ASME® 2019 ES

13th International Conference on Energy Sustainability
co-located with the Summer Heat Transfer Conference

Program

CONFERENCE
JULY 14–17, 2019

Hyatt Regency Bellevue
Bellevue, WA

Inventing the Sustainable Future

The American Society of Mechanical Engineers®
ASME®

ASME
SETTING THE STANDARD

Contents

Welcome

Roman Bader
Technical Program Co-Chair, SED
ITP Thermal Pty Ltd.
Turner, ACT, Australia

Heejin Cho
Technical Program Co-Chair, AESD
Mississippi State University
Mississippi State, MS

Navid Goudarzi
Technical Program Co-Chair, AESD
UNC Charlotte, The William States Lee College of Engineering
Charlotte, NC

George Nelson
Technical Program Co-Chair, AESD
University of Alabama in Huntsville
Huntsville, AL

Soumik Banerjee
Technical Program Co-Chair, AESD
Washington State University
Pullman, WA

Dear Colleagues,

Welcome to the ASME 2019 Energy Sustainability Conference! This year, the theme of our conference is *"Inventing the Sustainable Future!"* We all believe that sustainability is an inherent part of the future in all aspects, including how we obtain our energy. In 2019 two of ASME's premier events, i.e., the Energy Sustainability Conference and the Summer Heat Transfer Conference, are held under one roof. This creates a unique opportunity for the attendees to expand their network and combine theory with application.

We are excited and proud to announce that we have a packed schedule and much for you to engage in and learn about while you're in Bellevue. From expert technical presentations to keynote and plenary speakers, ASME Advanced Energy System Division and Solar Energy Division Technical Committee Meetings, poster session, and quality networking events, you will have many options to choose from for how to spend your days with us. Be sure to visit our tabletop sponsors and learn about the newest technological advancements in the field of energy. A special thank you to our volunteer session chairs, reviewers, track organizers, and executive Advisory Committee who have spent countless hours putting together a top-notch technical program. We would also like to thank all of our sponsors and exhibitors for their support of the program and express our gratitude to our attendees for sharing their latest research results with us. We look forward to meeting many of you. Lastly, we hope everyone will take some time and enjoy Bellevue.

Have a great conference and thank you again for attending.

Reza Baghaei Lakeh
Conference General Chair, AESD
California State Polytechnic University
Pomona, CA

Michael Keith Sharp
Conference General Chair, SED
University of Louisville
Louisville, KY

Guangdong Zhu
Technical Program Chair, AESD
National Renewable Energy Laboratory
Golden, CO

Erik Koepf
Technical Program Chair, SED
DuPont de Nemours
Sunnyvale, CA

Conference Information

CONFERENCE REFRESHMENT BREAKS

Morning and afternoon breaks will be provided in the exhibition area, Grand Ballroom Foyer, Second Floor. Come and meet our exhibitors, and join your fellow attendees for a few minutes of networking and discussion.
The schedule is as follows:

Monday–Wednesday, July 15–17
10:10AM–10:30AM
and
3:40PM–4:00PM

EXHIBITS INFORMATION

Grand Ballroom Foyer, Second Floor

Monday, July 15
10:00AM–4:00PM

Tuesday, July 16
10:00AM–4:00PM

Wednesday, July 17
10:00AM–4:00PM

AUDIOVISUAL EQUIPMENT IN SESSION ROOMS

All technical sessions are equipped with one LCD projector and one screen. Laptops will NOT be provided in the sessions. Presenters MUST bring their own or make arrangements in advance with the session organizers to share. Bring your presentation on a thumb drive 15 minutes prior to the session start time.

BADGES REQUIRED FOR ADMISSION

All conference attendees must wear the official ASME 2019 SHTC badge at all times in order to gain admission to technical sessions, exhibits, and other conference events. Without a badge, you will NOT be allowed to attend any conference activities.

CONFERENCE AWARD BANQUETS

(TICKET REQUIRED FOR GUESTS)

The Awards banquet will take place during the conference to recognize and celebrate a select group of individuals for their contributions and achievements in energy and heat transfer engineering. The schedule is as follows:

The ES Awards Banquet will be held on Tuesday, July 16, 6:30PM–9:00PM in Grand Ballroom A/B on the Second Floor.

CONFERENCE LUNCHES

Conference lunches will be held from 12:15PM–1:45PM on Monday, Tuesday, and Wednesday during the conference in Grand Ballroom HIJK, Second Floor. Please join your fellow attendees for a good meal and a great networking opportunity. On Tuesday, July 16, a joint with SHTC poster session will also take place during lunch.

CONFERENCE EVENT CONNECT APP

Download the new ASME CrowdCompass App and hold the entire program in the palm at your hand! The new ASME CrowdCompass App allows you to easily look up sessions, search for papers or people, message with other attendees, post to various social media platforms, and create your own schedule.

The ASME CrowdCompass App is available at the App Store, Google Play, and Windows Market.

CONFERENCE PROCEEDINGS

Each attendee receives a conference DVD that includes all of 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 on 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 toolboxhelp@asme.org.

EMERGENCY INFORMATION

In the event of an emergency, please dial 55 or 0 on any hotel phone to connect with the hotel emergency hotline. The hotel will communicate with the local authorities. The hotel also has 24-hour security, and officers trained in first aid, CPR, & AED service.

INTERNET ACCESS

Complimentary Basic Internet access is available in sleeping rooms and the hotel's public space as well as the meeting space. ASME19 will be the password for Internet access in the meeting space.

TECHNICAL TOUR

Boeing Future of Flight Tour
Wednesday, July 17
1:00PM–4:00PM
$50.00 for Members and Non-Members
Tickets Required

BOEING

Boeing Future of Flight is one of Seattle's most-loved, premier attractions. Located just 25 miles north of Seattle, the Boeing Tour, is a one-of-a kind opportunity to view 747, 767, 777, and 787 Dreamliners on the assembly line before they take to the sky. This will be followed by The Boeing Factory Tour which is a visit inside a working assembly plant. Each tour segment is approximately 90 minutes long and includes fascinating facts about Boeing and the planes that bear its name. The cost is $50, which includes transportation from the conference hotel to the Boeing facility and back, as well as the tour ticket.

https://www.futureofflight.org/boeing-tour-seattle

OPENING RECEPTION

Sunday, July 14
6:30PM–8:30PM
Grand Ballroom Foyer, Second Floor

AICHE SYMPOSIUM HONORING PROFESSOR PETER C. WAYNER, JR.

Monday, July 15
8:30AM–10:10AM and 2:00PM–5:40PM
Cedar Ballroom B, Second Floor

MEMBERSHIP TO ASME (ONE-YEAR FREE)

Registrants who paid the non-member conference registration fees will receive a complimentary one-year 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.

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.

REGISTRATION INFORMATION

Grand Ballroom Foyer, Second Floor

Sunday, July 14	12:00PM–5:00PM
Monday, July 15	7:30AM–5:30PM
Tuesday, July 16	7:30AM–5:30PM
Wednesday, July 17	8:00AM–4:00PM

Program At-A-Glance

Sunday, July 14			Monday, July 15	Tuesday, July 16	Wednesday, July 17
	8:30AM–10:10AM	Cottonwood	**Keynote 19-1 Chuck Kutscher and John Webley**	**Keynote 19-2 Ann Kosmal**	**3-2**
		Juniper			**4-2**
		Larch			**10-1**
		Madrona			**16-2**
	10:30AM–12:10PM	Cottonwood	**1-1**	**2-1**	**3-3**
		Juniper	**3-7**	**3-10**	4-3
		Larch	**8-1**	**9-2**	11-1
		Madrona	14-1	**16-3**	
	12:15PM–1:45PM	Grand Ballroom HIJK	**Lunch**	**SHTC/ES Poster Session & Lunch 21-1-1**	**Lunch**
	2:00PM–3:40PM	Cottonwood	**1-2**	**2-2**	**3-5**
		Juniper	**3-8**	**3-11**	**6-1**
		Larch	**8-2**	**9-3**	**11-2**
		Madrona	**16-1**	**16-4**	16-5
	4:00PM–5:40PM	Cottonwood	**1-4**	**3-1**	3-6
		Juniper	**3-9**	**4-1**	**7-1**
		Larch	**9-1**	**9-4**	12-1
		Madrona			
6:30PM–8:30PM (Grand Ballroom HIJK) **Opening Reception**	6:30PM–9:00PM			(Grand Ballroom A/B) **Awards Banquet**	

SED Committee Meetings WEDNESDAY

EXECUTIVE COMMITTEE MEETINGS

SOLAR ENERGY DIVISION EXCO MEETING
6:45 PM – 7:30 PM
Grand Ballroom B, Second Floor

ADVANCED ENERGY SYSTEMS DIVISION EXCO MEETING
6:00 PM – 7:30 PM
Regency Ballroom A, Second Floor

JOINT SED/AESD EXECUTIVE COMMITTEE MEETING
7:30 PM – 8:00 PM
Regency Ballroom A, Second Floor

JOINT SED/AESD EXECUTIVE COMMITTEE DINNER
8:00 PM Departure
from Reg. Ballroom A, Second Floor

TECHNICAL COMMITTEE MEETINGS

SOLAR CHEMISTRY AND BIOCONVERSION
6:00 PM – 6:45 PM
Cottonwood, Third Floor

SOLAR THERMAL POWER
6:00 PM – 6:45 PM
Juniper, Third Floor

CONSERVATION, HEATING & COOLING, BUILDINGS
6:00 PM – 6:45 PM
Larch, Third Floor

PHOTOVOLTAICS
6:00 PM – 6:45 PM
Madrona, Third Floor

WIND ENERGY
6:00 PM – 6:45 PM
Regency Ballroom C, Second Floor

AESD TECHNICAL COMMITTEES (JOINT WITH EXCO)
6:00 PM – 7:30 PM
Regency Ballroom A, Second Floor

Special Sessions

KEYNOTE SPEAKERS

Monday, July 15
8:30AM–10:10AM
Auditorium, Third Floor

"The Path to Zero Carbon"

Dr. Charles F. (Chuck) Kutscher
Renewable and Sustainable Energy Institute, Boulder, CO

John Webley, MSEE, DSc. (Hon)
Trevi Systems Inc.

Abstract

The cost of climate change damage around the world has continued to mount. As just one example, AccuWeather has estimated that the total cost of the 2018 California wildfires could be as high as $400 billion. This presentation will cover the urgency of addressing climate change, the emerging transition to a clean energy economy, and the challenges we face in achieving 100% renewables. It will describe the steps that are needed to get to a zero-carbon energy system:

1. Maximizing energy efficiency, especially in buildings
2. Electrifying everything we can
3. Providing electricity with wind and solar augmented with various storage options
4. Controlling demand to match a variable supply

As part of the presentation, Dr. Kutscher will briefly describe some of the free tools the National Renewable Energy Laboratory has developed for maximizing building energy efficiency and for designing renewable energy systems, examples of which are included in his textbook (with co-authors Jana Milford and Frank Kreith), *Principles of Sustainable Energy Systems, Third Edition*. He will conclude by describing some of the hopeful signs suggesting that 2019 may well go down in history as the year that the climate change crisis finally began to receive the serious attention it deserves.

Biography

Dr. Charles F. (Chuck) Kutscher is a Fellow and Senior Research Associate of the Renewable and Sustainable Energy Institute, a joint institute between the University of Colorado-Boulder and the National Renewable Energy Laboratory (NREL). He spent a 40-year career at NREL, leading research in a wide range of energy efficiency and renewable energy technologies and served as the Director of the Buildings and Thermal Sciences Center from 2013 until his retirement in July 2018. He is a Fellow of the American Solar Energy Society (ASES), served as the Society's chair in 2000 and 2001, and chaired the Society's national solar conference in 2006 and 2012. He led the 2007 ASES study, *Tackling Climate Change in the U.S.*, a 200-page report detailing how energy efficiency and six renewable energy technologies can greatly reduce U.S. carbon emissions by 2030 and has given presentations around the world on climate change solutions. He is the lead author of the recently published third edition of the college textbook, *Principles of Sustainable Energy Systems*, and has served as an adjunct professor at the University of Colorado-Boulder and the Colorado School of Mines. He is a registered Professional Engineer in the states of Colorado and California.

