# ES 2024

## 18th International Conference on Energy Sustainability

CONFERENCE
July 15–17, 2024

Hilton Anaheim
Anaheim, CA

# Program

https://event.asme.org/ES

The American Society of Mechanical Engineers®
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# WELCOME

## FROM THE CONFERENCE ORGANIZING COMMITTEE

Dear Colleagues,

On behalf of the ASME's Advanced Energy System Division (AESD) and Solar Energy Division (SED), we are delighted to welcome you to the ASME 2024 Energy Sustainability (ES 2024) Conference in Anaheim, CA!

The conference is a leading forum in which experts and researchers from academia, industry, national labs, and other key organizations gather to exchange ideas, research achievements, and technical developments related to energy and sustainability. The conference technical tracks cover a wide range of topics, including Sustainable Buildings and Communities, Concentrating Solar Power, Solar Chemistry, Wind Energy, Energy Storage, Sustainable Manufacturing, Industrial Process Heat, Alternative Fuels, Geothermal Energy, Hydrogen Energy, Carbon Capture, Education and Policy for Clean Energy Transition, and more. The ES 2024 Conference is co-located with both the Summer Heat Transfer Conference (SHTC) and the Fluids Energy Division Summer Meeting (FEDSM) to provide an opportunity for the attendees to expand their networks and participate in technical sessions on broader, but related, topics. We are pleased to announce that the conference has nearly doubled in size relative to ES 2023 and that we have a full schedule, including expert technical presentations, keynote speakers, panelists, and networking events.

Our conference theme this year is "Artificial Intelligence for Energy Sustainability." The rapid development of artificial intelligence (AI) in recent years has created unprecedented opportunities to revolutionize the energy transition. Through advanced analytics and machine learning algorithms, AI can optimize energy consumption, improve efficiency, and accelerate the integration of renewable energy sources into society. Our conference theme acknowledges the pace of adoption of AI and its machine learning counterparts and seeks to explore how these tools are being utilized in the energy space. We welcome Dr. Le Xie from Texas A&M to discuss how artificial intelligence and machine learning tools could transform and accelerate the transition to a sustainable future. In addition, we are co-hosting a workshop with SHTC to discuss the scientific machine learning methods for computational physics. Finally, attendees are invited to attend one of the five technical sessions focused on AI to listen to one of the nearly 25 presentations in which experts will share how they are using AI to support the development and adoption of sustainable energy.

This year's conference organizers have continued to prioritize the participation of new voices in our conference through registration discount awards funded by the AESD and SED. The first award is a registration discount for student participants. It recognizes the critical role that the next generation of scholars play in ushering along the energy transition and in the future of the conference. The second award supports attendance of scholars early in their careers and scholars from institutions that are often underrepresented in engineering spaces, including minority-serving institutions, undergraduate institutions, and institutions from the global south. This award affirms our strong belief that a diverse scholarly community will develop better, more durable, and more just paths to a sustainable future.

The Organizing Committee would like to express our deep gratitude to the many volunteers that have made the conference possible. Thank you to the track chairs and co-chairs, the session chairs and co-chairs, and the reviewers who have freely given their time to assemble a high-quality technical program. We would also like to thank ASME staff members for their support of the program, and we especially express our gratitude to our authors and presenters for sharing their research results. We sincerely hope you enjoy the conference!

**2024 Energy Sustainability Conference Organizing Committee**

**General Conference Chairs**

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*Presidential Frontier Faculty Fellow*
*Department of Mechanical Engineering*
*University of Houston*

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*University of Central Florida*

**Hailei Wang, Ph.D.**
*Assistant Professor of Mechanical Engineering*
*Utah State University*

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## REGISTRATION INFORMATION

**California Ballroom Foyer, Ballroom Level, Second Floor**

**Registration Hours:**

Sunday, July14, 10:00AM–6:00PM

Monday, July 15, 7:00AM–5:00PM

Tuesday, July 16, 7:00AM–5:00PM

Wednesday, July 17, 7:00AM–5:00PM

## SPONSOR EXHIBIT HOURS

**California Ballroom Foyer, Ballroom Level, Second Floor**

**Hours**

Monday, July 15, 10:00AM–4:00PM

Tuesday, July 16, 10:00AM–4:00PM

Wednesday, July 17, 10:00AM–4:00PM

**Don't forget to stop by and visit with our Exhibitors from NREL, Boeing, Carrier Corporation, University of Maryland, and the University of Minnesota. Their sponsorship and support help to make our conference sustainable.**

## BADGE REQUIRED FOR ADMISSION

All conference attendees must have an official ASME 2024 ES badge at all times in order to gain admission to technical sessions, exhibits, keynotes, meals, and other conference events. Without a badge, you will not be granted admission to conference activities.

## ASME EVENTS APP

ES/SHTC/FEDSM will utilize the mobile app "ASME Events" in place of a printed program to enhance the conference experience for attendees, speakers, exhibitors and sponsors.

The ASME Events app will allow you to:

- Have the most up-to-date conference schedule in the palm of your handView Speaker Profiles
- Receive important conference updates and reminders
- Build your session schedule - View session information including presentation abstracts and papers
- View speaker profiles and see when they are presenting

Registered attendees have been sent an email with download instructions and credentials from FEDSM-SHTC-ES-2024, no-reply@pheedloop.com

If any questions, please see ASME staff at the registration desk in California Ballroom Foyer.

## INTERNET ACCESS

Complimentary basic Internet is provided in the sleeping rooms if you are staying at the Hotel Anaheim. It is also available in the hotel's public space and in the conference meeting rooms.

**Network:** Hilton Honors
**Password:** 0724

## PRESENTER ATTENDANCE POLICY

According to ASME's Presenter Attendance Policy, if a paper is not presented at the conference, the paper will not be published in the official Archival Proceedings, which are registered with the Library of Congress and are abstracted and indexed. The paper also will not be published in the ASME Digital Collection and may not be cited as a published paper.

## SESSION ROOM EQUIPMENT

All technical sessions will be equipped with one projector and one screen. Presenters should share their presentation with the session chair in advance of the session or bring their presentation on a thumb drive

# Conference Information

## SPEAKER READY ROOM

The Green Room located on the Ballroom Level, Second Floor will be available per the schedule below to review and/or practice your presentation. A screen and LCD Projector will be provided.

**Monday, July 15, 7:00 AM–5:00 PM**

**Tuesday, July 16, 7:00 AM–5:00 PM**

**Wednesday, July 17, 7:00 AM–5:00 PM**

## OPENING RECEPTION

Join your peers for refreshments, light food and casual networking.

**Sunday, July 14, 6:00PM–7:30PM**
**California Ballroom A/B on the Second Floor**

## CONFERENCE AWARD LUNCHEON

The Awards Luncheon will be on Tuesday, July 16 from 12:05 PM to 1:35 PM in California Ballroom D on the Second Floor. Come celebrate a select group for their contributions and achievements in energy sustainability. Open to all ES registrants!

## CONFERENCE MEALS/POSTER PRESENTATIONS

On Monday and Wednesday, Conference lunches for all three conferences will be held from 12:05 PM to 1:35 PM in California Ballroom C/D located on the Ballroom Level, Second Floor. Please join your fellow attendees for a good meal and a great networking opportunity. On Monday, authors will present their research posters during lunch. Grab a boxed lunch and use the lunch time to view the posters and support the authors.

## CONFERENCE REFRESHMENT BREAKS

Morning and afternoon breaks will be provided in the California Ballroom Foyer on the Ballroom Level, Second Floor. Come and meet our exhibitors, NREL, Carrier Corporation, Boeing, UMD, and UMN, and join your fellow attendees for a few minutes of networking and discussion. The schedule is as follows:

**Monday–Wednesday, July 15–17**
**10:05 AM–10:25 AM and 3:15 PM–3:35 PM**

## CONFERENCE PROCEEDINGS AND DIGITAL PAPERS

Each attendee will receive an email with a unique code to access digital copies of all the papers accepted for presentation at the conference. The official conference archival proceedings will be published after the conference and will not include accepted papers that were not presented at the conference. The official conference proceedings are registered with the Library of Congress and are submitted for abstracting and indexing. The proceedings are published in the ASME Digital Library. You will be provided with an individual link to the online papers via email. In the event you do not receive the email, send a request to conferencepubs@asme.org.

## EMERGENCY INFORMATION

If you are experiencing a health emergency, please dial 911. If you are able or someone else is able, please dial 22 and inform the Security personnel so that the hotel can be on the alert for the emergency response team. The hotel also has 24-hour security and officers trained in first aid, CPR, & AED service.

