INFORMING STORAGE SOLUTIONS TO DECARBONIZE ELECTRICITY

Argonne NATIONAL LABORATORY

DAY 1 • NOVEMBER 2, 2021 • 10:00 A.M.–1:00 P.M. CT

Join on Zoom

Welcome
Paul Kearns
Director
Argonne National Laboratory

Plenary Session 1
Alejandro Moreno
Deputy Assistant Secretary for Renewable Power, Office of Energy Efficiency & Renewable Energy
U.S. Department of Energy

Pedro Pizarro
President and Chief Executive Officer
Edison International

Venkat Srinivasan
Director, Argonne Collaborative Center for Energy Storage Science, and Deputy Director, Joint Center for Energy Storage Research (JCESR)
Argonne National Laboratory

Panel 1: The Current Decarbonization Landscape
MODERATOR
George Crabtree
Director, JCESR
Argonne National Laboratory

PANELISTS
M. Granger Morgan
Hamerschlag University Professor of Engineering
Carnegie Mellon University

Robert Rosner
William E. Wrather Distinguished Service Professor, Astronomy & Astrophysics and Physics
University of Chicago

Melanie Kenderdine
Principal and Executive Vice President
Energy Futures Initiative

Plenary Session 2
Imre Gyuk
Director, Energy Storage Research, Office of Electricity
U.S. Department of Energy

Panel 2 - Climate Policy and Electricity Market Design
MODERATOR
Benjamin F. Hobbs
Theodore M. and Kay W. Schad Professor of Environmental Management
Johns Hopkins University

PANELISTS
Paul Joskow
Elizabeth and James Killian Professor of Economics, Emeritus
Massachusetts Institute of Technology

Jesse Jenkins
Assistant Professor of Mechanical and Aerospace Engineering and the Andlinger Center for Energy and the Environment
Princeton University

John Bistline
Principal Project Manager, Energy Systems and Climate Analysis Group
Electric Power Research Institute (EPRI)

Discussion groups

Wrap-Up
Vladimir Koritarov
Director, Center for Energy, Environmental, and Economic Systems Analysis
Argonne National Laboratory

INFORMING STORAGE SOLUTIONS TO DECARBONIZE ELECTRICITY

Argonne NATIONAL LABORATORY

DAY 2 • NOVEMBER 3, 2021 • 10:00 A.M.–1:00 P.M. CT

Join on Zoom

Welcome
Suresh Sunderrajan
Associate Laboratory Director for Energy and Global Security
Argonne National Laboratory

Plenary Session 3
Eric Hsieh
Director, Grid Systems and Components, Office of Electricity
U.S. Department of Energy

Panel 3: Analytical Models and Datasets
MODERATOR
Todd Levin
Principal Energy Systems Engineer
Argonne National Laboratory

PANELISTS
Magnus Korpås
Professor, Department of Electric Power Engineering
Norwegian University of Science and Technology

Wesley Cole
Researcher, Model Engineering
National Renewable Energy Laboratory

Jonghwan Kwon
Energy Systems Engineer
Argonne National Laboratory

Discussion Groups

Plenary Session 4
Arshad Mansoor
President and Chief Executive Officer
EPRI

Panel 4: Modeling Energy Storage in Decarbonization
MODERATOR
Rebecca O'Neil
Advisor
Pacific Northwest National Laboratory

PANELISTS
Sonja Wogrin
Professor and Head of the Institute of Electricity Economics and Energy Innovation
Graz University of Technology

Ramteen Sioshansi
Professor, Integrated Systems Engineering
The Ohio State University

Scott Burger
Senior Manager, Analytics
Form Energy

Discussion Groups

Wrap-up
Audun Botterud
Principal Systems Engineer
Argonne National Laboratory

Panel 1: The Current Decarbonization Landscape

MODERATOR
George Crabtree (Argonne National Laboratory and University of Illinois at Chicago)

PANELISTS
Granger Morgan (Carnegie Mellon University)
Robert Rosner (University of Chicago)
Melanie Kenderdine (EnergyFutures Initiative)

BACKGROUND
The present US electricity generation mix is approximately 40% natural gas, 20% coal, 20% renewable (7% hydroelectric, 13% wind, solar and other) and 20% nuclear. The guiding principles for design and operation of a decarbonized grid in 2035 will be significantly different from those of today's grid. This panel will explore these differences and how to establish new guiding principles for the grid in 2035.