Biography

With his two co-founders, John grew Advanced Fibre to 500 people and a market capitalization of $6 billion in 1999. Advanced Fibre was a telecommunications company enabling high speed services over copper. John left to found Turin Networks, an optical networking company, in 2000. After retiring from Turin and its subsequent sale to Dell for $700mm, he served as CEO of PAX Streamline (a Khosla Ventures funded bio-mimicry company) for two years. John then founded Innovative Labs, LLC to commercialize early stage technologies in air purification, dehumidification, desalination, plastics remediation and a number of other challenges to the environment (still active). Together with two water scientists, John founded Trevi Systems in 2010 to commercialize a promising Forward Osmosis water purification technology. Trevi Systems currently employs 30 people and has just commenced revenue shipments of its products. John's engineering background extends over 30 years in electrical, mechanical and chemical engineering. John received a B.S.E.E. and an M.S.E.E. from the University of Stellenbosch, South Africa in 1985 and an honorary Doctorate of Science from Sonoma State University. He served in the South African military and spent 14 months in Antarctica performing upper atmospheric physics experiments.

KEYNOTE SPEAKER

Tuesday, July 16
8:30AM–10:10AM
Auditorium, Third Floor

"Forward-Looking Design to Safeguard Assets in Changing Conditions"

A.R. Ann Kosmal, *FAIA, Office of Federal High-Performance Buildings, U.S. General Services Administration, Washington, DC*

Abstract

Because of a long intended service life, building performance is challenged to both endure and perform in conditions that are different from the past. The session will provide an overview of methods to safeguard assets and to ensure reliable performance in changing conditions. The session will include prioritization, use of actionable science, engineering options analysis, and adaptive management. The session will focus on the tactical and technical efforts to manage the intertwined risks which connect buildings, urban infrastructure, and integrated energy systems in risk-informed asset management. The session will include implications for professional practice for licensed design professionals as well as implications for owners and operators to ensure not only mission but life safety, public safety, and public health in the use of forward-looking design.

Biography

Ann Kosmal serves in the Office of Federal High-Performance Buildings of the U.S. General Services Administration. She safeguards assets from the observed and expected changes in climate for prudent investment, risk management, and augments life safety, public safety, health, and security. She prompts design innovation and bolsters our Nation's global competitiveness in the emerging sector of climate security which cannot be off-shored or outsourced. Ann is a co-author of the Fourth National Climate Assessment's Built Environment chapter. She is a graduate of Harvard's Senior Executive Fellows, a Passive House Consultant, and Permaculturist.

WORKSHOP

Carbon Dioxide Capture and Utilization (CCU) – Technology Opportunities and Challenges

Sunday, July 14
1:00PM–5:00PM
Cost: $30
Grand Ballroom C, Second Floor

A Comprehensive Overview of Carbon Management that will provide the State of Knowledge on Ongoing Carbon Dioxide Capture and Utilization Technology Development

Synopsis

The impact of rising carbon dioxide (CO_2) levels on climate change is now taken seriously, which is expected to stimulate global action to reduce CO_2 emissions as well as finding economic ways to convert CO_2 to value-added products in addition to utilizing CO_2 for Enhanced Oil Recovery (EOR) and geologic sequestration. When the global demand for electricity increased from 8.3 million GWh in 1980 to 22.7 million GWh in 2012, the resulting annual CO_2 emissions increased from 5.5 to 13.3 trillion tonnes. As such, the magnitude of CO_2 emissions is so large, that all possible technologies must be considered to make a realistic impact in the foreseeable future, namely: a) energy-efficiency in power generation and manufacturing; b) alternate fuels; c) renewable energy; d) CO_2 capture and sequestration (CCS); and e) CO_2 capture and utilization (CCU). The challenges associated with CO_2 capture, transport, and storage have been well documented. Therefore, the conversion of captured CO_2 to value-added products would eliminate CO_2 transportation and geologic sequestration costs, and encourage more facilities to convert CO_2 into a revenue generating products. There is a *Window of Opportunity* for innovative process and equipment designs for CO_2 capture and conversion to high-value products for offsetting the costs of CO_2 capture and conversion to products competitively.

The purpose of this workshop is to provide a comprehensive overview of ongoing projects and to evaluate techno-economic opportunities and challenges for developing innovative technologies for abatement of CO_2 emissions.

Why You Should Attend the Workshop and What You Can Expect

The workshop is intended for process and design engineers, managers, environmental engineers, and decision makers in power and manufacturing industries. If you are seeking the awareness of the current technology status of CO_2 capture and utilization, to explore funding sources for new technologies, and collaboration with ongoing projects, then this workshop will provide the basic knowledge to pursue opportunities.

Workshop Outline

Topic Area 1: CO_2 Emissions from Power Generation and Manufacturing
Topic Area 2: Ongoing CO_2 Capture Technology Developments
Topic Area 3: Ongoing CO_2 Utilization Technology Developments
Topic Area 4: Economics of CO_2 Capture and Utilization
Topic Area 5: Life Cycle Analysis (LCA) of CO_2 Utilization
Topic Area 6: Heat and Mass Transfer Challenges in CO_2 Capture and Utilization
Topic Area 7: Equipment Design: Challenges and Opportunities
Topic Area 8: Interfacing with the CO_2 Sources

Q&A and Open Discussion

Speakers

Dr. C.B. Panchal, E3Tec Service, LLC: After working for 25+ years at Argonne National Laboratory, Dr. Panchal founded E3Tec to better serve the industry with the focus on energy efficiency and process intensification. E3Tec has been pursuing utilization of captured CO_2 with Grants from DOE-SBIR and ERA, Alberta Canada Round 1. E3Tec has developed Heat Integrated Reactive Distillation (HIRD) equipped with side reactors for conversion of CO_2 to alkyl carbonates. Dr. Panchal holds a PhD in chemical engineering from the University of Manchester Institute of Science and Technology (UMIST), UK, and a BS in chemical engineering from the University of Bombay, India. He is a Fellow member of AIChE and was an active member of the AIChE Heat Transfer and Energy Division, now Transport and Energy Processes Division.

Richard D. Doctor, E3Tec Service, LLC: Chemical Engineer (P.E.) Northwestern University; investigates process design and economics for the full energy-chain analysis of fossil, nuclear, and renewable power cycles using ASPEN® including systems retrofitted for carbon capture and sequestration. Chapter chair for the IPCC Special Report on CO_2 Capture and Sequestration (2006). Coming from a background with ARCO Oil, during his 32-year career at Argonne National Laboratory he led the DOE energy and environmental monitoring of the Great Plains Coal-gasification plant (a $2.2 Billion facility in Beulah, ND) including heavy interaction with regulatory agencies.

Special Sessions

WOMEN IN ENGINEERING PANEL

22-1 - Women in Heat Transfer and Energy Sustainability

Tuesday, July 16
2:00PM–3:40PM
Cedar Ballroom B, Second Floor

Panel Organizer: Dr. Leslie Phinney, *Sandia National Laboratories, Albuquerque, NM, United States*

The Women in Heat Transfer Panel will be comprised of exemplary women engineers from academia and industry/ national labs who will describe their career paths including opportunities and challenges they encountered. They will provide career advice to younger engineers. Early career engineers, of both genders, are especially encouraged to attend. There will also be discussion on how to make the thermal engineering community more inclusive and welcoming for all.

Panelists: Jayathi Murthy, *University of California, Los Angeles, Los Angeles, CA;* Jane Davidson, *University of Minnesota, Minnesota, MN;* Amy Betz, *Kansas State University, Kansas City, KS,* Judith Vidal, *National Renewable Energy Laboratory,* Pei Dong, *George Mason University*

POSTER SESSIONS AND PRESENTATIONS

21-1-1 – SHTC and ES Joint Poster Session: Thermal Science and Engineering

Tuesday, July 16
12:15PM–1:45PM
Grand Ballroom HIJK, Second Floor

HEAT TRANSFER

16-1-1 - Endoscopic Visualization of Pool Boiling. HT2019-3835

16-1-1 - Visualization of Two-phase Flow Behavior Inside the Advanced Thermosyphon with Different Working Fluids. HT2019-3555

16-1-2 - Visual Investigation of Influence of Temperature on the Behavior of a Droplet's Spreading and Penetration Through an Oil/Water Column. HT2019-3822

21-1-1 - Refrigeration Systems for Heat Transfer Control of Space Exploration Vehicles in Extreme Environments. HT2019-3440

Heat Transfer Through Thin Film Profile in a Closed Loop Pulsating Heat Pipe. HT2019-3507

Effect of Temperature on the Surface Tension Components of Polar Liquids. HT2019-3622

Experimental Study of Critical Heat Flux on a Confined Finite Surface Under Pool Boiling. HT2019-3584

Modeling Borehole Thermal Energy Storage to Increase the Range of Recovered Waste Heat Utilization. HT2019-3751

Electrothermal Immersion Technique for Studying Heat Transfer Media in High-Temperature (up to 1200°C) Corrosive Environments. HT2019-3754

Experimental Work for Thermal and Hydraulic Performance of Printed Circuit Heat Exchangers (PCHE). HT2019-3777

Experimental Study of Bicellular Natural Convection Inside a Closed Rectangular Cavity. HT2019-3802

Modulation of Heat Transfer Characteristics Using Thin Film Boiling. HT2019-3786

Thermal Energy Grid Storage (TEGS) Using Multi-Junction Photovoltaics (MPV) "Sun-in-a-Box." HT2019-3826

Investigating the Phase Change of a Two-Phase Salt Mixture for a Latent Heat Storage Device. HT2019-3811

Introducing Novel Convergent Geometries to Enhance Pipe Flow Convective Heat Transfer. HT2019-3830

Phonon Conduction of Phase Transition 2D Materials. HT2019-3834

ENERGY SUSTAINABILTY

9-2 - CFD-Thermal Analysis of Flat Plate Solar Collectors. ES2019-4053

18-1 - Investigating the Phase Change of a Two-Phase Salt Mixture for a Latent Heat Storage Device. ES2019-4055

A Study of Developing Economizer Dry-Bulb Temperature Control According to Variable Mixed Air Temperature. ES2019-4057

18-1 - A Study on a Variable Water Flow Rate Control Method of the Circulation Pump in a Geothemal Heat Pump System. ES2019-4060

Design of a Domestic Water Heater Using a Phase Change Material for Heat Storage. ES2019-4073

Numerecal Modeling of Geothermal Heat Exchanger for Solar Panel Application. ES2019-4074

Examination of Cooling-Tower Performs With Treated Water on Industrial And Environmental Symbiosis. ES2019-3968

Design and Fabrication of Concentrated Solar Waste Water Treatment Apparatus. ES2019-3994

Solar Powered Atmospheric Water Generation. ES2019-4015

Design Aspects of Phase Change Material (PCM) Enhanced Gypsum Plasterboard. ES2019-4026

Development of Virtual Airflow Sensing Method in VAV Terminal Unit. ES2019-4022

AWARDS AND RECOGNITIONS

Tuesday, July 16
6:30PM–9:00PM
Grand Ballroom A/B, Second Floor

The awards will be jointly supported by AESD and SED divisions as follows:

Best Paper Award: 1st place (ES2019-3902)

Monetary award: $1500 ($750 supported by SED and $750 supported by AESD)

Glass plaque and labor: $91.20 ($45.60 supported by SED and $45.60 supported by AESD)

Best Paper Award: 2nd place (ES2019-3923)

Monetary award: $1000 ($500 supported by SED and $500 supported by AESD)

Glass plaque and labor: $91.20 ($45.60 supported by SED and $45.60 supported by AESD)

Best Paper Award: 3rd place (ES2019-3937)