## MEMBERSHIP TO ASME (4 MONTHS FREE)

Registrants who paid the non-member conference registration fees will receive a four-month complimentary ASME Membership. ASME will automatically activate this complimentary membership for qualified attendees. Please allow approximately four weeks after the conclusion of the conference for your membership to become active.

Visit www.asme.org/membership for more information about the benefits of ASME Membership.

## MOTHERS ROOM

**Balboa C, Concourse Level, Fourth Floor**

This private room is available on a first-come, first-served basis as a private space where lactating individuals are welcome to pump or nurse. A sign-up sheet will be provided on the door to schedule individual times.

A small refrigerator, chair, water station, and electrical outlets will be available.

## PRAYER ROOM

**Balboa A & B, Concourse Level, Fourth Floor**

## REGISTRANTS WITH DISABILITIES

Whenever possible, we are pleased to plan for registrants with disabilities. Advance notice may be required for certain requests. For on-site assistance, please visit the conference registration area and ask to speak with a conference representative.

## PHOTOGRAPHS/VIDEO/AUDIO RECORDINGS

Participants are reminded that material presented at ASME conferences is under copyright of ASME. As a result, any recording of the presentations is prohibited.

## LIMITATION OF LIABILITY

You agree to release and hold harmless ASME from all claims, demands, and causes of action arising out of or relating to your participation in this event.

## HILTON ANAHEIM PARKING

Current Parking Charges:

**Self-Parking**
$6.00 for first hour; $2.00 per half hour after that $20.00 Daily Max (no overnight)

**Self-Parking (with in & out privileges)**
$24.00 per day (Guests only)

**Valet Parking (with in & out privileges)**
$39.00 per day

# Schedule at a Glance

The schedule is subject to change  Please refer to the ASME Events app for detailed technical session schedule.

| TIME | EVENT | ROOM |
|---|---|---|
| **SUNDAY, JULY 14** | | |
| 10:00AM–6:00PM | Registration | California Registration Desk |
| 11:00AM– 2:00PM | Short Course: Scientific Machine Learning for Computational Physics (separate registration fee required) | Huntington B |
| 11:00AM– 2:00PM | Short Course: Verification & Validation Computational Simulations (separate registration fee required) | Huntington A |
| 2:30PM–5:30PM | Workshop: Modeling Methods for Particle Flow & Heat Transfer for Concentrated Solar Power Applications (separate registration fee required) | Huntington C |
| 6:00PM–7:30PM | Opening Reception | California Ballroom A/B |
| **MONDAY, JULY 15** | | |
| 7:00AM– 5:00PM | Registration | California Registration Desk |
| 7:00AM–5:00PM | Speaker Ready Room | Green Room |
| 7:00AM– 5:00PM | Prayer Room | Balboa A/B |
| 7:00AM–5:00PM | Mother's Room | Balboa C |
| 8:00AM–9:00AM | Underrepresented in STEM Discussion | Palos Verdes B |
| 9:05AM–10:05AM | Keynote – Dr.Le Xie, Texas A&M University<br>“Energy System Digitalization in the Era of AI: A Three-Layered Approach Toward Carbon Neutrality" | California Ballroom B |
| 10:05AM–10:25AM | Refreshment Break | California Foyer |
| 10:25AM–12:05PM | 08-01: Solar Chemistry: Thermochemical Fuel Production I | Palos Verdes A |
| 10:25AM–12:05PM | 01-01: AI for Energy Sustainability I | Palos Verdes B |
| 10:25AM–12:05PM | 03-01: Low Temperature Thermal Storage | Redondo |
| 10:25AM–12:05PM | 06-01: Thermal Energy Storage | Manhattan |
| 10:25AM–12:05PM | 04-01: Research for the Clean Energy Transition (Socio-Technical, Education, and Policy) | Sunset |
| 12:05PM–1:35PM | Lunch & Poster Session | California Ballroom C/D |
| 1:35PM–3:15PM | 02-01: Building Energy Efficiency Technologies | Palos Verdes B |
| 1:35PM–3:15PM | 05-01: Concentrating Solar Power I – Additively Manufactured, Aerogel, and Tubular Receivers | Redondo |
| 1:35PM–3:15PM | 17-01: Steinfeld Symposium - Solar Energy Perspectives | Manhattan |
| 1:35PM–3:15PM | 12-01: Hydrogen Energy, Alternative Fuels, Bioenergy, and Biofuels | Sunset |
| 1:35PM–3:15PM | 13-01: Carbon Capture & Cleaner Fossil Fuel Technologies | Salinas |
| 3:15PM–3:35PM | Refreshment Break | California Foyer |
| 3:35PM–5:15PM | 08-02: Solar Chemistry: Thermochemical Fuel Production II | Palos Verde A |
| 3:35PM–5:15PM | 02-02: Advances in Green Energy Modeling and Innovative Technologies | Palos Verde B |

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| TIME | EVENT | ROOM |
|---|---|---|
| 3:35PM–5:15PM | 03-02: High Temperature Thermal Storage | Redondo |
| 3:35PM–5:15PM | 06-02: Heat Transfer in CSP Applications 1 | Manhattan |
| 3:35PM–5:15PM | 01-02: AI for Energy Sustainability II | Salinas |
| 3:35PM–5:15PM | 13-02: Carbon Capture & Cleaner Fossil Fuel Technologies | Sunset |
| **TUESDAY, JULY 16** | | |
| 7:00AM–5:00PM | Registration | California Registration Desk |
| 7:00AM–5:00PM | Speaker Ready Room | Green Room |
| 7:00AM–5:00PM | Prayer Room | Balboa A/B |
| 7:00AM–5:00PM | Mother's Room | Balboa C |
| 8:00AM–9:00AM | Keynote – Dr.James Klausner, RedoxBlox Inc., Michigan State University<br>“Long Duration Thermochemical Energy Storage Technology – The Transformation From Laboratory to Commercialization" | California Ballroom A |
| 9:05AM–10:05AM | CSP Panel: What Does the Future Hold for CSP? | Palos Verdes A |
| 9:05AM–10:05AM | 14-01: Sustainable Manufacturing Processes for Low Carbon | Manhattan |
| 9:05AM–10:05AM | 04-02: Research for the Clean Energy Transition II | Sunset |
| 10:05AM–10:25AM | Refreshment Break | California Foyer |
| 10:25AM–12:05PM | 18-01 HelioCon Metrology | Palos Verdes A |
| 10:25AM–12:05PM | 02-03: HVAC System Analysis | Palos Verdes B |
| 10:25AM–12:05PM | 05-02: Concentrating Solar Power I – Heliostats and Trough Receivers | Redondo |
| 10:25AM–12:05PM | 17-02: Symposium Steinfeld - Solar Fuels Via Two-Step Cycles | Manhattan |
| 10:25AM–12:05PM | 12-02: Hydrogen Energy, Alternative Fuels, Bioenergy, and Biofuels | Sunset |
| 10:25AM–12:05PM | 01-03: AI for Energy Sustainability III | Salinas |
| 12:05PM–1:35PM | Solar Energy Division (SED) and Advanced Energy Systems Division (AESD) Awards Luncheon | California Ballroom D |
| 1:35PM–3:15PM | 18-02 HelioCon Windload | Palos Verdes A |
| 1:35PM–3:15PM | 02-04: Building Performance Analysis and Simulation | Palos Verdes B |
| 1:35PM–3:15PM | 10-01: Alternative Energy Conversion Technology (Including Wind, Geothermal, Hydro, and Ocean) | Redondo |
| 1:35PM–3:15PM | 17-03: Steinfeld Symposium - Solar Fuels Via an External Energy Addition | Manhattan |
| 1:35PM–3:15PM | 12-03: Hydrogen Energy, Alternative Fuels, Bioenergy, and Biofuels | Sunset |
| 1:35PM–3:15PM | 11-01: Process Heat for Desalination and Industrial Decarbonization | Salinas |
| 3:15 pm - 3:35PM | Refreshment Break | California Foyer |
| 3:35PM–5:15PM | Funding Program Managers Panel | California Ballroom B |
| 3:35PM–5:15PM | 18-03 HelioCon Solar Field | Palos Verdes A |