KEY QUESTIONS
What is the best mix of wind, solar, hydro, and nuclear generation for the grid in 2035? Should wind and solar dominate because of their low cost, scalability and the urgency of decarbonization by 2035? Should wind and solar be deployed in the most favorable locations (mid-continent and coasts for wind, the southwest for solar) requiring more transmission to move power to high demand zones, or should wind and solar generation be located near demand zones requiring less transmission and more local storage?

Where should storage be placed? It could be co-located with wind and solar generation to firm their output, placed at remote nodes such as repurposed coal and gas plants with their existing transmission infrastructure, or put in the distribution grid to enable greater demand response.

Demand is likely to rise as the economy decarbonizes, for example for electric vehicles and the electrification of buildings. How much will demand rise from each sector, and what is the temporal profile of the increased demand? How can the increased demand be met?

How will the future grid be stabilized against consecutive cloudy and calm days? History shows as many as 10 consecutive cloudy or calm days in many locations (though climate change may alter this). Options include many-day discharge batteries, chemical storage such as H_2, NH_3, or another net zero energy carrier, thermal storage and gravity storage. There are no commercial-ready technologies for many-day discharge available at present. The question is not which ones to deploy (as for generation) but which ones to innovate.

What is the role of nuclear electricity in the grid of 2035? It is hard to imagine achieving net-zero electricity by 2035 without the existing nuclear fleet. It is equally hard to imagine deploying additional conventional reactors at the scale needed and in time to make a difference. Will small modular reactors and microreactors now under development provide a solution? Will these next generation reactors be commercial-ready in time to deploy at scale before 2035? Can nuclear be made dispatchable? How would dispatchability be employed?

Panel 2: Climate Policy and Electricity Market Design

MODERATOR
Benjamin F. Hobbs (Johns Hopkins University)

PANELISTS
Paul Joskow (Massachusetts Institute of Technology)
Jesse Jenkins (Princeton University)
John Bistline (Electric Power Research Institute)

BACKGROUND
There is an urgent need to drastically lower greenhouse gas emissions to address global climate change and to meet the goals of the Paris Agreement. Most decarbonization plans and scenarios rely on a substantial increase in the use of electricity to meet a larger share of future energy demand. Within the entire energy system, the electricity sector is oftentimes considered the easiest one to decarbonize. The power system will therefore need to undertake a massive transition towards clean and sustainable sources of electricity generation over the next 1-2 decades. This transition raises a number of key questions around how we plan and operate the electric power system, and how electricity markets should be designed to provide adequate economic incentives for market participants, while also adhering to the societal needs of a rapid energy transition.

Environmental policies, such as carbon taxes, renewable portfolio standards, and feed-in tariffs are used to incentivize investments in clean electricity supply resources. However, there are growing concerns regarding how these policies interact with the economic signals provided by electricity markets. A key challenge for policy makers is how to align climate policies with efficient planning and operation of the electrical power grid. Moreover, most low and zero carbon electricity generation technologies have a cost structure that are dominated by capital as supposed to variable costs. Moreover, systems will become more weather driven as the amounts of wind and solar energy continue to increase. The changes in the cost structure and operational characteristics of the generation portfolio raises fundamental questions about whether we can continue to rely on existing market structures or if we need to fundamentally change electricity market design.

KEY QUESTIONS
- What energy-environmental policies should be adopted to incentivize a rapid and cost-effective transition towards a low or zero carbon electricity system?
- What are the key challenges in aligning climate polices and goals with efficient electricity market design?
- Are current electricity market designs adequate in providing incentives during and after the energy transition?
- What are the market implications of moving towards a future “zero marginal cost” power system, i.e., dominated by resources with low/zero fuel and operating costs and high capital costs?
- What are the market implications of moving towards a power system that is driven more extensively by climate and weather? What are implications for system resilience?
- What are the social equity challenges that will emerge during the transition of the electric power system and how can they be addressed?