Monetary award: $500 ($250 supported by SED and $250 supported by AESD)

Glass plaque and labor: $91.20 ($45.60 supported by SED and $45.60 supported by AESD)

Best Poster Award (TBD in the conference)

Monetary award: $500 ($250 supported by SED and $250 supported by AESD)

Glass plaque and labor: $91.20 ($45.60 supported by SED and $45.60 supported by AESD)

Technical Sessions – MONDAY

MONDAY, JULY 15

TRACK 19 ES CONFERENCE PLENARY/ KEYNOTE SESSIONS

19-1
KEYNOTE EVENT

Third Floor, Auditorium **8:30AM–10:10AM**

TRACK 1 SUSTAINABLE BUILDINGS

Track Organizer: Hamidreza Najafi, *Florida Institute of Technology, Melbourne, FL, United States*

Track Co-Organizer: Julia Haltiwanger Nicodemus, *Lafayette College, Easton, PA, United States*

1-1
ENERGY SUSTAINABILITY IN THE BUILDING SECTOR

Third Floor, Cottonwood **10:30AM–12:10PM**

Session Organizer: Navid Goudarzi, *UNC Charlotte, The William States Lee College of Engineering, Charlotte, NC, United States*

Building Stock Inertia and Impacts on Energy Consumption and CO_2 Emissions in Qatar

Technical Paper Publication. ES2019-3854

Athar Kamal, Sami Al-Ghamdi, Muammer Koç, *Hamad bin Khalifa University, Doha, Qatar*

Academic Building Equipment Standardization for Sustainability

Technical Paper Publication. ES2019-3872

Ferdinand G. Manegdeg, Juvy A. Balbarona, Roderaid T. Ibañez, *University of the Philippines Diliman, Quezon City, Philippines*

GeoBMS for Better Building Energy Management

Technical Paper Publication. ES2019-3901

Karthik Krishnamurthy, Pradeep Singh, Nikhil Sriraman, *Candela IoT, Mountain View, CA, United States*

Roof Top PV for Mitigating Peak Cooling Load on the Scale of a Tropical Coastal City

Technical Presentation. ES2019-3979

Rabindra Pokhrel, Jorge Gonzalez, *City College of New York, New York, NY, United States,* Andy Walker, *National Renewable Energy Laboratory, Golden, CO, United States*

TRACK 3 CONCENTRATING SOLAR POWER

Track Organizer: Craig Turchi, *National Renewable Energy Laboratory, Golden, CO, United States*

Track Co-Organizer: John Pye, *The Australian National University, ANU Canberra, Australia,* Matthew Bauer, *US Department of Energy, Washington, DC, United States*

3-7
PARTICLE-BASED CENTRAL RECEIVERS 2

Third Floor, Juniper **10:30AM–12:10PM**

Session Organizer: Clifford Ho, *Sandia National Laboratories, Albuquerque, NM, United States*

Experimental Evaluation of the Thermo-Optical Efficiency of a Centrifugal Particle Receiver

Technical Presentation. ES2019-3817

Cathy Frantz, Miriam Ebert, Lars Amsbeck, *German Aerospace Center, Stuttgart, Germany,* Dennis Thomey, *German Aerospace Center, Jülich, Germany*

Radiation Attenuation by Dust in a Particle Receiver Exposed to High-Flux Irradiation

Technical Presentation. ES2019-3877

Jingjing Chen, Apurv Kumar, Joe Coventry, Wojciech Lipinski, *Australian National University, Canberra, ACT, Australia*

Modeling the Thermal Performance of Falling Particle Receivers Subject to External Wind

Technical Paper Publication. ES2019-3913

Brantley Mills, Reid Shaeffer, Clifford Ho, Lindsey Yue, *Sandia National Laboratories, Albuquerque, NM, United States*

TRACK 8 ELECTROCHEMICAL ENERGY CONVERSION AND STORAGE

Track Organizer: Soumik Banerjee, *Washington State University, Pullman, WA, United States*

Track Co-Organizer: George Nelson, *University of Alabama in Huntsville, Huntsville, AL, United States*

8-1
FUEL CELL SYSTEMS

Third Floor, Larch **10:30AM–12:10PM**

Session Organizer: George Nelson, *University of Alabama in Huntsville, Huntsville, AL, United States*

Performance of Pressurized Anode Supported Solid Oxide Fuel Cell

Technical Paper Publication. ES2019-3912

Nathanael Royer, Ryan Hamilton, Jeffrey Collins, John Drazin, Dustin McLarty, *Washington State University, Pullman, WA, United States*

Performance of a Natural Gas Solid Oxide Fuel Cell System With and Without Carbon Capture

Technical Paper Publication. ES2019-3918

Arun Iyengar, *KeyLogic Systems Inc., Delmont, PA, United States,* Brian J. Koeppel, *Pacific Northwest National Lab, Richland, WA, United States,* Dale L. Keairns, *Deloitte Consulting Inc., South Park Township, PA, United States,* Mark C. Woods, *KeyLogic Systems Inc., South Park Township, PA, United States,* Gregory A. Hackett, Travis Shultz, *National Energy Technology Laboratory, U.S. Doe, Morgantown, WV, United States*

A System Analysis of Pressurized Electrolysis for Compressed Hydrogen Production

Technical Paper Publication. ES2019-3908

Ryan Hamilton, Dustin McLarty, *Washington State University, Pullman, WA, United States*

Optimal Operating Conditions for 5-kW Class Combined Energy Conversion System of Solid Oxide Fuel Cell and Internal Combustion Engine Using Spark-assisted Ignition

Technical Presentation. ES2019-4020

Jaehyun Kim, Yongtae Kim, Wonjae Choi, Han Ho Song, *Seoul National University, Seoul, Korea (Republic)*

Developing a Novel High Efficiency, Low Cost Hybrid SOFC/Internal Combustion Engine System for Distributed Generation

Technical Presentation. ES2019-4063

Robert Braun, David Wahlstrom, Neal Sullivan, *Colorado School of Mines, Golden, CO, United States,* Evan Reznicek, *Colorado School of Mines, Denver, CO, United States,* Brett Windom, Daniel Olsen, Todd Bandhauer, *Colorado State University, Fort Collins, CO, United States*

TRACK 14 OCEAN AND HYDROPOWER TECHNOLOGIES

Track Organizer: Navid Goudarzi, *UNC Charlotte, The William States Lee College of Engineering, Charlotte, NC, United States*

14-1
ADVANCED OCEAN RENEWABLE ENERGY TECHNOLOGIES

Third Floor, Madrona **10:30AM–12:10PM**

Session Organizer: Navid Goudarzi, *UNC Charlotte, The William States Lee College of Engineering, Charlotte, NC, United States*

Geometry Optimization of Cylindrical Flaps of Oscillating Wave Surge Converters Using Artificial Neural Network Models

Technical Paper Publication. ES2019-3878

Chen-Chou Lin, Yi-Chih Chow, Yu-Yu Huang, *National Taiwan Ocean University, Keelung, Taiwan*

Effects of Trailing Edge Alterations on the Performance of a Small-Scale, Low-Solidity Tidal Turbine Blade Designed for Less Energetic Flows

Technical Paper Publication. ES2019-3891

Job Immanuel Encarnacion, *University of the Philippines, Quezon City, Philippines,* Gavin Lavery, Stephanie Ordonez-Sanchez, Cameron Johnstone, *University of Strathclyde, Glasgow City, United Kingdom*

Assessment of a CFD-Based Machine Learning Approach on Turbulent Flow Approximation

Technical Paper Publication. ES2019-3925

Dorsa Ziaei, *University of Maryland, Baltimore County, Baltimore, MD, United States,* Seyyed Pooya Hekmati Athar, *NADGOD Research Group, Charlotte, NC, United States,* Navid Goudarzi, *UNC Charlotte, The William States Lee College of Engineering, Charlotte, NC, United States*

Numerical Simulation of Wave Energy Converter With Hydrofoil Blades Under Various Wave Conditions

Technical Paper Publication. ES2019-3936

Jie Lei, Erasmo Gonzalez, Yingchen Yang, Ben Xu, *University of Texas Rio Grande Valley, Edinburg, TX, United States,* Ying Zhang, *Nanchang University, Nanchang, China*

TRACK 1 SUSTAINABLE BUILDINGS

Track Organizer: Hamidreza Najafi, *Florida Institute of Technology, Melbourne, FL, United States*

Track Co-Organizer: Julia Haltiwanger Nicodemus, *Lafayette College, Easton, PA, United States*

1-2
BUILDING ENERGY MODELING

Third Floor, Cottonwood **2:00PM–3:40PM**

Session Organizer: Hamidreza Najafi, *Florida Institute of Technology Melbourne, FL, United States*

Comparison and Implementation of Thermally Massive Wall and Roof Models for Use in Simplified Building Energy Models

Technical Paper Publication. ES2019-3909

Christopher Fernandez, Sheldon Jeter, *Georgia Institute of Technology, Atlanta, GA, United States*

A Non-Linear Auto-Regressive With Exogenous Inputs (NARX) Artificial Neural Network (ANN) Model for Building Thermal Load Prediction

Technical Paper Publication. ES2019-3923

Byeongho Yu, Dongsu Kim, Heejin Cho, Pedro Mago, *Mississippi State University, Mississippi State, MS, United States*

Development and Exploration of Reduced-Order Simplified Building Energy Model

Technical Presentation. ES2019-4030

Christopher Fernandez, Sheldon Jeter, *Georgia Institute of Technology, Atlanta, GA, United States*

Verification of Stochastic Occupancy Simulator for Residential House Energy System Control

Technical Presentation. ES2019-4029

Chenli Wang, Hohyun Lee, *Santa Clara University, Santa Clara, CA, United States*

TRACK 3 CONCENTRATING SOLAR POWER

Track Organizer: Craig Turchi, *National Renewable Energy Laboratory, Golden, CO, United States*

Track Co-Organizer: John Pye, *The Australian National University, ANU Canberra, Australia,* Matthew Bauer, *US Department of Energy, Washington, DC, United States*

3-8
PARTICLE-BASED CENTRAL RECEIVERS 3

Third Floor, Juniper **2:00PM–3:40PM**

Session Organizer: John Pye, *The Australian National University, ANU Canberra, Australia*

Effect of Quartz Aperture Covers on the Fluid Dynamics and Thermal Efficiency of Falling Particle Receivers

Technical Paper Publication. ES2019-3910

Lindsey Yue, Brantley Mills, Clifford Ho, *Sandia National Laboratories, Albuquerque, NM, United States*

Optical Ray-Tracing Performance Modeling of Quartz Half-Shell Tubes Aperture Cover for Falling Particle Receiver

Technical Paper Publication. ES2019-3927

Julius Yellowhair, Clifford Ho, *Sandia National Laboratories, Albuquerque, NM, United States*

Preliminary Design of an All-Ceramic Discrete-Structure Particle Heating Receiver

Technical Presentation. ES2019-3998

George Peters, Matthew Golob, Clayton Nguyen, Sheldon Jeter, *Georgia Institute of Technology, Atlanta, GA, United States,* Syed Danish, Hany Al-Ansary, *King Saud University, Riyadh, Saudi Arabia*

Simulating Narrow-Channel, Counterflow Fluidized Beds for Indirect Particle Receivers

Technical Presentation. ES2019-4033

Luca Imponenti, Yahya Bokhary, Robert Braun, Gregory Jackson, *Colorado School of Mines, Golden, CO, United States*

TRACK 8 ELECTROCHEMICAL ENERGY CONVERSION AND STORAGE

Track Organizer: Soumik Banerjee, *Washington State University, Pullman, WA, United States*

Track Co-Organizer: George Nelson, *University of Alabama in Huntsville, Huntsville, AL, United States*

8-2
BATTERIES AND BEYOND

Third Floor, Larch **2:00PM–3:40PM**

Session Organizer: Soumik Banerjee, *Washington State University, Pullman, WA, United States*