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| TIME | EVENT | ROOM |
|---|---|---|
| 3:35PM–5:15PM | 02-05: International Emphasis Applications | Palos Verdes B |
| 3:35PM–5:15PM | 03-03: Energy Storage Separate from CSP: Thermal, Mechanical, Thermochemical | Redondo |
| 3:35PM–5:15PM | 06-03: Concentrated Solar Power II – Power Block and Components | Manhattan |
| 3:35PM–5:15PM | 08-03: Solar Chemistry: Reforming, Base Chemical, & Cement Production | Sunset |
| 3:35PM–5:15PM | 09-01: Photovoltaic & Electrochemical Technologies | Salinas |
| 5:20PM–6:20PM | SED Buildings Technical Committee | Palos Verdes A |
| 5:20PM–6:20PM | SED Concentrated Solar Technical Committee | Palos Verdes B |
| 5:20PM–6:20PM | SED Solar Chemistry Technical Committee | Redondo |
| 5:20PM–6:20PM | Conference Career Panel | Coronado |
| 6:25PM–8:30PM | SED Executive Committee (Closed Meeting) | Sunset |
| **WEDNESDAY, JULY 12** | | |
| 7:00AM–5:00PM | Registration | California Registration Desk |
| 7:00AM–5:00PM | Speaker Ready Room | Green Room |
| 7:00AM–5:00PM | Prayer Room | Balboa A/B |
| 7:00AM–5:00PM | Mother's Room | Balboa C |
| 8:00AM–9:00AM | 2024 Yellott Award Winner Presentation – Dr. Sophia Haussner, Ecole Polytechnique Fédérale de Lausanne (EPFL)<br>“Bridging Photoelectrochemical and Thermochemical Approaches for Solar Fuels and Chemicals" | California Ballroom B |
| 9:05AM–10:05AM | 18-04 HelioCon Heliostat Designs | Palos Veredes A |
| 9:05AM–10:05AM | 02-06: Sustainable Buildings, Communities, and Cities | Redondo |
| 9:05AM–10:05AM | 06-04: Heat Transfer in CSP Applications 2 | Manhattan |
| 9:05AM–10:05AM | 12-04: Hydrogen Energy, Alternative Fuels, Bioenergy, and Biofuels | Sunset |
| 9:05AM–10:05AM | 15-01: Lightning Talks | Salinas |
| 10:05AM–10:25AM | Refreshment Break | California Foyer |
| 10:25AM–12:05PM | 18-05 HelioCon Modeling & Training | Palos Veredes A |
| 10:25AM–12:05PM | 10-02: Alternative Energy Conversion Technology (Including Wind, Geothermal, Hydro, and Ocean) | Palos Veredes B |
| 10:25AM–12:05PM | 05-03: Concentrating Solar Power I:  Receiver Applications | Redondo |
| 10:25AM–12:05PM | 17-04: Symposium Steinfeld - New Solar Chemical Processes and Cycles | Manhattan |
| 10:25AM–12:05PM | 09-02: Photovoltaic & Electrochemical Technologies | Sunset |
| 10:25AM–12:05PM | 02-07: Sustainable Buildings, Communities, and Cities | Salinas |
| 12:05PM–1:35PM | Lunch | California Ballroom C/D |

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| TIME | EVENT | ROOM |
|---|---|---|
| 1:35PM–6:15PM | Heliocon Summary | Palos Verdes A |
| 1:35PM–3:15PM | 10-03: Alternative Energy Conversion Technology (Including Wind, Geothermal, Hydro, and Ocean) | Palos Verdes B |
| 1:35PM–3:15PM | 05-04: Concentrating Solar Power I – Receiver Simulations/Analysis | Redondo |
| 1:35PM–3:15PM | 17-05: Symposium Steinfeld - Concentrated Solar Power and Thermal/Thermochemical Energy Storage | Manhattan |
| 1:35PM–3:15PM | 07-01: Technoeconomic Analysis of CSP Receivers and Particle Storage Technologies | Sunset |
| 1:35PM–3:15PM | 01-04: AI for Energy Sustainability IV | Salinas |
| 3:15PM–3:35PM | Refreshment Break | California Foyer |
| 3:35PM–5:15PM | 10-04: Alternative Energy Conversion Technology (Including Wind, Geothermal, Hydro, and Ocean) | Palos Verdes B |
| 3:35PM–5:15PM | 11-02: Process Heat for Desalination and Industrial Decarbonization | Redondo |
| 3:35PM–5:15PM | 17-06: Symposium Steinfeld - Radiative and Materials Characterization and  Solar Technology Development | Manhattan |
| 3:35PM–5:15PM | 07-02: CSP Systems Analysis for Heat and Electricity Applications | Sunset |
| 3:35PM–5:15PM | 01-05: AI for Energy Sustainability V | Salinas |

# Committee Meetings

| TIME | EVENT | ROOM |
|---|---|---|
| **MONDAY, JULY 15** | | |
| 5:20 PM–6:20 PM | AED REEC Committee Meeting | Palos Verdes A |
| **TUESDAY, JULY 16** | | |
| 5:20 PM–6:20 PM | SED: Buildings Technical Committee<br>Chair: Jian Zhang | Palos Verdes A |
| 5:20 PM–6:20 PM | SED: Concentrated Solar Power Technical Committee<br>Chair: Jeremy Sment | Palos Verdes B |
| 5:20 PM–6:20 PM | SED: Solar Chemistry Technical Committee<br>Chair: Johannes Grobbel | Redondo |

**SUNDAY, JULY 14** **2:30 PM–4:30 PM**

### MODELING METHODS FOR PARTICLE FLOW AND HEAT TRANSFER FOR CONCENTRATED SOLAR POWER APPLICATIONS

**Fee $25**

This workshop will focus on a series of short tutorials/presentations that discuss modeling flow physics and heat transfer (conduction, convection, radiation) in particle flow systems with applications to Gen3 CSP technologies.

For additional details, visit: https://event.asme.org/ES/Program/Workshop

## SHORT COURSES

**SUNDAY, JULY 14** **2:00 PM–5:00 PM**

### SCIENTIFIC MACHINE LEARNING FOR COMPUTATIONAL PHYSICS

**Fee $25**

**Instructor:**
**Jian-Xun Wang**,
*Assistant Professor, University of Notre Dame, Indiana*

**Course Description:** While traditional methods of modeling and simulation using PDEs and numerical discretization have achieved considerable success, they face significant challenges in areas such as inverse problems, uncertainty quantification, and design optimization. These challenges are particularly pronounced in systems where the governing physics are not fully understood, complicating the development of first-principle numerical solvers. Recent advancements in data science and machine learning, coupled with the increasing availability of data, are paving the way for innovative data-enabled computational models. Despite the potential of state-of-the-art machine/deep learning techniques, they confront hurdles like dependency on large datasets, issues with generalizability and extrapolation, and a lack of interpretability. This course aims to address these challenges by introducing scientific machine learning (SciML) techniques that are deeply rooted in physics. These techniques leverage the wealth of existing knowledge about physical systems, including established physical laws and phenomenological principles, to develop transformative machine learning techniques specifically tailored for computational physics and predictive modeling.

Learning Objectives: Participants will learn various aspects of SciML for modeling complex physical systems, including the integration of physics into neural network architectures, the design of hybrid neural solvers via differentiable programming, the use of physics to inform or regularize ML training, and data-driven knowledge/equation discovery with uncertainty quantification (UQ).

**Schedule**

30 minutes: Introduction

30 minutes: Physics-Informed Neural Network and Neural Operators

60 minutes: Physics-Integrated Differentiable Neural Modeling

30 minutes: Generative Models for Chaotic and Stochastic Systems

30 minutes: Scalable Bayesian Learning and Model Form Discovery

**Dr. Jian-Xun Wang**

Jian-Xun Wang is an Assistant Professor in the Department of Aerospace and Mechanical Engineering at the University of Notre Dame. He earned his Ph.D. in Aerospace Engineering from Virginia Tech in 2017. Dr. Wang has a multidisciplinary research background, crossing over into SciML data assimilation, Bayesian inference, UQ, and computational mechanics. His research particularly focuses on the intersection of data-driven modeling, UQ, and computational fluid dynamics. He has led research projects sponsored by multiple agencies, including NSF, ONR, AFSOR, and DARPA. Dr. Wang is a recipient of the 2021 NSF CAREER Award and the 2023 ONR YIP Award. He is also an elected member-at-large of the US Association of Computational Mechanics (USACM) Technical Thrust Area on Uncertainty Quantification and the Technical Thrust Area on Data-Driven Modeling.

## VERIFICATION & VALIDATION OF COMPUTATIONAL SIMULATIONS

**Instructor:**
**Luís Eça,**
*Associate Professor, IST, Portugal*

**Course Description:** Computational simulations have become an Engineering tool that complements model testing. As for physical models, such capability requires the assessment of the quality of the results, which depends on the mathematical model (basin or wind tunnel for physical models in fluid dynamics) and its numerical solution (instrumentation for experiments).

This course teaches Computational Simulations practitioners to distinguish numerical and modelling errors. It presents the definitions of the different contributions to the numerical error of steady and unsteady flow simulations. Techniques to quantify numerical (Verification) and modelling errors (Validation) in Computational Simulations are presented including examples from practical simulations of Computational Fluid Dynamics (CFD). The course provides a framework for the establishment of the credibility of simulations so that they can be safely used for engineering decisions.