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Panel 2: Climate Policy and Electricity Market Design, continued

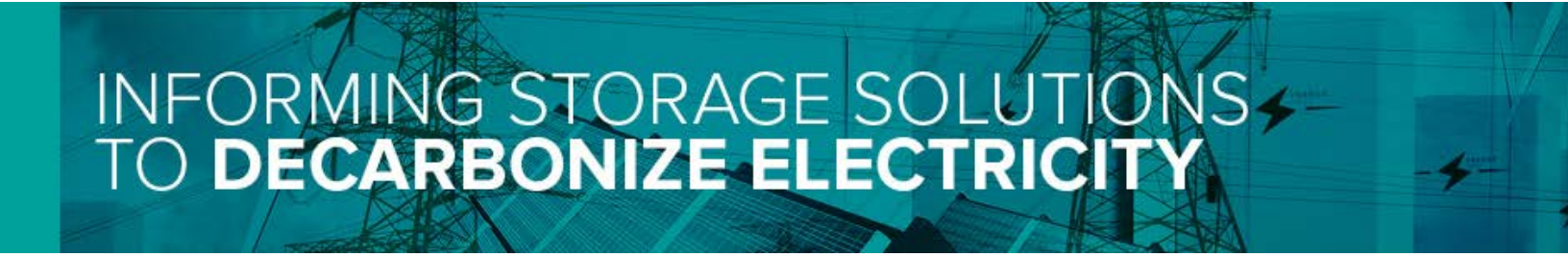
- What are key challenges and open questions for developers of modeling tools that address questions at the intersection of climate policy and electricity market design?
    - Are current tools capable of analyzing zero carbon electricity markets?
    - What are best approaches to model price formation, resource adequacy, and system resilience in future electricity markets?
    - What are key challenges for analysis of system flexibility and energy storage within these modeling tools?
    - What new methodologies and capabilities will be required in future models?

KEY QUESTIONS FOR DISCUSSION GROUPS

1. What are the key challenges in electricity market design during and after the energy transition?

2. How can climate policies and goals be better aligned with electricity market design?

3. What are the key challenges and open questions for modeling electricity markets under deep decarbonization?



Panel 3: Analytical Models and Datasets

MODERATOR
Todd Levin (Argonne National Laboratory)

PANELISTS
Magnus Korpås (Norwegian University of Science and Technology)
Wesley Cole (National Renewable Energy Laboratory)
Jonghwan Kwon (Argonne National Laboratory)

BACKGROUND
The current U.S. government aims to achieve a zero-carbon electrical grid by 2035 and a net-zero economy by 2050. Achieving these goals requires a rapid transition of electric power systems towards low- and zero-carbon solutions. Hence, there is increasing interest in analyzing paths for power system decarbonization, particularly related to long-term planning because the long-term planning decisions made today will significantly impact the future power system structures given the multi-decade planning horizons for many power system components.

Power system long-term planning models (e.g., generation expansion planning model, transmission expansion planning model, etc.) are commonly used throughout the industry to inform the long-term decision-making process, simulate potential long-term system outcomes, and understand broad system trends and the impact of key parameter sensitivities. However, the traditional long-term planning models and algorithms are designed to make investment (and retirement) decisions for conventional thermal generators. It has become increasingly clear that existing tools need improvements to better represent future power systems dominated by weather-driven low-carbon electricity generation (e.g., wind, solar, hydro, etc.) and energy storage technologies.

In this panel, we will share the best practices and discuss the critical challenges for the tools and data needed in power system decarbonization studies.

KEY QUESTIONS
- What are the critical challenges of power system long-term planning models in analyzing decarbonization paths?
- Do the traditional resource adequacy standards (e.g., 1-in-10 criteria, planning reserve margin) represent system reliability well in the power systems with high penetrations of low- or zero-carbon generation solutions?
- How do the current national/continent-scale long-term planning models address uncertainties? What are the research gaps? How can we improve planning models in capturing the uncertain nature of the variable renewable energy resources?
- How do the current national-scale models capture the value of the transmission system? How is power flow modeled? How is transmission expansion planning modeled? What are the research gaps?
- What are the main challenges of co-optimizing generation and transmission expansion planning? Model scalability? Data?