Modeling Ion Transport and Other Electrochemical Phenomena of a Novel Membraneless Non-Aqueous Organic Redox Flow Battery

Technical Presentation. ES2019-4072

Korey Cook, *Michigan State University, East Lansing, MI, United States*

A Simultaneous Multiscale and Multiphysics Model and Numerical Implementation of a Core-Shell Model for Lithium-Ion Full-Cell Batteries

Technical Presentation. ES2019-3827

Binghe Liu, Jun Xu, *Beihang University, Beijing, China*

Safety Issues Caused by Internal Short Circuits in Lithium-Ion Batteries

Technical Presentation. ES2019-3828

Binghe Liu, Jun Xu, *Beihang University, Beijing, China*

The Influence of Structure on the Electrochemical and Thermal Response of Li-Ion Battery Electrodes

Technical Paper Publication. ES2019-3926

Prehit Patel, George Nelson, *University of Alabama in Huntsville, Huntsville, AL, United States*

Development of Tape-Casting Process for the Electrolyte Supported Solid Oxide Fuel Cells With Solvent Control

Technical Presentation. ES2019-3992

Youngjin Kwon, Youngbae Han, Honghyun Kim, *Korea Military Academy, Seoul, Korea (Republic)*

TRACK 16 EMERGING TECHNOLOGIES

Track Organizer: Pei Dong, *George Mason University, Fairfax, TX, United States*

16-1
HYBRIDIZED ENERGY TECHNOLOGIES

Third Floor, Madrona **2:00PM–3:40PM**

Session Organizer: Guangdong Zhu, *National Renewable Energy Laboratory, Englewood, CO, United States*

Hybridizing Geothermal Power Plant With Concentrating Solar Power to Increase Economics and Dispatch Ability

Technical Presentation. ES2019-4006

Guangdong Zhu, *National Renewable Energy Laboratory, Englewood, CO, United States*

Case Study of the Puna Geothermal Power Plant and Proposed Retrofit H_2S Gas Mitigation Strategies

Technical Paper Publication. ES2019-3940

Kevin Anderson, Wael Yassine, *California State Polytechnic University at Pomona, Pomona, CA, United States*

An Energetic and Exergoeconomic Analysis of a CCHP System with Micro Gas Turbine, Organic Rankine Cycle and Ammonia-Water Absorption Refrigeration Cycle

Technical Paper Publication. ES2019-3928

Ganesh Doiphode, Hamidreza Najafi, *Florida Institute of Technology, Melbourne, FL, United States*

Clean Energy From Municipal Solid Waste (MSW)

Technical Paper Publication. ES2019-3961

Renan Galante, Andre Mariano, Jose V. Vargas, Wellington Balmant, *Universidade Federal Do Parana, Curitiba/Paraná, Brazil,* Juan Ordonez, *FSU, Tallahassee, FL, United States*

TRACK 1 SUSTAINABLE BUILDINGS

Track Organizer: Hamidreza Najafi, *Florida Institute of Technology, Melbourne, FL, United States*

Track Co-Organizer: Julia Haltiwanger Nicodemus, *Lafayette College, Easton, PA, United States*

1-4
COMPONENTS OF BUILDING ENERGY SYSTEMS

Third Floor, Cottonwood **4:00PM–5:40PM**

Session Organizer: Julia Haltiwanger Nicodemus, *Lafayette College, Easton, PA, United States*

Effects of Baffle Width on Heat Transfer to an Immersed Coil Heat Exchanger: Experimental Optimization

Technical Paper Publication. ES2019-3900

Julia Haltiwanger Nicodemus, Xiaoqi Huang, Emily Dentinger, Kyle Petitt, Joshua Smith, *Lafayette College, Easton, PA, United States*

Study of Different Types of Water Heating Systems – Under Living Lab Conditions

Technical Paper Publication. ES2019-3944

Swapnil Dubey, *Energy Research Institute at NTU, Singapore, Singapore*

Heat Current Method Based Modeling and Optimization of a Solar-Driven Absorption Chiller for Residential Houses

Technical Paper Publication. ES2019-3853

Qun Chen, Tian Zhao, *Tsinghua University, Beijing, China*

Life Cycle Assessment of Greenhouse Gas Emissions: Comparison Between a Cooling Tower and a Geothermal Heat Exchanger for Air Conditioning Applications in Ecuador

Technical Paper Publication. ES2019-3907

Frank Porras, *University of Campinas, Campinas, São Paulo, Brazil,* Angel D. Ramirez, *Escuela Superior Politecnica Del Litoral, Guayaquil, Guayas, Ecuador,* Arnaldo Walter, *University of Campinas, Campinas, Sao Paolo, Brazil,* Guillermo Soriano, *Escuela Superior Politecnica Del Litoral, Guayaquil, Guayas, Ecuador*

TRACK 3 CONCENTRATING SOLAR POWER

Track Organizer: Craig Turchi, *National Renewable Energy Laboratory, Golden, CO, United States*

Track Co-Organizer: John Pye, *The Australian National University, ANU Canberra, Australia,* Matthew Bauer, *US Department of Energy, Washington, DC, United States*

3-9
PARTICLE HEAT EXCHANGERS

Third Floor, Juniper **4:00PM–5:40PM**

Session Organizer: Ty Neises, *National Renewable Energy Laboratory, Golden, CO, United States*

Flowing Particle Fluidized Bath Design and Heat Transfer

Technical Paper Publication. ES2019-3911

Matthew Golob, Clayton Nguyen, Sheldon Jeter, Said Abdel-Khalik, *Georgia Institute of Technology, Atlanta, GA, United States,* Clifford Ho, *Sandia National Laboratories, Albuquerque, NM, United States*

Preliminary Design and Modeling of Candidate Particle to Air Heat Exchangers for a Particle Heating Receiver Based Concentrator Solar Power System

Technical Presentation. ES2019-3997

Sheldon Jeter, *Georgia Institute of Technology, Atlanta, GA, United States*

Assessing Heat Transfer in Fluidized Beds for Particle Heat Exchangers and Receivers in Concentrating Solar Power

Technical Presentation. ES2019-4017

Jeremy Abraham, William Coors, Daniel Miller, Luca Imponenti, Gregory Jackson, *Colorado School of Mines, Golden, CO, United States*

Evaluation of Radiative Heat-Transfer in Flowing Particle Systems

Technical Presentation. Es2019-4058

Rohini Bala Chandran, Pratyush Agarwal, Aishwarya Krishnan, *University of Michigan, Ann Arbor, MI, United States*

TRACK 9 THERMAL AND MECHANICAL ENERGY STORAGE

Track Organizer: Xiaoze Du, *North China Electric Power University, Beijing, Beijing, China*

Track Co-Organizer: Josh McTigue, *National Renewable Energy Laboratory, Golden, CO, United States*

9-1
THERMAL ENERGY STORAGE: HIGH TEMPERATURE 1

Third Floor, Larch **4:00PM–5:40PM**

Session Organizer: Josh McTigue, *National Renewable Energy Laboratory, Golden, CO, United States*

Numerical Simulation of a Composite Metal Foam-PCM Air Heat Exchanger Using Rod PTC Heating Elements

Technical Paper Publication. ES2019-3964

Pouyan Talebizadehsardari, Donald Giddings, Gavin Walker, Mark Gillott, David Grant, *University of Nottingham, Nottingham, United Kingdom*

Thermal Energy Grid Storage (TEGS) Using Multi-Junction Photovoltaics (MPV) "Sun-in-a-Box": Techno-Economics, Liquid Containment, and Pumping

Technical Presentation. ES2019-3975

Caleb Amy, *Massachusetts Institute of Technology, Allston, MA, United States,* Colin C. Kelsall, Asegun Henry, Mehdi Pishahang, *Massachusetts Institute of Technology, Cambridge, MA, United States*

Thermal Energy Grid Storage (TEGS) Using Multi-Junction Photovoltaics (MPV) "Sun-in-a-Box": MPV Design Challenges

Technical Presentation. ES2019-3993

Colin C. Kelsall, Caleb Amy, Asegun Henry, *Massachusetts Institute of Technology, Cambridge, MA, United States,* Daniel Friedman, Myles Steiner, *National Renewable Energy Laboratory, Lakewood, CO, United States*

Thermal-Energy Storage Design and Operating Strategies for Advanced Adiabatic Compressed Air Energy Storage Plants Under Realistic Operating Conditions

Technical Presentation. ES2019-4005

Philipp Roos, Andreas Haselbacher, *Professorship of Renewable Energy Carriers, ETH Zurich, Zurich, Switzerland*

TUESDAY, JULY 16

TRACK 19 ES CONFERENCE PLENARY/ KEYNOTE SESSIONS

19-2
KEYNOTE EVENT

Third Floor, Auditorium **8:30AM–10:10AM**

TRACK 2 SUSTAINABLE INFRASTRUCTURE AND TRANSPORTATION

Track Organizer: Luca Mastropasqua, *Politecnico di Milano, Milan, Italy*

2-1
SUSTAINABLE TRANSPORTATION

Third Floor, Cottonwood **10:30AM–12:10PM**

Session Organizer: Philipp Ahrend, *University of California Irvine, Irvine, CA, United States*

Improving Fuel Economy Estimates on a Chassis Dynamometer Using Air Conditioner Correction Factors

Technical Paper Publication. ES2019-3821

Jose Alejandro Reyes, Edwin N. Quiros, *University of the Philippines, Quezon, NCR, Philippines*

Robust Control of Hydrogen Flow for an Automotive Fuel Cell System via Model Reference Adaptive Control

Technical Paper Publication. ES2019-3882

Janghwan Hwang, Sangseok Yu, *Chungnam National University, Daejeon, Korea (Republic)*

A Solid Oxide Fuel Cell-Gas Turbine Hybrid System for a Freight Rail Application

Technical Paper Publication. ES2019-3906

Philipp Ahrend, Ali Azizi, Jacob Brouwer, G. Scott Samuelsen, *University of California, Irvine, Irvine, CA, United States*

A Study of Energy Consumption and Greenhouse Gas Emissions From Different Regenerative Braking Strategies in Electric Vehicles

Technical Presentation. ES2019-4010

Josue Ortega, Yuanyuan Xie, *California State University Fresno, Fresno, CA, United States*

TRACK 3 CONCENTRATING SOLAR POWER

Track Organizer: Craig Turchi, *National Renewable Energy Laboratory, Golden, CO, United States*

Track Co-Organizer: John Pye, *The Australian National University, ANU Canberra, Australia,* Matthew Bauer, *US Department of Energy, Washington, DC, United States*

3-10
INTEGRATED CSP SYSTEMS 1

Third Floor, Juniper **10:30AM–12:10PM**

Session Organizer: Matthew Bauer, *US Department of Energy, Washington, DC, United States*

Integrated Receiver-Storage for a Two-Stage Concentrating Solar Power System

Technical Presentation. ES2019-3814

Song Yang, Jun Wang, *Southeast University, Nanjing, China,* Peter Lund, *Aalto University, Helsinki, Finland*

Analysis of Concentrating Solar Thermal System to Support Thermochemical Energy Storage or Solar Fuel Generation Processes

Technical Paper Publication. ES2019-3871

Patrick Davenport, Janna Martinek, *National Renewable Energy Laboratory, Golden, CO, United States,* Zhiwen Ma, *National Renewable Energy Laboratory, Lakewood, CO, United States*

Techno-Economic Optimization of sCO_2 Recompression Brayton Cycles With Regenerators for Concentrating Solar Power

Technical Presentation. ES2019-4061

Robert Braun, *Colorado School of Mines, Golden, CO, United States,* Evan Reznicek, *Colorado School of Mines, Denver, CO, United States,* Ty Neises, *National Renewable Energy Laboratory, Golden, CO, United States,* Jacob Hinze, *University of Wisconsin-Madison, Madison, WI, United States*

TRACK 9 THERMAL AND MECHANICAL ENERGY STORAGE

Track Organizer: Xiaoze Du, *North China Electric Power University, Beijing, Beijing, China*