**Objectives:**

You will learn how to demonstrate the quality of your computational simulations and evaluate the accuracy of the mathematical models behind those simulations.

**Schedule:**

30 minutes: Introduction

30 minutes: Numerical Errors and Uncertainties

30 minutes: Code Verification

30 minutes: Solution Verification

60 minutes: Validation

**Luís Eça**

Luís Eça is an Associate Professor in the Department of Mechanical Engineering of Instituto Superior Técnico (IST) of the University of Lisbon. He received the M.S., Ph.D. and “Agregação” degrees from Technical University of Lisbon in 1987, 1993 and 2009 respectively. He has been working in Computational Fluid Dynamics (CFD) for the last 35 years in cooperation with the Maritime Research Institute Netherlands (MARIN). The main topics of the research have been the simulation of high Reynolds number flows around complex geometries and Verification and Validation in CFD. He is a member of the ASME Standards Sub-Committee in Verification, Validation and Uncertainty Quantification in Computational Fluid Dynamics and Heat Transfer since June 2015. Eça has been a member of the ASME Standards Committee of Verification, Validation and Uncertainty Quantification since June 2018.

**MONDAY, JULY 15** **9:05 AM–10:05 AM**
**CALIFORNIA BALLROOM B**

**Le Xie, Ph.D.**
*Segers Family Dean's Excellence Professor in Engineering*
*Texas A&M University*

**Keynote Title: Energy System Digitization in the Era of AI: A Three-Layered Approach Toward Carbon Neutrality**

**Abstract:** The transition toward carbon-neutral electricity is one of the biggest game changers in addressing climate change since it addresses the dual challenges of removing carbon emissions from the two largest sectors of emitters: electricity and transportation. The transition to a carbon-neutral electric grid poses significant challenges to conventional paradigms of modern grid planning and operation. Much of the challenge arises from the scale of the decision-making and the uncertainty associated with the energy supply and demand. Artificial intelligence (AI) could potentially have a transformative impact on accelerating the speed and scale of the carbon-neutral transition, as many decision-making processes in the power grid can be cast as classic, though challenging, machine-learning tasks. We point out that the AI algorithms originally developed for applications should be tailored in three layers: technology, markets, and policy. In this layered scheme, we will also present practical case studies demonstrating how AI can be utilized to support decision-making processes aimed at improving energy efficiency and resilience.

**Biography:** Dr. Le Xie is the Segers Family Dean's Excellence Professor, Chancellor EDGES Fellow, and Presidential Impact Fellow in the Department of Electrical and Computer Engineering at Texas A&M University, and the Associate Director-Energy Digitization at Texas A&M Energy Institute. He received his B.E. in Electrical Engineering from Tsinghua University in 2004, S.M. in Engineering Sciences from Harvard in 2005, and Ph.D. in Electrical and Computer Engineering from Carnegie Mellon in 2009. His industry experience includes ISO-New England and Edison Mission Energy Marketing and Trading. His research interest includes modeling and control in data-rich large-scale systems, grid integration of clean energy resources, and electricity markets.

Dr. Xie is a Fellow of IEEE and a Power and Energy Society (PES) Distinguished Lecturer. He received the National Science Foundation CAREER Award, and Oak Ridge Ralph E. Powe Junior Faculty Enhancement Award. He was awarded the 2021 IEEE Technical Committee on Cyber-Physical Systems Mid-Career Award, and 2017 IEEE PES Outstanding Young Engineer Award. He was the recipient of the Texas A&M Dean of Engineering Excellence Award, ECE Outstanding Professor Award, and TEES Select Young Fellow. He serves or has served on the Editorial Board of IEEE Transactions on Power Systems (Senior Editor), IEEE Transactions on Smart Grid, and IET Transaction on Smart Grid. He is the founding chair of IEEE PES Subcommittee on Big Data & Analytics for Grid Operations. His team received the IEEE PES Technical Committee Prize Paper award, and multiple Best Paper awards at North American Power Symposium 2012, IEEE SmartGridComm 2013, HICSS 2019 and 2021, IEEE Sustainable Power & Energy Conference 2019, and IEEE PES General Meeting 2020/2023.

# Keynote Speakers

**TUESDAY, JULY 16** **8:00 AM–9:00 AM**
**CALIFORNIA BALLROOM A**

**James Klausner, Ph.D.**
*Executive Chairman, RedoxBlox Inc.*
*MSU Foundation Professor, Michigan State University*

**Keynote Title: Long Duration Thermochemical Energy Storage Technology—The Transformation from Laboratory to Commercialization**

**Abstract:** The genesis of the thermochemical energy storage company, RedoxBlox, can be traced back to an encounter with Prof. Aldo Steinfeld in the late 2000's who inspired high temperature solar thermochemistry research at the University of Florida. The pathway to commercialization can be characterized by discovery, opportunity, and execution. While at the University of Florida, Ph.D. student Kelvin Randhir discovered a new mixed metal oxide redox material, magnesium manganese oxide, that has very unusual properties. The research team continued fundamental research on the material at Michigan State University (MSU), where its thermodynamic and thermal transport properties were characterized. An opportunity arose when ARPA-E released a funding solicitation for its DAYS program focusing on long duration energy storage. The MSU team was awarded funding to develop an electricity-to-electricity thermochemical long duration energy storage system based on magnesium manganese oxide as the storage media. The team executed on a bench scale thermochemical storage device that demonstrated an energy density of 2400 MJ/m3, which is on par with the energy density of lithium ion batteries. The thermochemical storage technology received interest from the cleantech sector, and RedoxBlox was launched in early 2021 with seed funding from Breakthrough Energy Ventures. RedoxBlox moved its headquarters to San Diego, CA in 2022 and opened an affiliate office in Dornbirn, Austria in the same year. RedoxBlox is currently executing on three demonstration projects: a 2 MWh thermochemical storage module for a cardboard manufacturer in Austria, a 10 MWh thermochemical storage module for Dow Chemical, and a 10 MWh electricity-to-electricity storage system for UC San Diego. This talk will examine the history of the thermochemical storage technology development, the challenges of commercialization, and ongoing pursuit to make an impact in global decarbonization.

**Biography:** Dr. James Klausner is a co-founder of the long duration energy storage company, RedoxBlox and currently holds the role as Executive Chairman. He also holds the position of MSU Foundation Professor at Michigan State University. He is formerly Dean of Engineering at UAE University (2021–2022), formerly the Director of the Fraunhofer USA Midwest Research Center (2022), and formerly a Department Chair of Mechanical Engineering at Michigan State University (2016–2021). He formerly served as Chair of the ASME Heat Transfer Division (2011–2012). He serves on the board of directors for the American Society of Thermal Fluid Engineers and the International Titanium Association Foundation. For three and a half years he served as a Program Director at the U.S. Department of Energy Advanced Research Projects Agency-Energy (ARPA-E). Prior to that he held the Newton C. Ebaugh Professorship in Mechanical and Aerospace Engineering at the University of Florida (1989-2015). He received his Ph.D. degree in 1989 from the University of Illinois, Urbana-Champaign. He has made substantial fundamental contributions to understanding the dynamics of boiling heat transfer systems. He has made fundamental and applied research contributions in high temperature thermochemistry, waste heat and solar driven desalination, and high heat flux phase-change heat transfer. Dr. Klausner has authored more than 175 refereed publications and is the author of more than ten patents and four provisional patents. He is a Fellow of the American Society of Mechanical Engineers and the American Society of Thermal Fluid Engineers. He is a recipient of the ASME Heat Transfer Division Memorial Award and the 75th Anniversary Award.

## 2024 YELLOTT AWARD WINNER PRESENTATION

**WEDNESDAY, JULY 17** **8:00 AM–9:00 AM**
**CALIFORNIA BALLROOM B**

The Yellott Award Yellott Award is presented by Solar Energy Division (SED) to an outstanding individual that has contributed significantly to the organization of the SED sponsored symposia, has demonstrated outstanding leadership in ASME, has a reputation for performing high-quality research, has made significant contributions to solar engineering through education, state or federal service, or in the private sector.

**Sophia Haussener, Ph.D.**
*Associate Professor*
*Laboratory of Renewable Energy Science and Engineering,*
*Ecole Polytechnique Fédérale de Lausanne (EPFL)*

**Presentation Title: Bridging Photoelectrochemical and Thermochemical Approaches for Solar Fuels and Chemicals**

Abstract: Solar radiation, abundant but distributed and intermittent, requires storage for practical use. Solar thermo-chemical and photo-electro-chemical methods (and combinations thereof) offer non-biological routes to produce solar fuels and chemicals. While thermochemical processes utilize high temperatures for endothermic reactions, photoelectrochemical processes harness photons (with sufficient energy) for reaction driving.

