IESI International Institute® for Energy Systems Integration

International Conference for Energy Systems Integration

December 5 – 6, 2017

European Commission

iea International Energy Agency Secure Sustainable Together

CESI National Centre for Energy Systems Integration

EERA European Energy Research Alliance

WORLD ENERGY COUNCIL

IRENA International Renewable Energy Agency

UVIG

Welcome

We're excited to have you at this year's inaugural International Institute for Energy Systems Integration (iiESI) conference. Over the next two days, you'll hear from subject matter experts from across the globe as we delve into this year's conference theme, "Infrastructure for an Integrated Energy System."

Energy systems integration (ESI) is the process of coordinating the operation and planning of energy systems across multiple pathways and/or geographical scales to deliver reliable, cost-effective energy services with minimal impact on the environment. Our goal for this conference is to address such pathways—including electricity, thermal energy, and fuels—from engineering, scientific, policy, regulatory, market, and behavioral perspectives. Speakers will represent a balance of industry, academia, and policy.

Through knowledge capture, management, and transfer, iiESI aims to ensure that investments in ESI research, development, and education are coordinated and optimized to yield the greatest value possible to the global community.

iiESI partnered with World Energy Council, International Renewable Energy Agency (IRENA), the International Energy Agency (IEA), the Center for Energy Systems Integration (CESI), the European Energy Research Alliance Joint Programme (EEERA JP), the Joint Research Centre - European Commission (JRC), and the Utility Variable-Generation Integration Group (UVIG) to bring you this conference.

iiESI Members

Electric Power Research Institute (EPRI)

General Electric (GE) Energy Consulting

Imperial College London

Karlsruhe Institute of Technology (KIT)

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Katholieke Universiteit Leuven (KU Leuven)

National Renewable Energy Laboratory (NREL)

Nanyang Technical University - Singapore

Technical University of Denmark (DTU)

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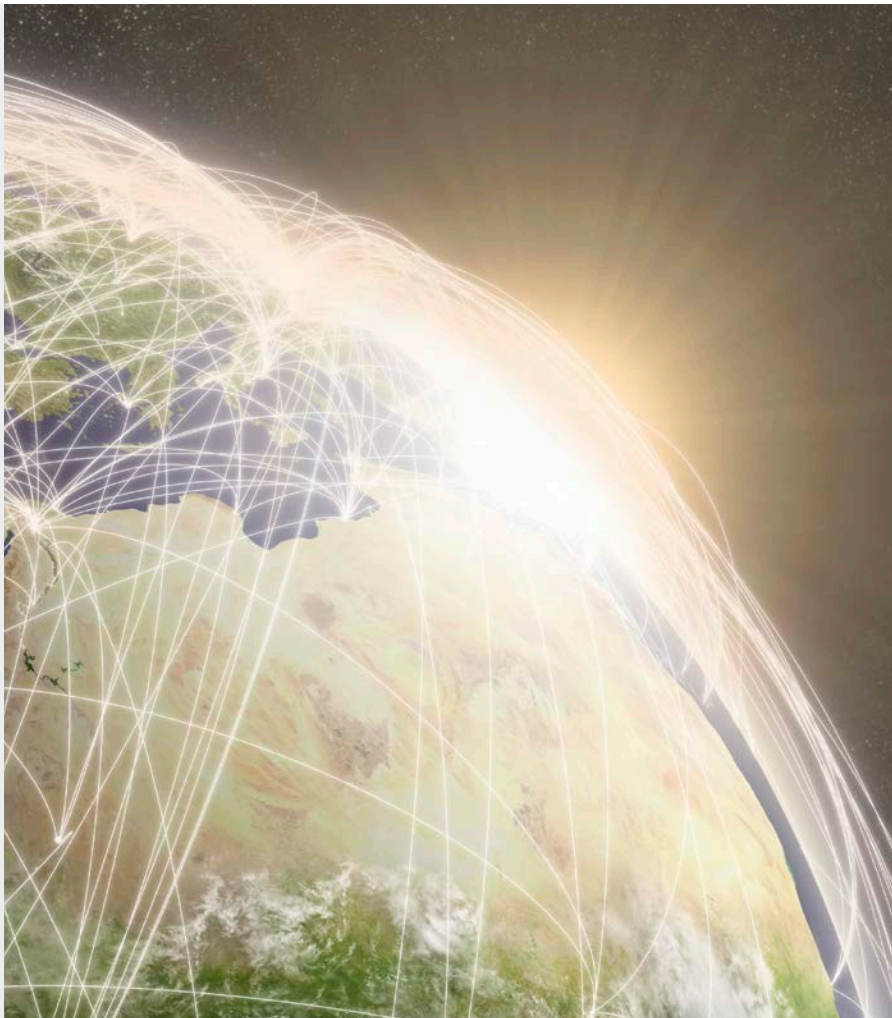
Learn more at **iiesi.org.**