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Panel 3: Analytical Models and Datasets, continued

- How do the current national-scale models capture the coupling issues between power systems and other energy sectors (e.g., natural gas system, heating, materials, manufacturing, etc.)?
- What are the key grid services that we need to consider in long-term planning models?
- What are the best strategies in designing scenarios for future zero-carbon systems?
- How do the current national-scale models capture the social equity aspects of decarbonization? Is it possible or practical to capture the social equity challenges in the long-term planning models?

KEY QUESTIONS FOR DISCUSSION GROUPS

1. What are the critical challenges of power system long-term planning models in analyzing decarbonization paths?

2. Imagine it is 2050 and the power system is fully decarbonized; how do power system models fundamentally differ from those used today?

3. How can evolving resource adequacy metrics and standards be incorporated into future models?

4. How will model data requirements evolve over the next decade?

Panel 4: Modeling Energy Storage in Decarbonization

MODERATOR
Rebecca O'Neil (Pacific Northwest National Laboratory)

PANELISTS
Sonja Wogrin (TU Graz, Austria)
Ramteen Sioshansi (The Ohio State University)
Scott Burger (Form Energy)

BACKGROUND
Electric power systems are undergoing a rapid transition towards cleaner sources of electricity supply. In particular, the current U.S. government aims to achieve a zero-carbon electrical grid by 2035 and a net-zero economy by 2050. The shift towards low- and zero-carbon solutions profoundly impacts the generation portfolio and the role of energy storage in future power systems. Hence, there is currently increasing focus on enhancing the capability of power system operation and planning models to more accurately represent the unique cost and performance characteristics of energy storage technologies. At the same time, there is a recognition that an individual energy storage system can simultaneously benefit many layers of the grid, and that a more integrated modeling storage that captures these layers would illustrate a broader value proposition for the technology.

Traditionally, power system models have relied upon relatively simplistic representation of storage resources when optimizing or simulating investment, commitment, and dispatch decisions. In terms of installed capacity, energy storage resources have been dominated by pumped storage hydro, which is dispatched primarily as a load following resource in many models. However, there are now an increasing number of commercially viable storage technologies each with their own unique durations, cost and performance characteristics, grid service capabilities, market participation models, system requirements and use cases that require a range of model enhancements to represent properly. Furthermore, storage resources must now be considered as economic investment options in capacity expansion models and the optimal choice of their type and quantity is intrinsically linked with other investment decisions and pathways.

This session will explore the unique technical requirements, challenges, and opportunities associated with integrating energy storage resources into bulk power system operations and planning models, while also demonstrating the importance of key model enhancements in properly capturing the value energy storage resources on evolving power systems.

KEY QUESTIONS
- What are the most impactful technical characteristics of energy storage resources that must be considered in power system models?
    - e.g., degradation, cycling costs, competitive market behavior, grid service provision, performance characteristics
- Do these key characteristics differ between different types of models?
    - e.g., generation expansion planning vs. production cost models vs. techno-economic models

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Panel 4: Modeling Energy Storage in Decarbonization, continued

- What broader model enhancements might be considered to ensure that the system value of storage is properly captured?
    - e.g., finer temporal resolution, considering consecutive time steps, storage dispatch logic
- What are the additional specific modeling challenges related to representing long-duration energy storage technologies?
    - e.g., seasonal dispatch logic, consideration of non-consecutive representative days
- Do we have the (economic and technical) data needed to adequately represent the range of different storage technologies in long-term planning models?
- What are the most important open questions for the research community to address when it comes to energy storage representation in decarbonization studies?

KEY QUESTIONS FOR DISCUSSION GROUPS

1. There are many types of energy storage technologies with variable characteristics and states of development. What are the most impactful technical characteristics of energy storage resources that must be considered in power system models, especially when projecting future grid conditions?

2. What are the most important regulatory and market design questions that will impact the role of energy storage in future zero-carbon systems? How can models best provide guidance to these questions?

3. What are the most important modeling challenges to better assess the role of energy storage in future decarbonized power systems? Will a gradual evolution of existing models be sufficient? Or do we need to rethink entirely how we analyze these systems?