Track Co-Organizer: Josh McTigue, *National Renewable Energy Laboratory, Golden, CO, United States*

9-2
THERMAL ENERGY STORAGE: HIGH TEMPERATURE 2

Third Floor, Larch **10:30AM–12:10PM**

Session Organizer: Philipp Roos, *Professorship of Renewable Energy Carriers, ETH Zurich, Zurich, Switzerland*

Development of Reversible-Reacting Materials for High-Temperature Thermochemical Heat Storage of Concentrated Solar Energy

Technical Presentation. ES2019-4008

Marco Gigantino, Aldo Steinfeld, *ETH Zurich, Zurich, Switzerland*

Integrating Pumped Thermal Electricity Storage (PTES) With a Concentrating Solar Power Plant

Technical Presentation. ES2019-4009

Josh McTigue, *National Renewable Energy Laboratory, Golden, CO, United States,* Pau Farres-Antunez, Alexander J. White, *Cambridge University, Cambridge, United Kingdom*

Sulfur Heat Transfer Behavior in a Vertically-Oriented Isochoric Thermal Energy Storage System

Technical Presentation. ES2019-4034

Kaiyuan Jin, Richard Wirz, *University of California, Los Angeles, Los Angeles, CA, United States*

System Level Performance and Cost Analysis of Elemental Sulfur Thermal Energy Storage System

Technical Presentation. ES2019-4035

Yide Wang, Richard Wirz, *University of California, Los Angeles, Los Angeles, CA, United States*

CFD-Thermal Analysis of Flat Plate Solar Collectors

Poster Presentation. ES2019-4053

Muhammad Ayaz Akbar, *Dalian University of Technology, Dalian, Liaoning, China*

TRACK 16 EMERGING TECHNOLOGIES

Track Organizer: Pei Dong, *George Mason University, Fairfax, TX, United States*

16-3
RECYCLING

Third Floor, Madrona **10:30AM–12:10PM**

Session Organizer: Yen-Hao Lin, *ExxonMobil, Baytown, VA, United States*

Exergy-Based Sustainability Analysis for Tile Production From Waste Plastics in Uganda

Technical Paper Publication. ES2019-3897

Paige Balcom, Van Carey, *University of California, Berkeley, Berkeley, CA, United States*

Deep Eutectic Solvents for Cathode Recycling of Li-ion Batteries

Technical Presentation. ES2019-4064

Mai K. Tran, Keiko Kato, Ganguli Babu, P.M. Ajayan, *Rice University, Houston, TX, United States,* Marco-Tulio F. Rodrigues, *Argonne National Laboratory, Lemont, IL, United States*

Environmental Impact Optimization of Stereolithography Process Using Topology Optimization

Technical Presentation. ES2019-4066

Nikhat W, Priyanka S. Umarji, C.P. Reddy, *Presidency University, Banglore, India*

Technical Sessions – TUESDAY

TRACK 2 SUSTAINABLE INFRASTRUCTURE AND TRANSPORTATION

Track Organizer: Luca Mastropasqua, *Politecnico di Milano, Milan, Italy*

2-2
SUSTAINABLE INFRASTRUCTURE

Third Floor, Cottonwood **2:00PM–3:40PM**

Session Organizer: Horacio Pinzon, *Promigas, Barranquilla, Colombia*

Session Co-Organizer: Luca Mastropasqua, *Politecnico di Milano, Milan, Italy*

Surrogate Modeling for Capacity Planning of Charging Station Equipped With PV and Hydropneumatic Energy Storage

Technical Paper Publication. ES2019-3831

Yang Chen, Brennan Smith, Xiaobing Liu, Ayyoub M. Momen, *Oak Ridge National Laboratory, Oak Ridge, TN, United States,* Fadwa Dababneh, *Georgia Southern University, Statesboro, GA, United States,* Bei Zhang, *Global Energy Interconnection Research Institute, San Jose, CA, United States,* Saiid Kassaee, *University of TN/Oak Ridge National Laboratory, Knoxville, TN, United States*

Enhancing the Fault Diagnosis Capability in Large Scale Dynamic Systems Using an Identification and Classification Hybrid Technique: A Case Study on Natural Gas Transmission Systems in Tropical Region

Technical Paper Publication. ES2019-3849

Horacio Pinzon, Cinthia Audivet, Fernando Landazury, Melitsa Torres, *Promigas, Barranquilla, Colombia,* Ivan Portnoy, *Universidad del Norte, Barranquilla, Colombia,* Marco E. Sanjuan, *Promigas, Barranquilla, Colombia*

Evaluating the Energy Savings from Community Scale Solar Water Heating in Los Angeles County: Residential Case Studies

Technical Paper Publication. ES2019-3960

Robert Cudd, *University of California, Los Angeles, Los Angeles, CA, United States,* Kevin Anderson, Wael Yassine, *California State Polytechnic University at Pomona, Pomona, CA, United States*

TRACK 3 CONCENTRATING SOLAR POWER

Track Organizer: Craig Turchi, *National Renewable Energy Laboratory, Golden, CO, United States*

Track Co-Organizer: John Pye, *The Australian National University, ANU Canberra, Australia,* Matthew Bauer, *US Department of Energy, Washington, DC, United States*

3-11
INTEGRATED CSP SYSTEMS 2

Third Floor, Juniper **2:00PM–3:40PM**

Session Organizer: Roman Bader, *ITP Thermal, Turner, ACT, Australia*

Design Features of the World's First Commercial Concentrating Solar Power Plant Using the Particle Heating Receiver Concept

Technical Paper Publication. ES2019-3856

Hany Al-Ansary, Abdelrahman El-Leathy, Eldwin Djajadiwinata, Shaker Alaqel, Rageh Saeed, Zeyad Al-Suhaibani, Syed Danish, Nader Saleh, *Ki King Saud University, Riyadh, Saudi Arabia,* Sheldon Jeter, Matthew Golob, Clayton Nguyen, Said Abdel-Khalik, *Georgia Institute of Technology, Atlanta, GA, United States,* Ahmed Al-Balawi, Fahad Al-Harthi, Salem Bashraheel, Hatim Gandayh, *Saudi Electricity Company, Riyadh, Saudi Arabia*

Progress on the Design and Development of the G3KSA Particle Heating CSP Project

Technical Presentation. ES2019-4036

Sheldon Jeter, *Georgia Institute of Technology, Atlanta, GA, United States,* Hany Al-Ansary, *King Saud University, Riyadh, Saudi Arabia*

Parametric Analysis of Particle CSP System Performance and Cost to Intrinsic Particle Properties and Operating Conditions

Technical Paper Publication. ES2019-3893

Kevin Albrecht, Clifford Ho, *Sandia National Laboratories, Albuquerque, NM, United States,* Matthew Bauer, *US Department of Energy, Washington, DC, United States*

Second Law Analysis of a Hybrid Concentrated Photovoltaic Thermal System Based on Experimental Data

Technical Paper Publication. ES2019-3962

Nikhil Gakkhar, *Sardar Swaran Singh National Institute of Bio-Energy, Kapurthala, Punjab, India,* Manoj K. Soni, *Birla Institute of Technology & Science, Pilani, Rajasthan, India,* Sanjeev Jakhar, *Modi University, Sikar, Rajasthan, India*

TRACK 9 THERMAL AND MECHANICAL ENERGY STORAGE

Track Organizer: Xiaoze Du, *North China Electric Power University, Beijing, Beijing, China*

Track Co-Organizer: Josh McTigue, *National Renewable Energy Laboratory, Golden, CO, United States*

9-3
THERMAL ENERGY STORAGE: MEDIUM AND LOW TEMPERATURE 1

Third Floor, Larch **2:00PM–3:40PM**

Session Organizer: Sophia Haussener, *EPFL, Lausanne, Vaud, Switzerland*

Modeling and Experiments of Thermal Energy Storage With Composite Phase-Change Material Integrated With a Building Air Conditioner

Technical Presentation. ES2019-4011

Anurag Goyal, Eric Kozubal, Jason Woods, *National Renewable Energy Laboratory, Golden, CO, United States*

Analogies, Comparisons, and Synergies Between Thermal and Electrochemical Energy Storage

Technical Presentation. ES2019-4019

Jason Woods, Anurag Goyal, Eric Kozubal, *National Renewable Energy Laboratory, Golden, CO, United States*

Novel Form-Stable Inorganic Latent Heat Thermal Energy Storage Composites for Low-Temperature Applications

Technical Presentation. ES2019-4042

Adewale Odukomaiya, *National Renewable Energy Laboratory, Denver, CO, United States*

TRACK 16 EMERGING TECHNOLOGIES

Track Organizer: Pei Dong, *George Mason University, Fairfax, TX, United States*

16-4
PEROVSKITES

Third Floor, Madrona **2:00PM–3:40PM**

Session Organizer: Hsinhan (Dave) Tsai, *Los Alamos National Laboratory, Los Alamos, VA, United States*

Thin Film X-Ray Detector Using Ruddles-Popper Layered Perovskites

Technical Presentation. ES2019-3987

Hsinhan (Dave) Tsai, Fangze Liu, Sergei Tretiak, Duc T. Vo, Wanyi Nie, *Los Alamos National Laboratory, Los Alamos, VA, United States,* Joseph Strzalka, *Argonne National Laboratory, Lemont, IL, United States*

Millimeter-Size All-Inorganic Perovskite $CsPbBr_3$ Single Crystal via Chemical Vapor Deposition

Technical Presentation. ES2019-4001

Yuan Zhou, *Hunan University, Changsha, Hunan, China,* Kasun Fernando, Fangze Liu, Jeremy Tyler Tisdale, Sergei Tretiak, Hsinhan (Dave) Tsai, Wanyi Nie, *Los Alamos National Laboratory, Los Alamos, NM, United States,* Juanyong Wan, *Hunan University, Changsha, Hunan, China*

Layered Perovskite Semiconductors for Opto-Electronic Device

Technical Presentation. ES2019-4045

Hsinhan (Dave) Tsai, Fangze Liu, Sergei Tretiak, Wanyi Nie, *Los Alamos National Laboratory, Los Alamos, VA, United States,* Cunming Liu, *Argonne National Laboratory, Lemont, IL, United States,* Ashraf Alam, *Purdue University, West Lafayette, IN, United States,* Aditya Mohite, *Rice University, Houston, TX, United States,* Joseph Strzalka, Xiaoyi Zhang, *Argonne National Laboratory, Lemont, IL, United States*

Visualizing Photo-Induced Electronic and Structural Evolution of Lead-Free Perovskites Using Transient X-Ray Absorption Spectroscopy and Scattering

Technical Presentation. ES2019-4062

Xiaoyi Zhang, Cunming Liu, *Argonne National Laboratory, Lemont, IL, United States,* Yingqi Wang, *Center for High Pressure Science & Technology Advanced Research, Shanghai, China,* Kaibo Zheng, *Lund University, Lund, Sweden,* Sophie E. Canton, *3ELI-ALPS, ELI-HU Non-Profit Ltd., Szeged, Hungary*

TRACK 3 CONCENTRATING SOLAR POWER

Track Organizer: Craig Turchi, *National Renewable Energy Laboratory, Golden, CO, United States*

Track Co-Organizer: John Pye, *The Australian National University, ANU Canberra, Australia,* Matthew Bauer, *US Department of Energy, Washington, DC, United States*

3-1
FLUID-BASED CENTRAL RECEIVERS

Third Floor, Cottonwood **4:00PM–5:40PM**

Session Organizer: Craig Turchi, *National Renewable Energy Laboratory (NREL), Golden, CO, United States*

Durability, Cost, and Efficiency Trade-Offs in Tubular Receivers for CSP

Technical Presentation. ES2019-3834

Meige Zheng, John Pye, Joe Coventry, *The Australian National University, ANU Canberra, ACT, Australia*

Thermophysical Properties of High-Temperature Solar Containment Materials

Technical Presentation. ES2019-3894

Sonja Brankovic, Bettina Arkhurst, Andrey Gunawan, Shannon K. Yee, *Georgia Institute of Technology, Atlanta, GA, United States*