Opening Session

Martin Keller, NREL Director, United States

Martin Keller is NREL's 9th director and also serves as the president of the Alliance for Sustainable Energy, LLC. Prior to NREL, he served as Associate Laboratory Director at Oak Ridge National Laboratory (ORNL), where he led the Energy and Environmental Sciences directorate and was responsible for the energy, biological, and environmental research programs supported by the U.S. Department of Energy (DOE), the Environmental Protection Agency, and the National Institutes of Health. Martin served as the Founding Director of the DOE BioEnergy Science Center and also served as the Director of the Biosciences Division.

Beth LaRose, Conference Chair and General Manager of Energy Consulting, GE, United States

Beth leads GE's Energy Consulting global team of power-system experts to deliver a full portfolio of techno-economic consulting services on thermal and renewable power generation, electrical power systems, and power economic studies. She brings 29-years of energy industry experience on electric power markets, asset valuation, integrated resource planning, generation plant operational analyses and the impact of environmental regulations.

Mark O'Malley, Conference Scientific Chair, NREL Senior Research Fellow, and Professor of Engineering at University College Dublin, Ireland

Chief scientist of energy systems integration, senior research fellow at NREL, director and co-founder of iiESI, and chair of electrical engineering at University College Dublin, Mark O'Malley is recognized as a world authority on energy systems integration and grid integration of renewable energy. He is a member of the Royal Irish Academy, a fellow of the Institute of Electrical and Electronic Engineers, and has received two Fulbright fellowships.

Session 1: Sector coupling solutions to renewables integration

Chair: Phil Taylor, National Centre for Energy Systems Integration (CESI), United Kingdom

Kevin Harrison, Hydrogen Systems Engineering Lead, NREL, United States

Kevin leads a team of engineers conducting research aimed at transforming U.S. energy sectors into cleaner, more efficient and sustainable integrated systems. He is also the principal investigator on a number of high profile research and development projects in areas including: hydrogen production systems development; energy systems integration and optimization; energy storage using hydrogen and methane; biological conversion of hydrogen and carbon dioxide to methane; and automation/robotics for accelerated life testing of critical hydrogen infrastructure systems.

Chongqing Kang, Professor of Electrical Engineeringing, Tsinghua University, China

Chongqing Kang has been teaching electrical engineering at Tsinghua University since 2005. His research interests include power system planning, power system operation, renewable energy, low carbon electricity technology, load forecasting, and the electric market. He has been recognized by a number of distinguished organizations, has received several awards for excellence in teaching, and serves the editorial board of five international journals.

Ning Zhang, Associate Professor of Electrical Engineering, Tsinghua University, China

Ning Zhang has been teaching at Tsinghua University since 2014, after completing his doctoral degree from Tsinghua and performing research at both the University of Manchester and Harvard University. His research focuses on multiple energy systems, power system planning, and operation with renewable energy, including wind power, photovoltaics, and concentrated solar power.

Leah Kaffine, Senior Consultant, GE Energy Consulting , United States

Leah leads the development of an integrated natural gas-electric model and the analysis of natural gas market fundamentals to provide forecasts of natural gas hub and burner tip prices for GE Energy Consulting. This integrated gas-electric model incorporates customized models of gas demand for electric power and is used to evaluate the impact of pipeline failure on the electric system and natural gas price scenarios for asset valuation.