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SPEAKER BIOGRAPHIES

JOHN BISTLINE

Principal Project Manager, Energy Systems and Climate Analysis Group
Electric Power Research Institute

John Bistline is a Principal Project Manager in the Energy Systems and Climate Analysis Group at the Electric Power Research Institute (EPRI). His research analyzes the economic and environmental effects of policy and technological development to inform energy systems planning and company strategy. Bistline's current research activities examine renewable integration, energy storage modeling, electrification, and the impacts of federal and state climate policies.

AUDUN BOTTERUD

Principal Systems Engineer
Argonne National Laboratory

Audun Botterud is an Energy Systems Engineer in the Center for Energy, Environmental and Economic Systems Analysis. His research focuses on modeling and analysis of electricity markets and power systems, using a variety of mathematical optimization and simulation methods. He is particularly interested in decision making under uncertainty as it pertains to the planning and operation of power and energy systems.

SCOTT BURGER

Senior Manager, Analytics
Form Energy

Scott Burger leads Form Energy's Analytics team, responsible for developing and delivering the market and project modeling and data science that powers Form's commercial, strategy, battery product management, and policy and regulatory affairs activities. Burger executes product management for the software suite that powers these analytics.

WESLEY COLE

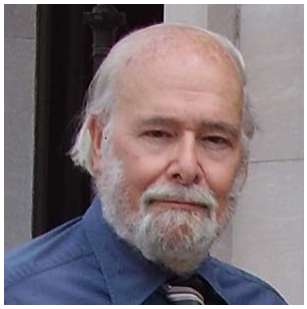
Researcher, Model Engineering
National Renewable Energy Laboratory

Wesley Cole performs capacity expansion modeling and analysis of the U.S. electricity sector. His work considers a variety of technology, policy, and economic pathways and helps to inform decisions made today that will help to shape a better future. He is an active developer of the Regional Energy Deployment System (ReEDS) model, which is the primary tool used at NREL for capacity expansion modeling.

GEORGE CRABTREE

Director
Joint Center for Energy Storage Research

George Crabtree, an Argonne National Laboratory Senior Scientist and Distinguished Fellow, is the Director of the Joint Center for Energy Storage Research (JCESR). As JCESR Director, Crabtree directs the overall strategy and goals of the research program and operational plan, acts as liaison to executives of JCESR partner organizations, and represents JCESR with external constituencies and advisory committees.



IMRE GYUK

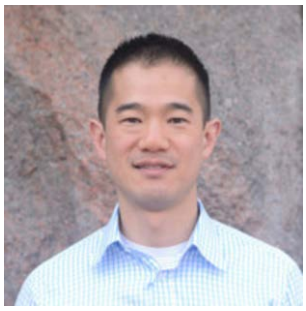
Director, Energy Storage Research, Office of Electricity
U.S. Department of Energy

Imre Gyuk directs the Energy Storage research program in DOE's Office of Electricity, which funds work on a wide variety of technologies such as advanced batteries, flywheels, super-capacitors, and compressed air energy storage. Applications include seamless continuity of power supply for high tech industry during outages, making renewables dispatchable, and helping to increase the capacity factor and ease congested distribution lines.

BENJAMIN F. HOBBS

Theodore M. and Kay W. Schad Professor of Environmental Management
Johns Hopkins University

Benjamin F. Hobbs, the Theodore M. and Kay W. Schad Professor of Environmental Management at Johns Hopkins University, uses systems analysis and economics to improve electric utility planning, operations and policy, as well as management of environmental and water resources systems. Hobbs is founding director of Johns Hopkins' Environment, Energy, Sustainability & Health Institute and holds a joint appointment in the Department of Applied Mathematics and Statistics.



ERIC HSIEH

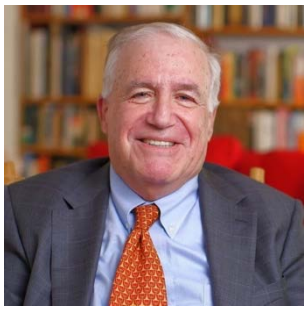
Director, Grid Systems and Components, Office of Electricity
U.S. Department of Energy

Eric Hsieh leads a DOE group that, as a part of the Office of Electricity's Advanced Grid R&D division, delivers grid modernization through technology innovation. This portfolio includes transformers, power electronics, robotics, and energy storage. Hsieh previously served as Director of the DOE Office of Energy Finance and Incentives Analysis.