CFD Modeling of the Solidification and Melting of Nitrate Salts in a Receiver Tube

Technical Presentation. ES2019-3985

Luca Imponenti, *National Renewable Energy Laboratory, Golden, CO, United States,* Ryan Shininger, Keith Gawlik, Henry Price, *SolarDynamics LLC, Broomfield, CO, United States,* Guangdong Zhu, *National Renewable Energy Laboratory, Englewood, CO, United States*

On-Sun Characterization of Microchannel Supercritical Carbon Dioxide Solar Thermal Receivers: Preliminary Findings

Technical Paper Publication. ES2019-3898

Erfan Rasouli, Caton Mande, Matt Stevens, Vinod Narayanan, *University of California Davis, Davis, CA, United States*

MCRT Coupled CFD Analysis of a 3 kW Solar Cavity Receiver Radiated via 10 kW HFSS: Experimental Validation and Parametric Optimization Study

Technical Presentation. ES2019-3859

Cedric Ophoff, David Moens, *KU Leuven, Lier, Belgium,* Mostafa Abuseada, Nesrin Ozalp, *University of Minnesota Duluth, Duluth, MN, United States*

TRACK 4 SOLAR CHEMISTRY

Track Organizer: Justin Lapp, *University of Maine, Orono, ME, United States*

4-1
THERMOCHEMICAL REACTORS

Third Floor, Juniper **4:00PM–5:40PM**

Session Organizer: Rohini Bala Chandran, *University of Michigan, Ann Arbor, MI, United States*

Demonstration Reactor System for the Indirect Solar-Thermochemical Reduction of Redox Particles: The Particle Mix Reactor

Technical Paper Publication. ES2019-3902

Sebastian Richter, *German Aerospace Center, Jülich, Germany,* Stefan Brendelberger, Christian Sattler, *German Aerospace Center, Köln, Germany,* Felix Gersdorf, *Bundesanstalt für Straßenwesen, Bergisch Gladbach, Germany,* Tobias Oschmann, *IAV GmbH, Munich, Germany*

Modal Switching for Continuous Solar Reforming

Technical Presentation. ES2019-4027

Lucas Freiberg, Fuqiong Lei, Nick AuYeung, *Oregon State University, Corvallis, OR, United States*

A 50 kW Solar Receiver-Reactor for Thermochemical Splitting of H_2O and CO_2

Technical Presentation. ES2019-4021

Stefan Zoller, Erik Koepf, Dustin Nizamian, Adriano Patané, Aldo Steinfeld, *ETH Zurich, Zurich, Switzerland*

Syngas Production via Solar Chemical-Looping Dry Reforming of Methane over Ceria

Technical Presentation. ES2019-4068

Kent Warren, Jonathan Scheffe, *University of Florida, Gainesville, FL, United States*

TRACK 9 THERMAL AND MECHANICAL ENERGY STORAGE

Track Organizer: Xiaoze Du, *North China Electric Power University, Beijing, Beijing, China*

Track Co-Organizer: Josh McTigue, *National Renewable Energy Laboratory, Golden, CO, United States*

9-4
THERMAL ENERGY STORAGE: MEDIUM AND LOW TEMPERATURE 2

Third Floor, Larch **4:00PM–5:40PM**

Session Organizer: Jason Woods, *National Renewable Energy Laboratory, Golden, CO, United States*

Role of Cold Energy Storage (CES) in the LNG-Based Cold Economy

Technical Presentation. ES2019-4025

Lizhong Yang, Antoni Gil, Jia Yin Sze, Alessandro Romagnoli, *Nanyang Technological University, Singapore,* Wooi Leong Tan, Govindaraj Naralasetti, Kavindran Nagarathnam, Derek Sun Soon Wong, Anthony Boon Poh Chang, *Surbana Jurong Private Limited, Singapore*

Design and Development of Cold Energy Storage (CECS) Facility to Identify Potential Technologies to Improve the Efficiency of LNG-Based Energy Systems

Technical Presentation. ES2019-4041

Antoni Gil, Lizhong Yang, Jia Yin Sze, Alessandro Romagnoli, *Nanyang Technological University, Singapore,* Wooi Leong Tan, Govindaraj Naralasetti, Kavindran Nagarathnam, Derek Sun Soon Wong, Anthony Boon Poh Chang, *Surbana Jurong Private Limited, Singapore*

Commissioning of a New Modular Thermal Energy Storage Testbed With a Heat Capacity in the MJ-Scale

Technical Presentation. ES2019-4049

Clemens Suter, *École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland,* Selmar Binder, Sophia Haussener, *École Polytechnique Fédérale de Lausanne, Lausanne, Vaud, Switzerland*

Shape-Stabilized Phase Change Material For Solar Thermal Energy Storage: CaO Containing $MgCO_3$ Mixed With Polyethylene Glycol

Technical Presentation. ES2019-4054

Hasan Md. Zahir, *King Fahd University of Petroleum & Minerals, Dhahran, Saudi Arabia*

WEDNESDAY, JULY, 17

TRACK 3 CONCENTRATING SOLAR POWER

Track Organizer: Craig Turchi, *National Renewable Energy Laboratory, Golden, CO, United States*

Track Co-Organizer: John Pye, *The Australian National University, ANU Canberra, Australia,* Matthew Bauer, *US Department of Energy, Washington, DC, United States*

3-2
PARTICLE-BASED CENTRAL RECEIVERS 1

Third Floor, Cottonwood **8:30AM–10:10AM**

Session Organizer: Cathy Frantz, *German Aerospace Center, Stuttgart, Germany*

Characterization of Particle and Heat Losses From Falling Particle Receivers

Technical Paper Publication. ES2019-3826

Clifford Ho, Sean Kinahan, *Sandia National Laboratories, Albuquerque, NM, United States,* Jesus Ortega, Peter Vorobieff, Andrea Mammoli, *University of New Mexico, Albuquerque, NM, United States,* Vanderlei Martins, *AirPhoton, Baltimore, MD, United States*

Development of Multi-Stage Falling Particle Receiver System: Research Progress and On-Sun Test Plan

Technical Presentation. ES2019-4043

Jin-Soo Kim, Wilson Gardner, Yen Chean Soo Too, Daniel Potter, Michael Rae, Adrian Dawson, *CSIRO Energy, Newcastle, Australia,* Clifford Ho, *Sandia National Laboratories, Albuquerque, NM, United States*

Determination of Mechanical Properties Related to Granular Flows for Thermal/Thermochemical Storage of Concentrated Solar Irradiation in Solar Particle Heating Receivers/Reactors

Technical Presentation. ES2019-4070

Malavika Bagepalli, Justin Yarrington, Andrew J. Schrader, Zhuomin Zhang, Devesh Ranjan, Peter Loutzenhiser, *Georgia Institute of Technology, Atlanta, GA, United States*

Validation of Two-Dimensional Eulerian-Eulerian Particle-Gas Heat Transfer Model of a Free-Falling Particle Solar Receiver

Technical Presentation. ES2019-3861

Apurv Kumar, Joe Coventry, Wojciech Lipinski, *The Australian National University, Canberra, Australia*

TRACK 4 SOLAR CHEMISTRY

Track Organizer: Justin Lapp, *University of Maine, Orono, ME, United States*

4-2
HYBRID SOLAR THERMOCHEMISTRY

Third Floor, Juniper **8:30AM–10:10AM**

Session Organizer: Meng Lin, *California Institute of Technology, Pasadena, CA, United States*

Renewable Hydrogen Production via Thermochemical/ Electrochemical Coupling

Technical Paper Publication. ES2019-3905

Sean Babiniec, Andrea Ambrosini, *Sandia National Laboratories, Albuquerque, NM, United States,* James E. Miller, *Arizona State University, Tempe, AZ, United States*

An Experimental- and Simulation-Based Evaluation of CO_2 Utilization Efficiency of Solar-Driven CO_2 Reduction Reactors With Ion-Selective Membranes in Aqueous Electrolytes

Technical Presentation. ES2019-3999

Meng Lin, Lihao Han, Chengxiang Xiang, *California Institute of Technology, Pasadena, CA, United States,* Meenesh Singh, *University of Illinois at Chicago, Chicago, IL, United States*

Electrolysis in a Hybrid Thermochemical Water-Splitting Cycle Based on Cobalt Oxide

Technical Presentation. ES2019-4038

Rachel Silcox, Shahin Nudehi, Jon Schoer, Carol Larson, Luke J. Venstrom, *Valparaiso University, Valparaiso, IN, United States,* Robert Palumbo, *University of Minnesota - Duluth, Duluth, MN, United States,* Richard B. Diver, *Sandia National Laboratories, Albuquerque, NM, United States*

An Integrated Solar Reactor for Hydrogen and Syngas Production by High-Temperature Electrolysis

Technical Presentation. ES2019-4051

Clemens Suter, *École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland,* Meng Lin, Sophia Haussener, *École Polytechnique Fédérale de Lausanne, Lausanne, Vaud, Switzerland*

Technical Sessions – WEDNESDAY

TRACK 10 NEXUS: ENERGY, WATER AND CLIMATE

Track Organizer: Jian Zhang, *Mississippi State University, Mississippi State, MS, United States*

10-1
NEXUS: ENERGY, WATER AND CLIMATE

Third Floor, Larch **8:30AM–10:10AM**

Session Organizer: Yang Chen, *Oak Ridge National Laboratory, Oak Ridge, TN, United States*

Experimental Study of Condensation in Different 3D Printed Regenerators in a Thermoacoustic Cooler

Technical Paper Publication. ES2019-3937

Aibek Bekkulov, Andrew Luthen, Ben Xu, *University of Texas Rio Grande Valley, Edinburg, TX, United States*

Significant Enhancements in Data Center Cooling Rates (or Power Density) Along With Associated Waste Heat Recovery as Electricity

Technical Presentation. ES2019-3967

Amitabh Narain, *Michigan Tech University, Houghton, MI, United States,* Ritunesh Kumar, *Indian Institute of Technology, Indore, Indore, India,* Vibhu Vivek, *Vivek Technologies LLC, Santa Clara, CA, United States,* Nikhil A. Shinde, Amit D. Vojini, Hrishikesh Ranga Prasad, Soroush Sepahyar, Divya Pandya, *Mechanical Engineering, Houghton, MI, United States*

Reverse Osmosis Concentrate: A Waste or An Asset

Technical Presentation. ES2019-4078

Reza Baghaei Lakeh, Mohammadali Sharbatmaleki, *California State Polytechnic University, Pomona, Pomona, CA, United States,* Saied Delagah, *Bureau of Reclamation, Denver, CA, United States*

Water Pollution Caused by Leather Industry: A Review

Technical Paper Publication. ES2019-3949

Magdeline Hutton, Maryam Shafahi, *California State Polytechnic University, Pomona, Pomona, CA, United States,*

Water Efficiency of Aquaponics

Technical Presentation. ES2019-3952

Maryam Shafahi, Reza Baghaei Lakeh, Kevin Anderson, *California State Polytechnic University, Pomona, Pomona, CA, United States*

TRACK 16 EMERGING TECHNOLOGIES

Track Organizer: Pei Dong, *George Mason University, Fairfax, TX, United States*

16-2
ADVANCED MATERIALS AND SUSTAINABLE MANUFACTURING

Third Floor, Madrona **8:30AM–10:10AM**

Session Organizer: Feng Hao, *UESTC, Chengdu, China*

Electrochemical Behaviors of Two-Dimensional Materials for Energy Applications

Technical Presentation. ES2019-4018

Jun Lou, *Rice University, Houston, TX, United States*

Perovskite-Based Metal-Organic Frameworks for Bright Light-Emitting Diodes

Technical Presentation. ES2019-4003

Juanyong Wan, *Hunan University, Changsha, Hunan, China,* Kasun Fernando, Shreetu Shrestha, Sergei Tretiak, Hsinhan (Dave) Tsai, Wanyi Nie, *Los Alamos National Laboratory, Los Alamos, VA, United States,* Huihui Huang, *Hunan University, Changsha, Los Alamos National Laboratory, Los Alamos, VA, United States*