Ben Haley, Co-founder of Evolved Energy, United States

Ben has extensive experience developing energy system models to support energy transformation decision-making. He was the lead technical analyst for the research team representing the United States in the Deep Decarbonization Pathways Project (DDPP), convened at the behest of the United Nations. His work has been used by state governments in California, Washington, and New York to support greenhouse gas target-setting and decarbonization policy implementation. His experience is leveraged by clients ranging from governmental organizations like NREL and DOE, to technology leaders, strategic investors, and non-governmental organizations that are interested in analyzing the implications of transforming the way we produce, convert, deliver, and consume energy in the 21st century.

Steve Chalk, Deputy Assistant Secretary for Sustainable Transportation, DOE's Office of Energy Efficiency and Renewable Energy (EERE), United States

Steve is responsible for vehicle, bioenergy and hydrogen fuel cell research. He was recently designated as Acting Assistant Secretary and charged with leading the Presidential transition from the Obama to the Trump administration for EERE's $2B clean energy research portfolio. Chalk has championed the modernization of NREL, and specifically the new Energy Systems Integration Facility. He has received three Presidential Rank Awards and the Science and Environment medal from the Partnership for Public Service.

Food for Thought

"Energy efficiency revisited—what it means in an integrated energy system and the impacts on infrastructure investment."

William D'Haeseleer, Professor of Engineering, University of Leuven (KU Leuven), Belgium

William teaches courses in the domain of energy technology and management (thermodynamics, nuclear energy, thermal systems, and renewable energy). His research involves energy conservation and energy management, energy and environment, energy systems, and energy policy. He is the director of the KU Leuven Energy Institute, has been a Fulbright fellow, and is an elected member of the Royal Academy of the Sciences and the Arts of Belgium (KVAB). He is also the chair of the Belgian Committee of the World Energy Council.

Session 2: The role of energy demand in an integrated energy system

Chair: Charlie Smith, UVIG, United States

Goran Strbac, Professor of Energy Systems, Imperial College London, United Kingdom

Goran brings extensive experience in advanced modelling and analysis of operation, planning, security, and economics of future energy systems. He led the development of advanced whole-energy system analysis approaches and methodologies that have been extensively used to inform industry, governments, and regulatory bodies about the role and value of emerging new technologies and systems in supporting cost-effective evolution for a smart, low-carbon energy future. His research also involves design of market for energy and flexibility services, efficient network pricing, business models for decentralized operation and investment, security, and resilience of future energy infrastructure.

Jochim Seel, Scientific Engineering Associate, Lawrence Berkeley National Laboratory (LBNL), United States

Jochim's research focuses on solar and wind market developments, as well as the integration of high shares of intermittent and distributed renewable generation into electricity markets. He has presented in front of the Governor of California, the California Energy and Public Utilities Commissions, and at academic and industry conferences.

Linda Steg, Professor of Environmental Psychology, University of Groningen, Netherlands

Linda's research focuses on understanding factors influencing sustainable behavior, the effects and acceptability of strategies aimed to encourage sustainable behavior, and how and why acting sustainably affects wellbeing. She is a member of the Royal Netherlands Academy of Arts and Sciences and previously served as president of Division 4 'Environmental Psychology' of the International Association of Applied Psychology (IAAP).

Henrik Madsen, Professor, Technical University of Denmark

Henrik has held many academic positions at the Technical University of Denmark since he received his Ph.D. in statistics there in 1986. His main research interests are related to analysis and modelling of stochastic dynamics systems. This includes signal processing, time series analysis, identification, estimation, grey-box modelling, prediction, optimization and control. In 2017, Henrik was appointed to Professor II at the Norwegian University of Science and Technology in Trondheim. He has authored or co-authored nearly 500 papers and 12 books.