JESSE D. JENKINS

Assistant Professor of Mechanical and Aerospace Engineering and the Andlinger Center for Energy and the Environment
Princeton University

Jesse D. Jenkins is an assistant professor at Princeton University with a joint appointment in the Department of Mechanical and Aerospace Engineering and the Andlinger Center for Energy and Environment. He is a macro-scale energy systems engineer with a focus on the rapidly evolving electricity sector, including the transition to zero-carbon resources, the proliferation of distributed energy resources, and the role of electricity in economy-wide decarbonization.



PAUL JOSKOW

Elizabeth and James Killian Professor of Economics, Emeritus
Massachusetts Institute of Technology

Paul Joskow is the Elizabeth and James Killian Professor of Economics, Emeritus at MIT. He previously served as President of the Alfred P. Sloan Foundation. In his research and teaching, Joskow focuses on industrial organization, government regulation of industry, competition policy, and energy and environmental economics.

PAUL K. KEARNS

Laboratory Director
Argonne National Laboratory

Paul K. Kearns has served as Director of the U.S. Department of Energy's Argonne National Laboratory since 2017. Kearns manages a growing multidisciplinary science and engineering research center with a $1.2 billion diversified research portfolio and more than 3,400 employees, more than 6,700 facility users, and 800 visiting researchers. Kearns served as Argonne Chief Operations Officer from 2010 to 2017.

MELANIE KENDERDINE

Principal and Executive Vice President
Energy Futures Initiative

Melanie Kenderdine joined former U.S. Secretary of Energy Ernest J. Moniz and fellow Principal Joseph S. Hezir in founding Energy Futures Initiative, a non-profit organization dedicated to driving innovation in energy technology, policy, and business models. In the Department of Energy, she served concurrently as Energy Counselor to the Secretary and as the Director of the Office of Energy Policy and Systems Analysis.

VLADIMIR KORITAROV

Director, Center for Energy, Environmental, and Economic Systems Analysis
Argonne National Laboratory

Vladimir Koritarov is the Manager of the CEESA Power Systems group in Argonne National Laboratory's Energy Systems division. The group provides analytical services on strategic energy and environmental issues to government agencies, international organizations, and private institutions around the world. He is also a Senior Fellow at the University of Chicago's Energy Policy Institute at Chicago.

MAGNUS KORPÅS

Professor, Department of Electric Power Engineering
Norwegian University of Science and Technology (NTNU)

Magnus Korpås heads the research group "Electricity Markets and Energy Systems Planning" at the Department of Electric Power Systems at NTNU. His interests are especially focused towards integration of renewable energy in the energy system and his research activities include market design for power markets with variable renewable energy sources and storage and optimization of energy storage and distributed flexible resources in connection with renewables.

JONGHWAN KWON

Energy Systems Engineer
Argonne National Laboratory

Jonghwan Kwon is an Energy Systems Engineer in the Center for Energy, Environmental and Economic Systems Analysis at Argonne National Laboratory. His research focus is on modeling and analysis of power systems, electricity markets, and renewable energy integration. His research focuses primarily on modeling and analysis of power systems operations and planning using a variety of mathematical optimization and simulation methods.

TODD LEVIN

Principal Energy Systems Engineer
Argonne National Laboratory

Todd Levin is an Energy Systems Engineer in the Center for Energy, Environmental and Economic Systems Analysis at Argonne National Laboratory. His research interests focus on utilizing advanced optimization and simulation methodologies to model complex interactions in electricity markets and quantify the implications of domestic energy policies and regulations. As Deputy Lead of Argonne's Building Energy Decision and Technology Research Program he also manages a range of programs that seek to increase the efficiency of building energy consumption.

ARSHAD MANSOOR

President and Chief Executive Officer
Electric Power Research Institute

Arshad Mansoor is President and Chief Executive Officer of the Electric Power Research Institute, responsible for the institute's operation and its portfolio of R&D and demonstration programs, spanning all sources of generation, power delivery and utilization, and the environment. He previously served as senior vice president, research and development.

ALEJANDRO MORENO

Deputy Assistant Secretary for Renewable Power, Office of Energy Efficiency & Renewable Energy
U.S. Department of Energy

Alejandro Moreno directs EERE's renewable energy applied research, development, and demonstration activities for the geothermal, solar energy, and wind and water power technology offices. In addition, he oversees EERE's energy system integration efforts. Previously, Moreno was the Director for the Water Power Technologies Office.