A Flexible Solar Cell/Supercapacitor Integrated Energy Device

Technical Presentation. ES2019-4016

Pei Dong, *George Mason University, Fairfax, TX, United States,* Jun Lou, *Rice University, Houston, TX, United States*

Promise and Prospects of Lead-Free Perovskite Solar Cells

Technical Presentation. ES2019-4052

Feng Hao, *UESTC, Chengdu, China*

Development of a Cascade Active Elastocaloric Regenerator

Technical Paper Publication. ES2019-3887

Nehemiah Emaikwu, David Catalini, Jan Muehlbauer, Ichiro Takeuchi, Reinhard Radermacher, Yunho Hwang, *University of Maryland, College Park, College Park, MD, United States*

TRACK 3 CONCENTRATING SOLAR POWER

Track Organizer: Craig Turchi, *National Renewable Energy Laboratory, Golden, CO, United States*

Track Co-Organizer: John Pye, *The Australian National University, ANU Canberra, Australia,* Matthew Bauer, *US Department of Energy, Washington, DC, United States*

3-3
PARTICLE LIFTS & SALT PUMPS

Third Floor, Cottonwood **10:30AM–12:10PM**

Session Organizer: Patrick Davenport, *National Renewable Energy Laboratory, Golden, CO, United States*

Particle Lift Challenges and Solutions for Solid Particle Receiver Systems

Technical Paper Publication. ES2019-3833

Joshua Christian, Jeremy Sment, Clifford Ho, Lonnie Haden, Kevin Albrecht, *Sandia National Laboratories, Albuquerque, NM, United States*

Optimization of Storage Bin Geometry for High Temperature Particle-Based CSP Systems

Technical Paper Publication. ES2019-3903

Jeremy Sment, Kevin Albrecht, Joshua Christian, Clifford Ho, *Sandia National Laboratories, Albuquerque, NM, United States*

Dynamic Simulation and Control of an Efficient High-Temperature Particle Lift System

Technical Presentation. ES2019-4028

Kenzo Repole, *Georgia Institute of Technology, Roswell, GA, United States,* Sheldon Jeter, *Georgia Institute of Technology, Atlanta, GA, United States*

Potential 3-D Printing of Refractory Insulation for Low-Cost Thermal or Thermochemical Energy Storage

Technical Presentation. ES2019-4037

Sheldon Jeter, Russell Gentry, *Georgia Institute of Technology, Atlanta, GA, United States,* Zhiwen Ma, *National Renewable Energy Laboratory, Lakewood, CO, United States,* Matthew Lambert, *Allied Mineral Products, Inc., Columbus, OH, United States,* Jian Luo, Shaochen Chen, *UC San Diego, La Jolla, CA, United States*

High Temperature Centrifugal Pumps for Molten Salt

Technical Presentation. ES2019-4076

Xu Tan, Asegun Henry, Bamdad Barari, *Massachusetts Institute of Technology, Cambridge, MA, United States*

TRACK 4 SOLAR CHEMISTRY

Track Organizer: Justin Lapp, *University of Maine, Orono, ME, United States*

4-3
SOLAR CHEMICAL PROCESSES

Third Floor, Juniper **10:30AM–12:10PM**

Session Organizer: Justin Lapp, *University of Maine, Orono, ME, United States*

Operation for Efficient Solar Chemical Looping Methane Reforming in a Fixed-Bed Reactor

Technical Presentation. ES2019-3996

Jesse Fosheim, *University of Minnesota - Twin Cities, Minneapolis, MN, United States,* Jane Davidson, *University of Minnesota, Minneapolis, MN, United States*

Solar Steam Gasification of Cellulose in Molten Alkali Salts With Autothermal Hybridization

Technical Presentation. ES2019-4032

Brandon Hathaway, Nathaniel J. Lewin, *University of Minnesota, Minneapolis, MN, United States,* Jane Davidson, *University of Minnesota, Wayzata, MN, United States*

Characterizing the Kinetics of Ceria Oxidation by Carbon Dioxide

Technical Presentation. ES2019-4039

Daniel J. Keene, *Seattle Pacific University, Seattle, WA, United States*

Magnesium Production via Solar Methanothermic Reduction of Magnesium Oxide

Technical Presentation. ES2019-3929

Hamed Abedini Najafabadi, Nesrin Ozalp, Richard Davis, *University of Minnesota Duluth, Duluth, MN, United States,* Michael Epstein, *Tel Aviv University, Tel Aviv, Israel,* Samuel Lucas, *University of Minnesota Duluth, Centerville, MN, United States*

Technical Sessions – WEDNESDAY

TRACK 11 CONVERSION AND PROCESSING OF BIOFUEL AND ALTERNATIVE FUEL

Track Organizer: Ben Xu, *University of Texas Rio Grande Valley, Edinburg, TX, United States*

11-1
CONVERSION AND PROCESSING OF WASTE AND MICROALGAE

Third Floor, Larch **10:30AM–12:10PM**

Session Organizer: Majid Hosseini, *University of Texas Rio Grande Valley, Edinburg, TX, United States*

Session Co-Organizer: Feiqiang Guo, *China University of Mining Technology, Xuzhou, China*

Comparative Studies on the Effect of Selected Iron-Based Additives on Anaerobic Digestion of Okra Waste

Technical Paper Publication. ES2019-3820

Samson N. Ugwu, Christopher Enweremadu, *University of South Africa, Florida, Johannesburg, Gauteng, South Africa*

Sustainable Biodiesel Production From Blends of Waste Cooking Oil and Microalgae Oil

Technical Paper Publication. ES2019-3951

Daniela Sugai, Wellington Balmant, Priscila Dario, Leonardo Martinez, Dhyogo Taher, Jose V. Vargas, *Universidade Federal do Parana, Curitiba/Paraná, Brazil*

Green Diesel from Microalgae

Technical Paper Publication. ES2019-3959

Iago Costa, Wellington Balmant, Arion Zandona Filho, Luiz Ramos, Dhyogo Taher, Andre Mariano, Jose V. Vargas, *Universidade Federal do Parana, Curitiba/Paraná, Brazil*

Hydrogen and Compounds With Biological Activity from Microalgae

Technical Paper Publication. ES2019-3965

Marcos Rosa, Daiani Savi, Beatriz Santos, Wellington Balmant, Andre Mariano, Andre Servienski, Vanessa Kava, Fernando Dias, Jose V. Vargas, *Universidade Federal do Parana, Curitiba/Paraná, Brazil,* Juan Ordonez, *Florida State University, Tallahassee, FL, United States*

Development of an Exergy-Based Method to Evaluate the Improvement Potential of a Fluidized Bed Waste-to-Energy Plant

Technical Presentation. ES2019-3986

Francis Chinweuba Eboh, Peter Ahlström, Tobias Richards, *University of Borås, Borås, Västergötland, Sweden*

TRACK 3 CONCENTRATING SOLAR POWER

Track Organizer: Craig Turchi, *National Renewable Energy Laboratory, Golden, CO, United States*

Track Co-Organizer: John Pye, *The Australian National University, ANU Canberra, Australia,* Matthew Bauer, *US Department of Energy, Washington, DC, United States*

3-5
NOVEL COLLECTORS

Third Floor, Cottonwood **2:00PM–3:40PM**

Session Organizer: Guangdong Zhu, *National Renewable Energy Laboratory, Englewood, CO, United States*

Optical Performance Modeling and Analysis of a Tensile Ganged Heliostat Concept

Technical Paper Publication. ES2019-3933

Julius Yellowhair, Charles Andraka, Kenneth Armijo, Jesus D. Ortega, *Sandia National Laboratories, Albuquerque, NM, United States,* Jim Clair, *Skysun, LLC, Bay Village, OH, United States*

On-Sun Tracking Evaluation of a Small-Scale Tensile Ganged Heliostat Prototype

Technical Paper Publication. ES2019-3935

Julius Yellowhair, Kenneth Armijo, Jesus D. Ortega, *Sandia National Laboratories, Albuquerque, NM, United States,* Jim Clair, *Skysun, LLC, Bay Village, OH, United States*

Intensity Distribution From a Single-Bulb Solar Simulator Identification Through Inverse Ray Tracing

Technical Paper Publication. ES2019-3860

Mostafa Abuseada, Nesrin Ozalp, *University of Minnesota Duluth, Duluth, MN, United States*

TRACK 6 WIND ENERGY AND PV: INTERMITTENT RENEWABLE

Track Organizer: Min Zhang, *Praxair, Inc., Tonawanda, NY, United States*

6-1
WIND ENERGY AND PV

Third Floor, Juniper **2:00PM–3:40PM**

Session Organizer: Min Zhang, *Praxair, Inc., Tonawanda, NY, United States*

Influence of Metal Electrodes on the Charge Extraction of Inverted Perovskite Solar Cells

Technical Paper Publication. ES2019-3807

Jiawei Gong, *Penn State Erie, The Behrend College, Erie, PA, United States,* Sumathy Krishnan, *North Dakota State University, Fargo, ND, United States*

Comparison of Water-Free PV Cleaning Techniques In Summer and Winter Conditions of Hot Desert Regions

Technical Presentation. ES2019-4014

Mohammed Al-Housani, Yusuf Bicer, Muammer Koç, *Hamad Bin Khalifa University, Doha, Ad Dawhah, Qatar*

Aeroelastic Response of Variable-Speed Stall-Controlled Wind Turbine Rotors

Technical Paper Publication. ES2019-3803

Sarah Jalal, Fernando L. Ponta, Apurva Baruah, *Michigan Technological University, Houghton, MI, United States*

An Analysis of the Technical Feasibility of Off-Shore Wind Energy in the Philippines

Technical Paper Publication. ES2019-3835

Gerard Lorenz Maandal, *Chevron Philippines Inc., Makati City, Philippines,* Mili Ann Tamayao, Louis Angelo Danao, *University of the Philippines, Quezon City, Philippines*

Fabrication, Testing and Modeling/Correlation of a PV/PWMCC/BES Experimental Test Apparatus

Technical Paper Publication. ES2019-3822

Kevin Anderson, Wael Yassine, Gerald Herder, *California State Polytech University, Pomona, CA, United States*

TRACK 11 CONVERSION AND PROCESSING OF BIOFUEL AND ALTERNATIVE FUEL

Track Organizer: Ben Xu, *University of Texas Rio Grande Valley, Edinburg, TX, United States*

11-2
PERFORMANCE EVALUATION AND PROCESSING OF BIOFUEL AND ALTERNATIVE FUEL

Third Floor, Larch **2:00PM–3:40PM**

Session Organizer: Hamidreza Shabgard, *University of Oklahoma, Norman, OK, United States*

Session Co-Organizer: Jie Qu, *China University of Mining Technology, Xuzhou, China*

Performance Characteristics of Philippine Hydrous Ethanol-Gasoline Blends: Preliminary Findings

Technical Paper Publication. ES2019-3824

John Luis Yu, Edwin N. Quiros, *University of the Philippines, Quezon City, Philippines*

Experimental Study on Performance of a Single-Cylinder Engine Fueled with Diesel and Vegetable Oil-Diesel Blends

Technical Paper Publication. ES2019-3830

Amarlo A. Banania, *Aurora State College of Technology, Baler, Philippines,* Edwin N. Quiros, *Department of Mechanical Engineering, University of the Philippines, Quezon, Philippines,* Jose Gabriel Mercado, *University of the Philippines Mechanical Engineering Department, Quezon City, National Capital Region, Philippines*

Supercritical Water Gasification of Ethanol for Fuel Gas Production

Technical Paper Publication. ES2019-3950

Brian R. Pinkard, Elizabeth G. Rasmussen, John C. Kramlich, Per G. Reinhall, Igor V. Novosselov, *University of Washington, Seattle, WA, United States*