Tim Unruh, Deputy Assistant Secretary for Renewable Power, EERE, United States

Tim is responsible for leading all of EERE's applied research, development, and demonstration for renewable energy—including geothermal, solar, wind, and water power. As former U.S. Federal Energy Management Program Director, he managed the implementation of policy and actions that resulted in greater energy efficiency, renewable energy, and reduced energy water use in federal government operations. Tim was instrumental in guiding DOE to streamline the Super Energy Saving Performance Contract selection process.

Session 3: Electrification: The good, the bad, and the ugly.

Chair: Mark McGranaghan, EPRI

Nick Miller, Senior Technical Director, GE Energy Consulting, United States

With over 35 years of experience in applied research on power systems, Nick has led efforts to develop new applications, controls, and systems for large-scale coordination of wind and solar generation with other system resources. He has lectured and provided consultation on wind and solar power integration to governments and institutions in more than three dozen countries, is a fellow of the Institute of Electrical and Electronics Engineers (IEEE), and is a member of CIGRÉ. Nick was founding chairman of the IEEE Task Force on Wind Generation and is past-chairman of the IEEE Renewable Machines Subcommittee. He has authored over 150 technical papers and articles and holds 20 U.S. patents for power control devices, solar, and wind technologies.

Stephen Beuning, Energy Market Design, Excel Energy, United States

Stephen is active in industry efforts to improve grid operating practices and the integration of renewable resources. He is currently active on the establishment of an expanded regional transmission organization in the U.S. Western Interconnection. He has served on the California Independent System Operator's (ISO's) Transitional Committee, which established an independent governance structure for the Energy Imbalance Market in the Western Interconnection. He has also served as Board President for UVIG and has publications on renewable integration with the NREL, IEEE, and the North American Electric Reliability Corporation (NERC).

Thomas Wilson, Principal Technical Executive, EPRI, United States

Thomas's current research activities focus on: the future of energy and a closer integration of energy and natural resource systems; costs of alternative climate policies and the role of technology research and development in potentially reducing these costs; exploring mechanisms that allow flexibility in domestic and international climate policies, as well as their interactions with regulatory approaches; exploring the interfaces between planning and reliability models; examining alternative approaches to model natural gas supply and deliverability; and providing information and methods to help electric utilities make decisions in the face of environmental and energy policy uncertainty.

Robert (Bob) Ethier, Vice President of Market Operations, New England ISO, United States

Bob oversees the day-ahead and real-time markets, the Forward Capacity Market auctions, the Forward Reserve Auction, Financial Transmission Rights auctions, resource registration, market settlements, market analysis, and customer service and training. He previously served as Vice President of Market Development, Director of Resource Adequacy, and Director of Market Monitoring. He also led the ISO's efforts to implement the initial Forward Capacity Auction. He has authored papers on electricity price volatility, electricity auctions, and asset valuation, including papers in *The Energy Journal, Land Economics*, and the *Journal of Environmental Economics and Management*.

Food for Thought

"Why anthropology is important in understanding the evolution of energy infrastructure."

Gretchen Bakke, Assistant Professor of Anthropology, McGill University, Canada

Gretchen's work focuses on the chaos and creativity that emerge during social, cultural, and technological transitions. For the past decade, she has been researching and writing about the changing culture of electricity in the United States. She is a former fellow in Wesleyan University's Science in Society program, a former Fulbright fellow, and is currently an assistant professor of anthropology at McGill University. Her book *The Grid* was selected by Bill Gates as one of his top five reads of 2016.

Session 4: Infrastructure investment for resilience: How do we improve?

Chair: Ben Kroposki, NREL, United States

Muireann Lynch, Postdoctoral Research Fellow and Research Officer, Economic and Social Research Institute, Ireland

Muireann holds a Ph.D. from the Department of Communications, Electronic and Electrical Engineering at University College Dublin. Her research interests are power system economics, risk and uncertainty in electricity generation portfolios, electricity market design and regulation, and energy systems integration. Her research methodologies include simulation, optimization, equilibrium modelling and game theory.