M. GRANGER MORGAN

Hamerschlag University Professor of Engineering
Carnegie Mellon University

M. Granger Morgan is the Hamerschlag University Professor of Engineering at Carnegie Mellon University. His research addresses problems in science, technology and public policy with a particular focus on energy, electric power, environmental systems, climate change, the adoption of new technologies, and risk analysis. Much of his work has involved the development and demonstration of methods to characterize and treat uncertainty in quantitative policy analysis.

REBECCA O'NEIL

Advisor
Pacific Northwest National Laboratory

Rebecca O'Neil is an advisor for Pacific Northwest National Laboratory. In her career at PNNL, she has served as the lab relationship manager for the US DOE EERE Renewable Energy portfolio, served a rotation into the U.S. Department of Energy's Water Power Technologies Office to develop a hydropower-grid research program, and led the regulatory area for energy storage. Her research interests relate to energy justice, energy storage, community-scale innovation, sustainable hydropower and marine energy development.

PEDRO PIZARRO

President and Chief Executive Officer
Edison International

Pedro J. Pizarro is president and chief executive officer of Edison International, the parent company of Southern California Edison (SCE), one of the nation's largest electric utilities. Edison International is also the parent company of Edison Energy, a portfolio of competitive businesses providing commercial and industrial customers with energy management and procurement services. He is a member of Edison International's board of directors.

ROBERT ROSNER

William E. Wrather Distinguished Service Professor, Astronomy & Astrophysics and Physics
University of Chicago

Robert Rosner is a theoretical physicist, on the faculty of the University of Chicago since 1987, where he is the William E. Wrather Distinguished Service Professor in the departments of Astronomy & Astrophysics and Physics, as well as in the Enrico Fermi Institute and the University of Chicago Harris School of Public Policy. He previously served as the Director of Argonne National Laboratory and is the founding director of the Energy Policy Institute at the University of Chicago.

RAMTEEN SIOSHANSI

Professor, Integrated Systems Engineering
The Ohio State University

Ramteen Sioshansi is a professor with the Department of Integrated Systems Engineering at The Ohio State University, Columbus. His research focuses on renewable and sustainable energy system analysis and the design of restructured competitive electricity markets.

VENKAT SRINIVASAN

Director, Argonne Collaborative Center for Energy Storage Science (ACCESS)
Argonne National Laboratory

Venkat Srinivasan is the director of the Argonne Collaborative Center for Energy Storage Science (ACCESS) and deputy director of the Joint Center for Energy Storage Research (JCESR). ACCESS provides the vision and coordinates the energy storage programs at Argonne and serves as a point of entry for industry to take advantage of the lab's unique capabilities and facilities to solve their problems in energy storage. JCESR is a national program led by Argonne that focuses on next-generation energy storage research that goes beyond lithium-ion technology.

STEPHEN STREIFFER

Deputy Laboratory Director for Science and Technology
Argonne National Laboratory

Stephen Streiffer is the Deputy Laboratory Director for Science and Technology at Argonne National Laboratory. He previously served as Associate Laboratory Director for Photon Sciences directorate and Director of the Advanced Photon Source at Argonne, as well as interim director of Argonne's Center for Nanoscale Materials.

SURESH SUNDERRAJAN

Associate Laboratory Director, Energy and Global Security
Argonne National Laboratory

Suresh Sunderrajan is the Associate Laboratory Director for the Energy and Global Security directorate. He leads a team that applies crosscutting expertise in science, engineering, and technology to develop solutions to challenging problems related to energy, manufacturing, and global security. Previously, he served as Associate Laboratory Director of Argonne's Science and Technology Partnerships and Outreach Directorate.

SONJA WOGRIN

Professor and Head of the Institute of Electricity Economics and Energy Innovation
Graz University of Technology

Sonja Wogrin is the Head of the Institute of Electricity Economics and Energy Innovation at the Graz University of Technology. Her research interests lie within the area of decision support systems in the energy sector, optimization and in particular, generation capacity expansion planning and optimization of storage technologies.