The presentation will review the state of both approaches, addressing challenges and exploring their combined potential. Specifically, the utilization of concentrated solar irradiation and thermal integration for photo-electrochemical approaches will be discussed, along with quantification of their potential and strategies to scale. To further reduce overpotentials and reliance on rare materials, we will discuss a modeling-based assessment of high-temperature (temperatures > 400 K) photo-electrochemical approaches in a solid-state equivalent design. The presentation will discuss requirements on materials (solid electrolyte, catalysts, semiconductor absorber and barriers, etc.), operating conditions and design for such approaches and explore limiting efficiencies. We will then present the experimental implementation of such a solar-driven high-temperature electrolysis approach in a simpler integrational approach before ending with discussing how electrochemistry can help in enhancing the performance of solar thermochemical cycles.

**Biography:** Sophia Haussener, Ph.D. is an Associate Professor heading the Laboratory of Renewable Energy Science and Engineering at the Ecole Polytechnique Fédérale de Lausanne (EPFL). Her current research is focused on providing design guidelines for thermal, thermochemical, and photoelectrochemical energy conversion reactors through multi-physics modeling. Her research interests include thermal sciences, fluid dynamics, charge transfer, electro-magnetism, and thermo/electro/photochemistry in complex multi-phase media on multiple scales. She received her MSc (2007) and PhD (2010) in Mechanical Engineering from ETH Zurich. Between 2011 and 2012, she was a postdoctoral researcher at the Joint Center of Artificial Photosynthesis (JCAP) and the Energy Environmental Technology Division of the Lawrence Berkeley National Laboratory (LBNL). She has published over 70 articles in peer-reviewed journals and conference proceedings. She has been awarded the ETH medal (2011), the Dimitris N. Chorafas Foundation award (2011), the ABB Forschungspreis (2012), the Prix Zonta (2015), the Global Change Award (2017), and the Raymond Viskanta Award (2019), and is a recipient of a Starting Grant of the Swiss National Science Foundation (2014). She is a deputy leader in the Swiss Competence Center for Energy Research (SCCER) on energy storage and acts as a Member of the Scientific Advisory Council of the Helmholtz Zentrum.

## CSP PANEL

**TUESDAY, JULY 16** **9:05 AM–10:05 AM**
**PALOS VERDES A**

**What Does the Future Hold for CSP?**

The goal of this panel is to elicit discussion around current innovation and future directions for the technology, market, and workforce of CSP. The panel hosts diverse perspectives from industry, academia, government, and national labs to discuss lessons learned and provide insight into potential pathways for CSP innovation.

**Moderator**
**Lindsay Walter, Ph.D.**
*ORISE Science and Technology Policy Fellow*
*U.S. Department of Energy Solar Energy Technologies Office*

Dr. Lindsay Walter is an ORISE Science and Technology Policy fellow at the U.S. Department of Energy Solar Energy Technologies Office (SETO). She joined SETO in December 2023 and works on the Concentrating Solar-Thermal Power team. Prior to joining SETO, Lindsay earned her Ph.D. in mechanical engineering from the University of Utah, where her research focused on modeling near-field radiative heat transfer between complex-shaped particles supporting localized surface phonons in Dr. Mathieu Francoeur's group.

**Apurba Das, Ph.D.**
*VP Engineering*
*Heliogen*

Dr. Apurba K Das is a recognized leader with extensive experience in the clean energy sector. He serves as a VP of Engineering at Heliogen, an energy technology company focused towards decarbonization. Apurba is experienced in concentrated solar power plant design, integration, startup, and commissioning. He has deep expertise in product development of direct steam (Gen 1), molten salt (Gen 2), and particle receiver (Gen 3) technologies for concentrated solar power applications. In recognition of his contributions, he has been honored with ASME Distinguished Engineer Award (Hartford, 2016). Recently he secured support from DOE for a proposal to develop solar calciner technology for industrial decarbonization. Dr. Das has authored multiple papers and patents, reflecting his commitment to research, innovation, and thought leadership in clean energy domain.

Apurba has a BTech & MTech in Mechanical Engineering from Indian Institute of Technology (IIT), Kharagpur, India. He also holds a Ph.D. in Mechanical Engineering from Case Western Reserve University (CWRU), Cleveland, Ohio.

**Jeremy Sment**
*Principal Engineer*
*Sandia National Laboratories*

ASME Optical Systems, Receivers and Reactors Track Chair, Jeremy Sment, is a researcher and Principal Engineer at Sandia National Laboratories in Albuquerque, New Mexico, where he has worked since 2010. In his role at the National Solar Thermal Test Facility, Jeremy leads a team of particle-based CSP experts on the Generation 3 Particle Pilot Plant currently under construction. Jeremy focuses on thermal energy storage and market adoption of CST applications for industrial heat and solar wastewater treatments concerning the thermal decomposition of PFAS. Jeremy also specializes in system integration, commercialization, and techoeconomics and leads the Field Deployment task in HelioCon in collaboration with NREL. In this role, he has had the opportunity to conduct a series of interviews with industry experts around the world to develop a high-level understanding of solar field deployments in the context of US energy market trends. He is currently performing studies on site-selection and the impacts of heliostats and solar panels on desert tortoise habitats, and heliostat foundation requirements. Throughout his career, Jeremy has performed CFD modeling and measurements of wind loading over heliostat fields, and developed functions for photovoltaic power models and heliostat flux mapping and calibration tools. More recently, Jeremy has developed structural cost modeling tools for receiver towers with tower-integrated storage, particle hoists conveyance machinery, and ground based hot-particle silo construction. Jeremy holds a master's degree in Science in Mechanical Engineering from the University of New Mexico.

**Mike Wagner, Ph.D.**
*Assistant Professor*
*University of Wisconsin-Madison*

Mike Wagner is an Assistant Professor of Mechanical Engineering at the University of Wisconsin-Madison, where he is Director of the Energy Systems Operations Lab and a faculty member of the Solar Energy Lab. His research includes thermal systems modeling, system design and operations optimization, and predictive performance analysis of energy generation and storage technologies. Prior to joining UW-Madison, he was a Researcher and project manager for 12 years in the Thermal Systems group at NREL in Golden, Colorado. Dr. Wagner holds Bachelor's and Master's degrees from the University of Wisconsin-Madison and a Ph.D. from Colorado School of Mines.

**John Webley, MSEE, DSc. (Hon)**
*Founder Chairman and CEO*
*Trevi Systems*

With his two co-founders, John grew Advanced Fibre to a market capitalization of $6 billion in 1999 and thereafter he founded Turin Networks, with a subsequent sale to Dell for $700mm in 2007. John then founded Trevi Systems (2010) to commercialize a promising Forward Osmosis water purification technology which is in large scale pilot roll-out.

**Guangdong Zhu, Ph.D.**
*Senior Researcher and Group Manager*
*National Renewable Energy Laboratory (NREL)*

Dr. Guangdong Zhu has been a senior researcher since 2010 and the group manager of Thermal Energy Systems, at the National Renewable Energy Laboratory (NREL). The Thermal Energy Systems group is focused on concentrating solar power technologies, thermal energy storage and renewable energy hybridization. At NREL, Guangdong has been leading research efforts related to solar collector development, linear Fresnel technology, seasonal storage, and renewable energy hybridization. He is the executive director of the newly formed 5-year $25M heliostat consortium co-led by NREL and Sandia National Labs, partnering with Australian Solar Thermal Research Institute (ASTRI). He is the associate editor of the ASME Solar Energy Engineering since 2023 and was the editor of the ASME Journal of Energy Resources Technology between 2019–2022. He has served as technical/general program chair for ASME Energy Sustainability international conference in 2017–2020. He won NREL's staff award for outstanding performance in 2021, President's award in 2016, and Outstanding New Partnership Award in 2016. He has published over 40 peer-reviewed journal/conference papers and given invited presentations at various research institutes. Dr. Zhu obtained his Ph.D. in mechanical engineering from the University of New Mexico in 2006.

## PROGRAM MANAGERS FUNDING PANEL

**TUESDAY, JULY 16** **3:35PM–5:15PM**
**CALIFORNIA BALLROOM B, BALLROOM LEVEL, SECOND FLOOR**

The federal funding panel will provide the opportunity for program managers to outline their funding priorities to conference attendees.

