Prior to leading the UTC's Policy and Legislative Affairs Section, she served as the Director of the Administrative Law Division, as an administrative law judge for the UTC, and as an assistant attorney general representing the UTC. Ann is a graduate of Wellesley College and received a master's degree in Public Policy from the Goldman School of Public Policy at the University of California, Berkeley. She received her law degree from UC Law San Francisco.

Elizabeth Stein, *Institute for Policy Integrity*

Elizabeth Stein joins the Institute for Policy Integrity as the State Policy Director in March 2023. Elizabeth's work focuses on utility regulation and environmental and energy policy. Before joining Policy Integrity, Elizabeth was Lead Counsel, Energy Transition, at Environmental Defense Fund. In that role, Elizabeth led EDF's state utility commission advocacy in support of widespread electrification of trucks and buses, and contributed to relevant research efforts. In previous roles at EDF, Elizabeth's work also encompassed electric utility business model innovations, leveraging distributed energy resources for improved environmental outcomes, sustainable electric rate design issues, emissions reductions from the buildings sector, and natural gas system regulation. She served on the Technical Advisory Committee for New York City's Energy Infrastructure Pathways Study in 2019, and was recognized by City & State's Energy and Environment Power 100 list in 2020 and 2021. She is currently serving as co-chair of the Energy Committee of the NYC Bar Association. She received an A.B., magna cum laude, from Harvard University, and a J.D., magna cum laude, from NYU Law. Elizabeth is admitted to practice law in New York.

Dede Subakti, *California ISO*

Dede Subakti servies as Vice President, System Operations. Subakti joined the California ISO in 2010, serving first as manager for operations planning. In 2012, he was promoted to his most recent position as director of operations for engineering services, in which he was responsible for operational engineering and support functions, including resource adequacy assessments, seasonal operating and outage coordination studies, and operating and reliability analyses. He also supported the onboarding and day-to-day operations engineering for the Western Energy Imbalance Market (EIM), and RC West, the ISO's reliability coordinator function for balancing authorities and transmission operators in the Western Interconnection. Prior to joining the ISO, Subakti worked with OATI, Inc., a global energy solutions and software company, managing project development for various transmission system applications for transmission service providers in both the Western and Eastern Interconnections. Before that, he served as Manager of Regional Operations Engineering at the Midwest ISO (now Midcontinent ISO) where he managed real-time operations engineers providing control room operations support. Subakti also has worked with representatives of the North American Electric Reliability Corporation (NERC) and Western Electricity Coordinating Council (WECC) to develop reliability standards and support operation of the Western Interconnection. He is a licensed professional engineer in Minnesota and a certified NERC System Operator. Subakti received a master's degree in business administration from the University of Minnesota and a master's degree in electrical engineering from Iowa State University, with an emphasis in power systems. He received his bachelor's degree in electrical engineering from Iowa State University.

Sue Tierney, *Analysis Group*

Dr. Susan Tierney, a Senior Advisor at Analysis Group, is an expert on energy economics, regulation, and policy, particularly in the electric and gas industries. She consults to businesses, government agencies, foundations, tribes, environmental groups, and other organizations on energy markets, economic and environmental regulation and strategy, and climate-related energy policies. Previously, Dr. Tierney served as the Assistant Secretary for Policy at the U.S. Department of Energy, and was the Secretary for Environmental Affairs in Massachusetts, Commissioner at the Massachusetts Department of Public Utilities, and Executive Director of the Massachusetts Energy Facilities Siting Council. She co-authored the energy chapter of the National Climate Assessment, and serves on the boards of the Barr Foundation, Resources for the Future, and World Resources Institute. She recently served on the boards of ClimateWorks Foundation and the Energy Foundation. She has served on several National Academies' Committees, including The Future of Electric Power and Accelerating Decarbonization of the U.S. Economy. She taught at the Department of Urban Studies and Planning at MIT and at the University of California at Irvine, and has lectured at Harvard University, University of Chicago, Yale University, New York University, Tufts University, Northwestern University, and University of Michigan. Dr. Tierney has a Ph.D. and Master's degree in regional planning from Cornell University and a B.A. in Art History from Scripps College.

Gordon Van Welie, *ISO-New England*

Gordon van Welie (NAE) is President and Chief Executive Officer of ISO New England Inc., having previously served as the company's Executive Vice President and Chief Operating Officer. He joined ISO New England from Siemens Power Transmission & Distribution LLC, where he served as Vice President and General Manager of the Power Systems Control Division and was responsible for managing information technology solutions for electric companies. Before coming to Siemens, Mr. van Welie held several positions at ESKOM, South Africa's electric utility based in Johannesburg. Mr. van Welie is a member of a number of industry groups, including the National Academy of Engineering, the Executive Committee of the U. S. National Committee of CIGRE, the Member Representatives Committee of the North American Electric Reliability Corporation (NERC), the ISO/RTO Council, and the IEEE Power & Engineering Society. He is a recipient of 2017 Utility Variable-Generation Integration (UVIG) Achievement Award and, in 2016, was awarded the IEEE Power & Energy Society Leadership in Power Award.