James McCalley, Professor of Power Systems Engineering, Iowa State University, United States

An Anson Marston Distinguished Professor, James teaches power systems engineering at the Department of Electrical and Computer Engineering at Iowa State University. James previously served Atlanta Gas Light-Company as well as Pacific Gas and Electric Company (PG&E), where he performed planning, design, and operating studies of the Western U.S. interconnected power grid. He was elected as an IEEE Fellow in 2003.

Jim Watson, Director of UK Energy Research Centre and Professor of Energy Policy, University of Sussex, United Kingdom

Jim brings 20 years' research experience on climate change, energy, and innovation policy. His recent outputs include co-edited books, including New Challenges in Energy Security: The UK in a multipolar world and Global Energy: Issues, Potentials and Policy Implications. Jim frequently advises U.K. government departments and other organizations. He is a judge for the Queens Awards, a member of the U.K. government's fossil fuel price projections panel and a member of the strategic advisory group for the Global Challenges Research Fund. He has also been a specialist adviser with three U.K. parliamentary committees and has extensive international experience, including over ten years working on energy scenarios and energy innovation policies in China and India.

David Brayshaw, Associate Professor of Climate Science and Energy Meteorology at the University of Reading and Principal Investigator at the National Centre for Atmospheric Science, United Kingdom

David's research interests concern large-scale atmospheric dynamics and its impact on human and environmental systems. In 2012, he founded the University of Reading's energy-meteorology research group. He is involved in a wide range of academic and industry-partnered projects on weather and climate risk in the energy sector, covering timescales from days to decades ahead.

Juan Torres, Associate Laboratory Director of Energy Systems Integration, NREL , United States

Juan oversees continuing efforts at NREL's Energy Systems Integration Facility (ESIF) to strengthen the security and resilience of the nation's electrical grid. He leads NREL's global initiative to optimize links between electricity, fuel, thermal, water, and communication networks in order to develop and demonstrate new technologies for grid modernization. He also co-leads the DOE's Grid Modernization Laboratory Consortium (GMLC) efforts.

Schedule at a Glance

Day 1: December 5, 2017, San Juan Meeting Room Research Support Facility X344	
8:00 a.m.	**Breakfast**
9:00 a.m.	**Opening Session:** Welcome remarks and introduction from NREL Director and conference chairs
9:30 a.m.	**Session 1:** Sector coupling solutions to renewables integration - Presentations
10:50 a.m.	*Coffee break*
11:00 a.m.	*Panel Discussion: Sector coupling solutions to renewables integration*
12:00 p.m.	**Food for Thought:** Energy efficiency revisited
12:30 p.m.	**Lunch**
1:45 p.m.	**Session 2:** The role of energy demand in an integrated energy system - Presentations
3:05 p.m.	*Coffee break*
3:15 p.m.	*Panel Discussion: The role of energy demand in an integrated energy system*
4:30 p.m.	**Day 1 Closing Remarks**
4:30-5:30 p.m.	*Shuttles to Marriott*
5:00 p.m.-7:00 p.m.	**Poster Session & Reception:** Denver West Marriott, Monarch Room
Day 2: December 6, 2017, San Juan Meeting Room, Research Support Facility X344	
8:00 a.m.	**Breakfast**
9:00 a.m.	**Session 3:** Electrification: The good, the bad, and the ugly - Presentations
10:50 a.m.	*Coffee break*
11:00 a.m.	*Panel Discussion: Electrification: The good, the bad, and the ugly*
12:00 p.m.	**Food for Thought:** Why anthropology is important in understanding the evolution of energy infrastructure
12:30 p.m.	**Lunch & Energy Systems Integration Facility Tour**
2:30 p.m.	**Session 4:** Infrastructure investment for resilience: How do we improve? - Presentations
3:50 p.m.	*Coffee break*
4:00 p.m.	*Panel Discussion: Infrastructure investment for resilience: How do we improve?*
5:00 p.m.	**Conference Adjourn & Closing Remarks**
5:00-6:00 p.m.	*Shuttles to Marriott*