**Panelists:**

**Sumanta Acharya,**
*Program Director, NSF Thermal Transport Processes (TTP) Program*

**David Haas,**
*Senior Technical Advisor, DOE Solar Energy Technologies Office (SETO)*

**Yogendra Joshi,**
*Program Manager, DARPA Microsystems Technology Office (MTO)*

**Zachary Pritchard,**
*Technology Manager, DOE Industrial Efficiency & Decarbonization Office (IEDO)*

**Mark Spector,**
*Program Officer, Office of Naval Research (ONR), Thermal Science and Engineering Program*

## SYMPOSIUM TO HONOR PROFESSOR ALDO STEINFELD

**TUESDAY, JULY 16** **10:25 AM–12:05 PM**
**MANHATTAN ROOM**

**Prof. Aldo Steinfeld**
*Department of Mechanical and Process Engineering*
*ETH Zürich*

The Symposium to honor Prof. Aldo Steinfeld at the 18th ASME International Conference on Energy Sustainability is sponsored by the ASME Solar Energy Division and is being organized to recognize Prof. Steinfeld's seminal contributions to the science and engineering of solar energy conversion.

Prof. Steinfeld will retire from the ETH Zurich after this year, and he will leave behind a legacy that resonates throughout the world. He has been a world leader in developing innovative technologies aimed at the solar-driven production of power, fuels, and chemicals. His work has sought to address some of the most challenging energy and environmental problems of our times, spanning from fundamental research in thermodynamics, transport phenomena, multiphase reacting flows, and high-flux optics to applications in concentrated solar energy, thermochemical processing, CO2 capture and utilization, thermal energy storage, and sustainable energy systems. In particular, he is most renowned for his pioneering work in solar fuels. He has conducted R&D on short- to mid-term pathways to solar fuels by solar-upgrading the calorific value of carbonaceous feedstock through reforming and gasification processes. However, his long-term goal has been to reverse the combustion process by producing solar fuels exclusively from CO2 and H2O via redox cycles. One of his most notorious achievements was the first-ever demonstration of the entire thermochemical process chain to synthetic drop-in fuels from sunlight and air.

He has published over 360 refereed journal papers, including publications in Science and Nature, and filed 27 patents. Perhaps his most enduring legacy has been the mentoring of PhD students and postdoctoral researchers: 57 PhD students to date have successfully completed their PhD dissertations under his guidance and 18 postdoctoral researchers have worked with him throughout his distinguished career. Many of these PhD students and postdoctoral researchers have followed in Prof. Steinfeld's footsteps and pursued careers in academia at top institutions situated throughout Asia, Europe, and North America.

Born and raised in Montevideo, Uruguay, Aldo Steinfeld completed his BSc in Aeronautical Engineering at the Technion in 1983 and his MSc in Mechanical Engineering at Tel Aviv University in 1986. He performed his doctoral research at the University of Minnesota under Prof. Edward A. Fletcher, studying the carbothermal reduction of metal oxides in solar-driven processes, receiving his PhD in 1989. His scientific advancement continued at the Weizmann Institute of Science as a postdoctoral fellow where he was first introduced to solar tower technologies. Switzerland ultimately became his basecamp for reimagining his brand of solar thermochemistry. He joined the Paul Scherrer Institute in 1991, where he later directed the Solar Technology Laboratory until 2014. In parallel, he pursued an academic career at ETH Zurich, where he has held the Chair of Renewable Energy Carriers since 1999.

During his illustrious career, Prof. Steinfeld has established an impressive record of service to the scientific and engineering communities. He served as the Editor-in-Chief of the ASME Journal of Solar Energy Engineering (2005–2009) and co-Editor of the CRC Handbook on Hydrogen Energy (2014). His contributions to science and education have been recognized with numerous accolades, including the ASME Solar Energy Division's Yellott Award (2008), the European Research Council Advanced Grant (2012), the ISES-International Solar Energy Society's Farrington Daniels Award (2013), the Heat Transfer Memorial Award (2013), the ASME Kreith Energy Award (2016), and the AIChE-American Institute of Chemical Engineer's Sustainable Engineering Research Award (2022). Two spin-off companies have emerged from his research, founded by his former PhD students: Climeworks commercializes the technology for CO2 capture from air, and Synhelion commercializes the technology for solar fuel production. Prof. Steinfeld was inducted into the Swiss Academy of Engineering Sciences (2010) and the Pan-American Academy of Engineering (2016).

**Invited Speaker**
**D. Yogi Goswami, Ph.D, PE**
Distinguished University Professor and Director,
Clean Energy Research Center
University of South Florida, Tampa, FL
Editor-in-Chief, Solar Compass Journal

**Presentation Title: Hybrid Solar CSP, PV and Thermal Energy Storage for Baseload Power, Industrial Process Heat and Solar Fuels**

**Topic**

In honor of Prof. Steinfeld's broad contributions to the field of concentrated solar thermochemistry.

**Symposium Organizers**

**Peter Loutzenhiser**, *Georgia Institute of Technology*

**Jonathan Scheffe**, *University of Florida*

**Erik Koepf**, *Dupont*

**Sophia Haussener**, *EPFL*

## UNDERREPRESENTED IN STEM DISCUSSION

**MONDAY, JULY 15** **8:00 AM–9:00 AM**
**PALOS VERDES B**

Join peers for networking and guided discussions around our experiences as members of underrepresented groups in STEM. Morning beverages and light breakfast food will be served.

We welcome anyone who is part of an underrepresented group in STEM, including, but not limited to, underrepresentation based on gender, sexuality, race, ethnicity, or (dis)ability.

Guided group discussions will give us a chance to meet and get to know each other as well as share experiences and learn from each other about both the common and unique experiences we face as members of underrepresented groups.

## STUDENT ACTIVITIES

In addition to offering the ES 2024 Student Registration Fee Scholarship, ES2024 features activities dedicated to students, including the Poster Presentation Session and Career Panel. These activities will be available to all student registrants.

Be sure to join the Solar Energy Division (SED) and Advanced Energy Systems Division (AESD) Awards Luncheon to support the Student Paper Award and Graduate Student Award winners! The Award Luncheon is open to all ES24 registrants.

## POSTER PRESENTATION COMPETITION

**MONDAY, JULY 15** **12:05 PM–1:35 PM**
**CALIFORNIA BALLROOM C & BALLROOM LEVEL, SECOND FLOOR**

Please join us to support ES students during this poster presentation.

## STUDENT CAREER PANEL

**TUESDAY, JULY 16** **5:20 PM–6:20 PM**
**CORONADO ROOM, CONCOURSE LEVEL, FOURTH FLOOR**

Members of industry, academia, and national labs will discuss their careers, how they selected the path they have taken, and answer questions from the audience about work/life balance in each respective field, etc.

## SOLAR ENERGY DIVISION (SED) AND ADVANCED ENERGY SYSTEMS DIVISION (AESD) AWARDS LUNCHEON

**TUESDAY, JULY 16** **12:05 PM–1:35 PM**
**CALIFORNIA BALLROOM D**

# Awards

## ES 2024 AWARDS

The ASME Advanced Energy Systems Division and Solar Energy Division are pleased to present six awards in two categories to the participants of the ES 2024.

### OUTSTANDING PAPER AWARD

To promote high quality research contributions in the field of Energy Sustainability, up to three outstanding papers will be recognized for their originality, impact, clarity, and elegance. The selection will be based on input from the reviewers, track chairs, and the organizing committee. The recipients will be recognized at an awards banquet held during lunch of the conference and will have their names published on the conference website.

### OUTSTANDING STUDENT-LED PAPER AWARD

To promote the contributions of undergraduate and/or graduate students in the field of Energy Sustainability, up to three outstanding papers featuring students as lead author(s) will be recognized for their originality, impact, clarity, and elegance. The selection will be based on input from the reviewers, track chairs, and the organizing committee. The recipients will be recognized at the Solar Energy Division (SED) and Advanced Energy Systems Division (AESD) Awards Luncheon and will have their names published on the conference website.

### GRADUATE STUDENT AWARD

Each year, the ASME Solar Energy Division (SED) recognizes an outstanding graduate student working in an area of solar energy including, but not limited to, conservation and solar buildings, heating and cooling, photovoltaics, solar chemistry and bio-conversion, solar thermal power, wind energy, solar ponds, solar chimneys, OTEC, and/or energy policy.

The winner receives $500 and is encouraged to give an invited talk at the track level at the conference.

The SED has selected Mario Zuber as the 2024 Graduate Student Award recipient.

Mario is presented in session 17-03 on July 16 at 1:35 PM.

The title of his presentation is Modeling of the Ceria-Based Redox Cycle for Dry Reforming of Methane: Towards Optimized Thermochemical Syngas Production.

**Mario Zuber**

**Biography:** Mario Zuber began his PhD under the supervision of Prof. Dr. Steinfeld in 2019, where his thesis focuses on renewable energy carriers, notably solar fuels. His research investigates the system on the theoretical, experimental, and computational fronts. Prior to his doctorate studies, Mario received his BASc from the University of Toronto where he studied mechanical engineering, and later continued his studies at ETH Zürich where he received his MSc in the mechanical engineering department.

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| Ramos | Mario | 121387 | Application of Multi-Objective Bayesian Optimization to Elucidate the Trade-Off Between the Solar Fraction and Cost of Parabolic Trough Solar Industrial Process Heat With Thermal Energy Storage | 11-01: Process Heat for Desalination and Industrial Decarbonization |
| Ghaith | Fadi | 121712 | Design of Solar Powered Desalination System and Applications in a Luxurious Beach Resort | 11-02: Process Heat for Desalination and Industrial Decarbonization |
| Huber | David | 121756 | Network Optimization for Sustainable Integration of Decentralized Biogas Production | 12-02: Hydrogen Energy, Alternative Fuels, Bioenergy, and Biofuels |
| Al-Fazari | Mohamed | 121821 | Toward Thermal Operation Decarbonization Improvements in Solar Steam Production Facility Efficiency for Higher Value and Higher Ghg Emissions Savings. | 16-01: Poster Presentations |
| Zuber | Mario | 122052 | Modeling of the Ceria-Based Redox Cycle for Dry Reforming of Methane: Towards Optimized Thermochemical Syngas Production | 17-03: Symposium Steinfeld - Solar fuels via an external energy addition |
| Rosenstiel | Andreas | 122128 | Cost Optimal Design of Solar E-Methanol Production Powered by Csp/pv Hybrid Power Plants. | 07-02: CSP Systems Analysis for Heat and Electricity Applications |
| Tubeuf | Carlotta | 122475 | Improving Control of Energy Systems With Reinforcement Learning: Application to a Reversible Pump Turbine | 01-01: AI for Energy Sustainability I |
| Fischer | Martin | 123705 | AI for Energy Intensive Industry: A Hybrid Optimization Approach for Flexibility Service Providers | 01-02: AI for Energy Sustainability II |
| Al-Amer | Ghadah | 124025 | Enhancing Energy Efficiency in Fluid Transport Pipelines Through Drag Reduction Agents | 11-02: Process Heat for Desalination and Industrial Decarbonization |
| Sharma | Ajay | 124141 | Assessing Energy Savings: A Comparative Study of Reflective Roof Coatings in Four USA Climate Zones | 02-01: Building Energy Efficiency Technologies |
| Dorosti | Ehsan | 124369 | Efficiency-Driven Supervised Learning Regressors in Power Modeling and Optimization of Vertical Axis Wind Turbines | 01-01: AI for Energy Sustainability I |
| Garraway | David | 125884 | Improved Performance of Transcritical R744 Gas Coolers For Efficient Heat Pumps in the Northeastern US Winter Markets | 02-07: Sustainable Buildings, Communities, and Cities |
| Osterwood | Kristen | 125960 | Nontechnical Barriers to Building Decarbonization in the U.S. | 04-01: Research for the Clean Energy Transition I |
| Lüchinger | Richard | 126235 | An Elementary Approach to Evaluating the Thermal Self-Sufficiency of Residential Buildings With Thermal Energy Storage | 02-01: Building Energy Efficiency Technologies |
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| Mengistu | Mebratu Assaye | 128357 | Enhancement of Heat Transfer in Solar Air Heater With Semi-Circular Shaped Transverse Rib. | 06-04: Heat Transfer in CSP Applications 2 |
| Liang | Xinbin | 129687 | Distribution Shift Problem in Artificial Intelligence Model of Smart Building: Concept, Impact, and Solutions | 01-05: AI for Energy Sustainability V |
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| Garcia-Maldonado | Luis | 130155 | Development and Real-Time Deployment of a Gen 3 Concentrating Solar Power Particle Pilot System Operational Model | 07-02: CSP Systems Analysis for Heat and Electricity Applications |
| Schaefer | Laura | 130180 | From Waste to Resource: A Techno-Economic Evaluation of a CO2 Heat Pump and ORC Combined System With Photovoltaic Integration and Thermal Storage | 04-01: Research for the Clean Energy Transition I |
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| Kerr | Matthew | 130508 | Evaluating Reduced Order Models for Training Reinforcement Learning Agents for Building HVAC Control | 01-05: AI for Energy Sustainability V |
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*Ben Xu, University of Houston*

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**Abdlmonem Beitelmal**, *JESBC Editor*

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**Jeremy Sment**, *Sandia National Laboratory*

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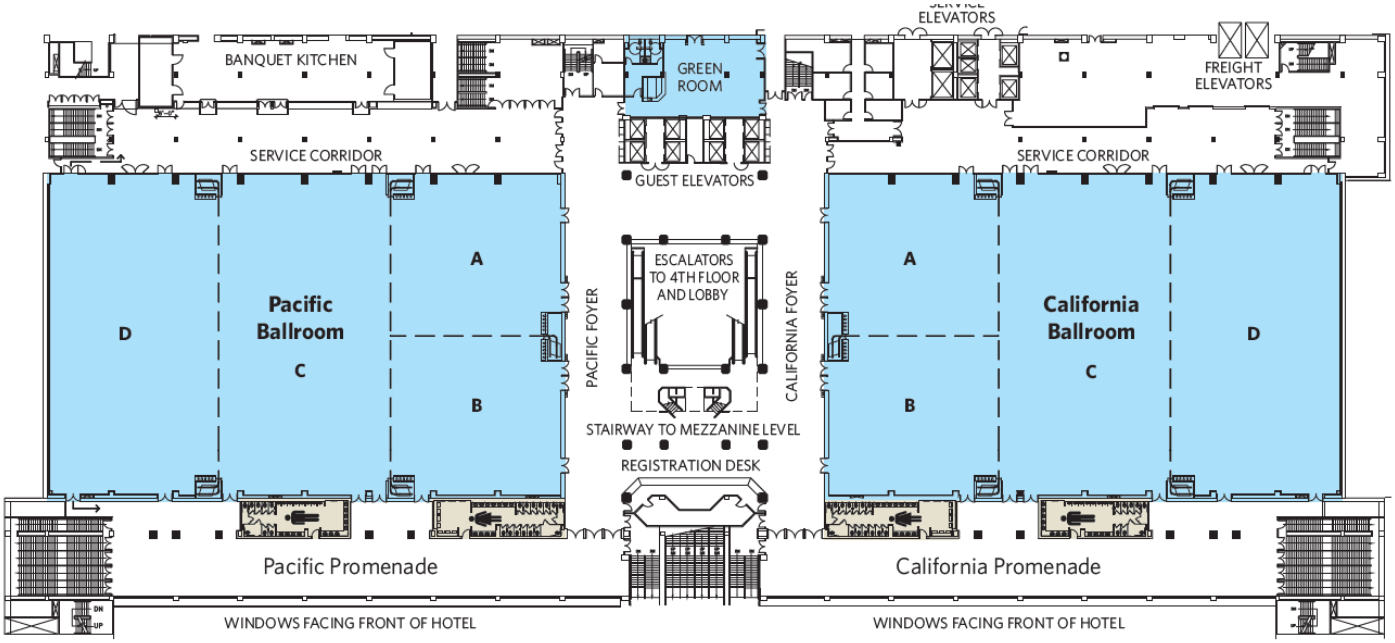

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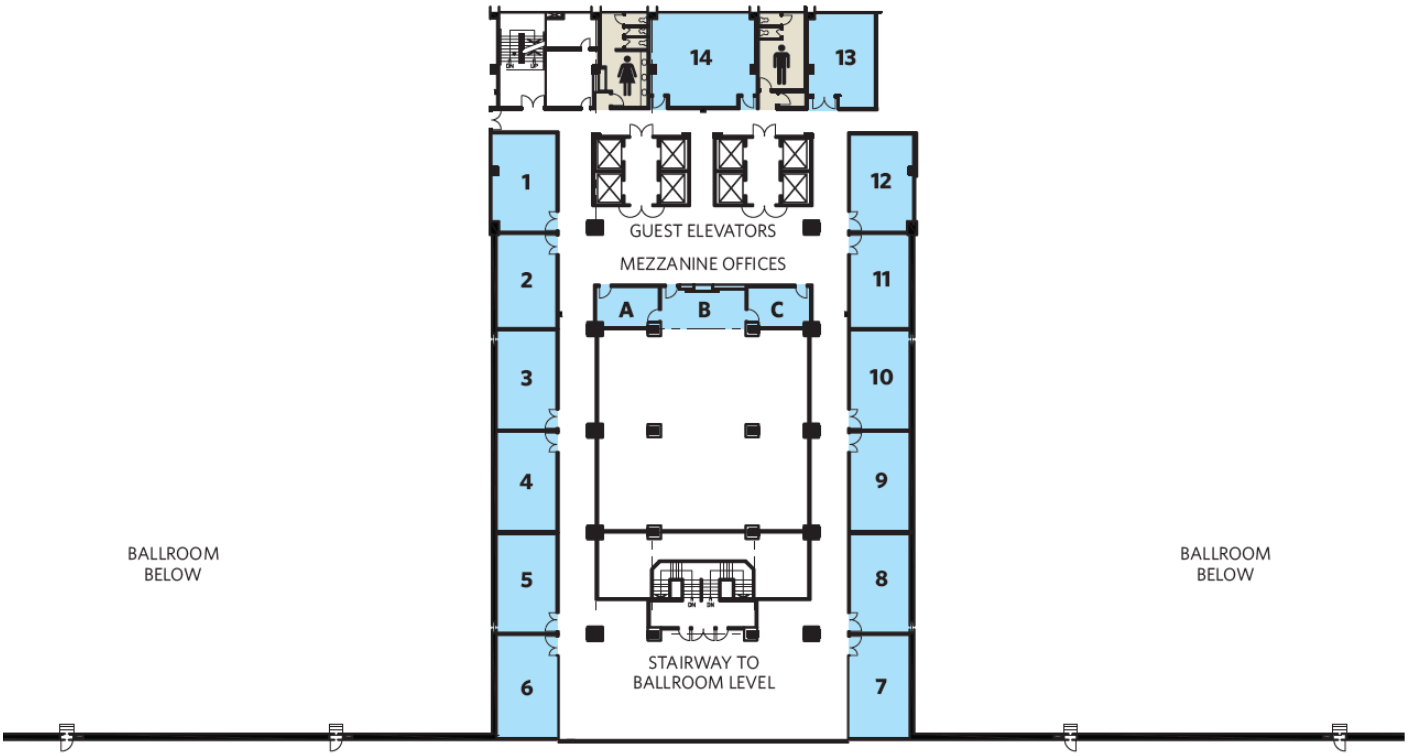

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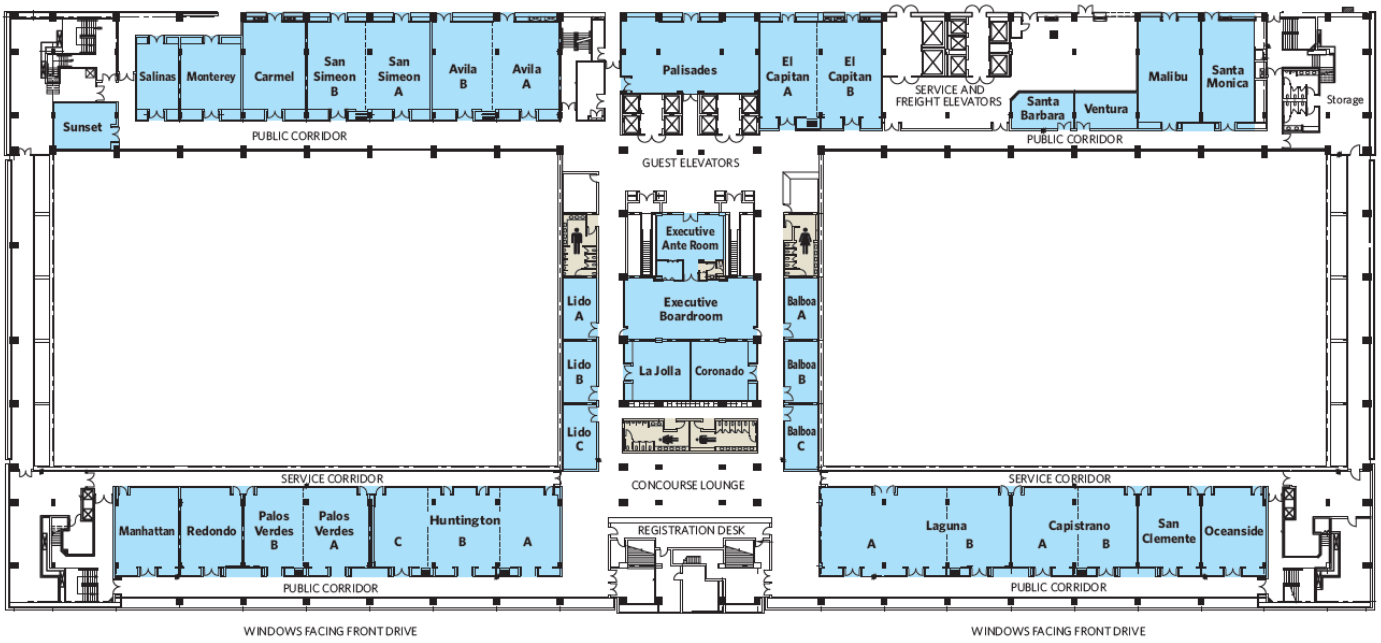

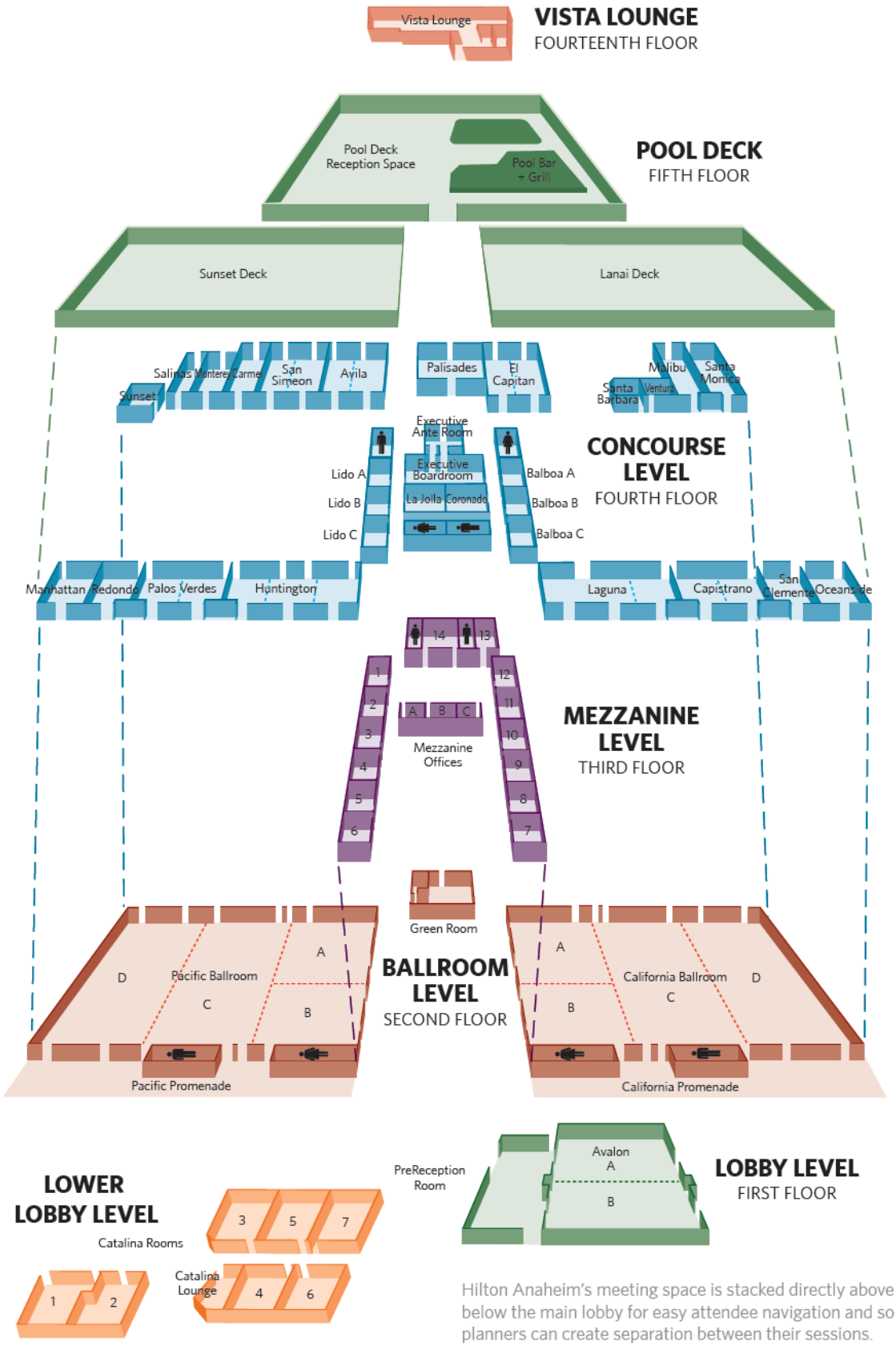


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