Optimization of a Biomass Torrefaction Plant With Near Zero Emissions

Technical Paper Publication. ES2019-3963

Mahmudul Hasan, Yousef Haseli, *Central Michigan University, Mt. Pleasant, MI, United States*

Impact of DEE on Sustainability Index, Exergy Destruction and Emission Characteristics of Diesel Engine Fueled With Waste Cooking Oil Biodiesel

Technical Presentation. ES2019-4075

Veena Chaudhary, *I*Rakesh P Gakkhar, *Indian Institute of Technology Roorkee, Roorkee, Uttrakhand, India*

TRACK 3 CONCENTRATING SOLAR POWER

Track Organizer: Craig Turchi, *National Renewable Energy Laboratory, Golden, CO, United States*

Track Co-Organizer: John Pye, *The Australian National University, ANU Canberra, Australia,* Matthew Bauer, *US Department of Energy, Washington, DC, United States*

3-6
CHARACTERIZATION AND CONTROL

Third Floor, Cottonwood **4:00PM–5:40PM**

Session Organizer: Julius Yellowhair, *Sandia National Laboratories, Albuquerque, NM, United States*

An Experimental and Numerical Study on Temperature Control of a Solar Reactor

Technical Presentation. ES2019-3858

Sofie Verstraete, *KU Leuven, Brugge, Belgium,* Nesrin Ozalp, *University of Minnesota Duluth, Duluth, MN, United States,* Stijn Debruyne, *KU Leuven, Brugge, Belgium*

An Innovative Non-Intrusive Optical Method to Perform in-situ Optical Characterization of Heliostats in Utility-Scale Power Tower Plants

Technical Presentation. ES2019-3990

Rebecca Mitchell, *National Renewable Energy Laboratory, Boulder, CO, United States,* Guangdong Zhu, *National Renewable Energy Laboratory, Englewood, CO, United States*

A Sensitivity Study of an Optical Method to Measure Optical Errors of Heliostats in Utility-Scale Power Tower Plants

Technical Presentation. ES2019-3991

Rebecca Mitchell, *National Renewable Energy Laboratory, Boulder, CO, United States,* Guangdong Zhu, *National Renewable Energy Laboratory, Englewood, CO, United States*

The Effect of Compressor Shaft Speed Control on Supercritical Carbon Dioxide Recompression Cycle Off-Design Performance for Concentrating Solar Applications

Technical Presentation. ES2019-4013

Ty Neises, *National Renewable Energy Laboratory, Golden, CO, United States*

Off-Design Performance of Molten Salt-Driven Rankine Cycles and Its Impact on the Optimal Dispatch of Concentrated Solar Power Systems

Technical Presentation. ES2019-4031

William T. Hamilton, Robert Braun, Alexandra M. Newman, *Colorado School of Mines, Golden, CO, United States*

TRACK 7 SOLAR DESALINATION AND INDUSTRIAL PROCESS HEAT

Track Organizer: Parthiv Kurup, *National Renewable Energy Laboratory, Golden, CO, United States*

7-1
SOLAR IPH

Third Floor, Juniper **4:00PM–5:40PM**

Development and Test of a Direct Contact Heat Exchanger (Particle – Air) for Industrial Process Heat Applications

Technical Paper Publication. ES2019-3818

Johannes Hertel, *German Aerospace Center, Stuttgart, Baden-Wurttemberg, Germany,* Miriam Ebert, Lars Amsbeck, Birgit Gobereit, Jens Rheinländer, Cathy Frantz, *German Aerospace Center, Stuttgart, Germany,* Alexander Hirt, *Furtwangen University, Villingen-Schwenningen, Germany*

Solar Desalination of Non-Traditional Wastewater via Radiative Heating: From Evaporation Ponds to Forward Osmosis Desalinatioo

Technical Presentation. ES2019-4007

Akanksha Menon, Robert Kostecki, Ravi Prasher, *Lawrence Berkeley National Laboratory, Berkeley, CA, United States*

Energy Efficient Ionic Liquid Forward Osmosis (IL-FO) Based Water Desalination: A System Level Application

Technical Presentation. ES2019-4071

Md. Imran, Robert Kostecki, *Lawrence Berkeley National Laboratory, Berkeley, CA, United States,* David Suich, *Cree, Inc., Durham, NC, United States,* Emily Tow, *Olin College of Engineering, Needham, MA, United States*

Optimization of Solar Drying of Aerial Yam Using Response Surface Methodology

Technical Presentation. ES2019-3948

Emmanuel Nwadike, Joseph Nwabanne, Paschal Ohale, *Nnamdi Azikiwe University, Awka, Awka/Anambra, Nigeria,* Samuel Enibe, *University of Nigeria, Nsukka, Enugu, Enugu, Nigeria*

TRACK 12 DISTRIBUTED ENERGY SYSTEMS

Track Organizer: Wahiba Yaici, *CanmetENERGY Research Centre/Natural Resources Canada, Ottawa, ON, Canada*

Track Co-Organizer: Ali Al-Alili, *Khalifa University, Abu Dhabi, United Arab Emir.*

12-1
DISTRIBUTED ENERGY SYSTEMS I

Third Floor, Larch **4:00PM–5:40PM**

Session Organizer: Jian Zhang, *Mississippi State University, Mississippi State, MS, United States*

Session Co-Organizer: Jiawei Gong, *Penn State Erie, The Behrend College, Erie, PA, United States,* Pouyan Talebizadehsardari, *University of Nottingham, Nottingham, United Kingdom*

Thermodynamic and Performance Study of Solar Regenerative Organic Rankine Cycle System for Use in Residential Micro-Combined Heat and Power Generation

Technical Paper Publication. ES2019-3832

Wahiba Yaici, Evgueniy Entchev, *CanmetENERGY Research Centre/Natural Resources Canada, Ottawa, ON, Canada*

DC Microgrids for Future Homes

Technical Presentation. ES2019-3988

Diego A. Aponte-Roa, *Universidad Ana G. Mendez, Gurabo, PR, United States,* Xavier Collazo, Jeffrey Borres, Melvin Nuñez, *UAGM - Gurabo Campus, Gurabo, PR, United States*

A Study on Urban Heating System Flexibility: Modeling and Evaluation

Technical Paper Publication. ES2019-3863

Jiaying Chen, Wei Zhong, Yi Zhou, Xiaojie Lin, Wei Huang, *Zhejiang University, Hangzhou City, Zhejiang Province, China*

Performance Enhancement of Solar Air Conditioners Using Hybrid Heat Rejection System

Technical Paper Publication. ES2019-3930

Abdul Ahad Iqbal, Ali Al-Alili, *Khalifa University, Abu Dhabi, United Arab Emir.*

Microgrids With Energy Storages "AngelNet-MicroGryd": An Optimized Reliable, Affordable, and Renewable Electricity Supply System for Towns and Communities

Technical Presentation. ES2019-4065

Hebab Quazi, *Martech International Inc., Sugar Land, TX, United States*

Author Index

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		ES2019-3911	Flowing Particle Fluidized Bath Design and Heat Transfer	Concentrating Solar Power	Third Floor, Juniper	3-9
Abraham	Jeremy	ES2019-4017	Assessing Heat Transfer in Fluidized Beds for Particle Heat Exchangers and Receivers in Concentrating Solar Power	Concentrating Solar Power	Third Floor, Juniper	3-9
Abuseada	Mostafa	ES2019-3859	MCRT Coupled CFD Analysis of a 3 kW Solar Cavity Receiver Radiated via 10 kW HFSS: Experimental Validation and Parametric Optimization Study	Concentrating Solar Power	Third Floor, Cottonwood	3-1
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Agarwal	Pratyush	ES2019-4058	Evaluation of Radiative Heat-Transfer in Flowing Particle Systems	Concentrating Solar Power	Third Floor, Juniper	3-9
Ahlström	Peter	ES2019-3986	Development of an Exergy-Based Method to Evaluate the Improvement Potential of a Fluidized Bed Waste-to-Energy Plant	Conversion and Processing of Biofuel and Alternative Fuel	Third Floor, Larch	11-1
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		ES2019-4036	Progress on the Design and Development of the G3KSA Particle Heating CSP Project	Concentrating Solar Power	Third Floor, Juniper	3-11
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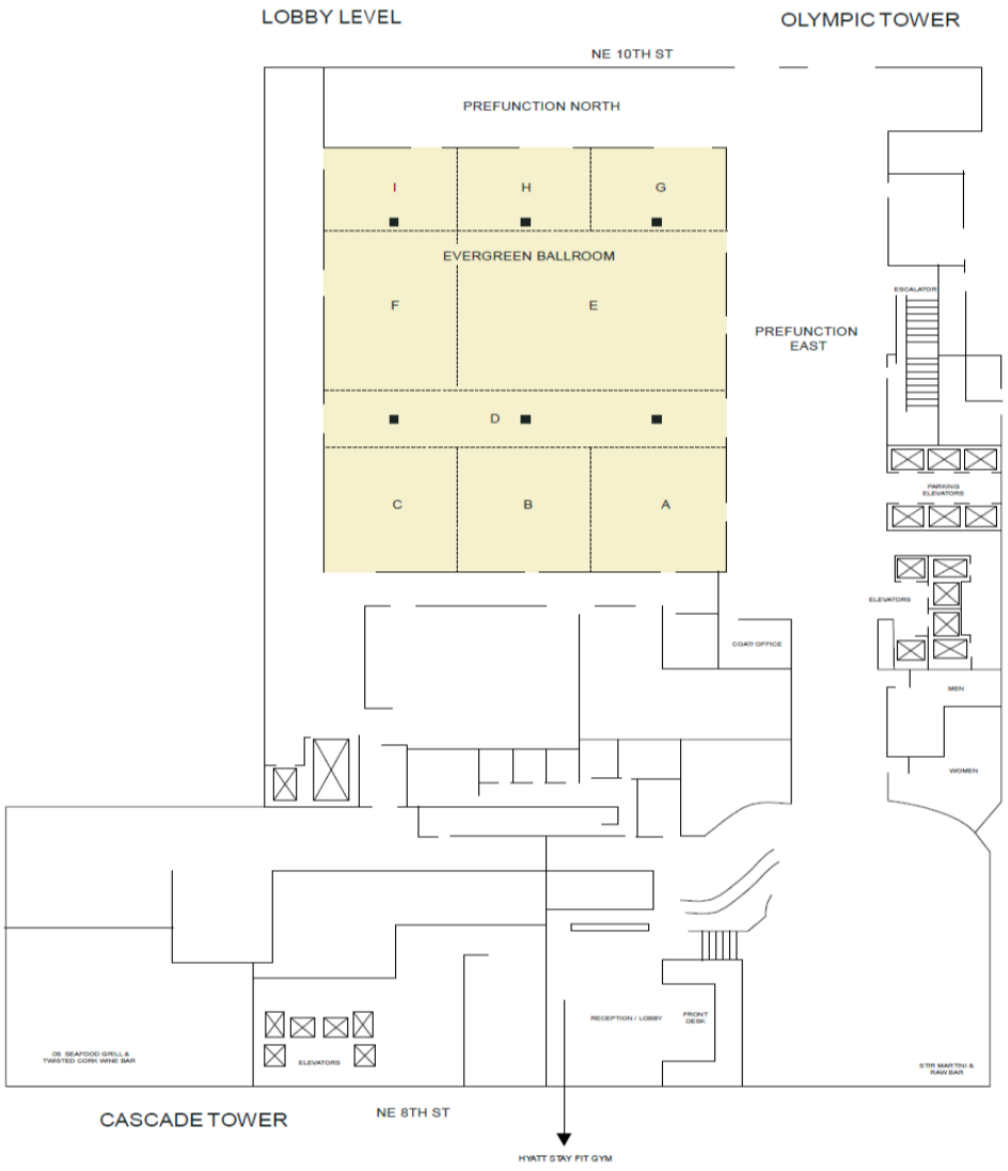

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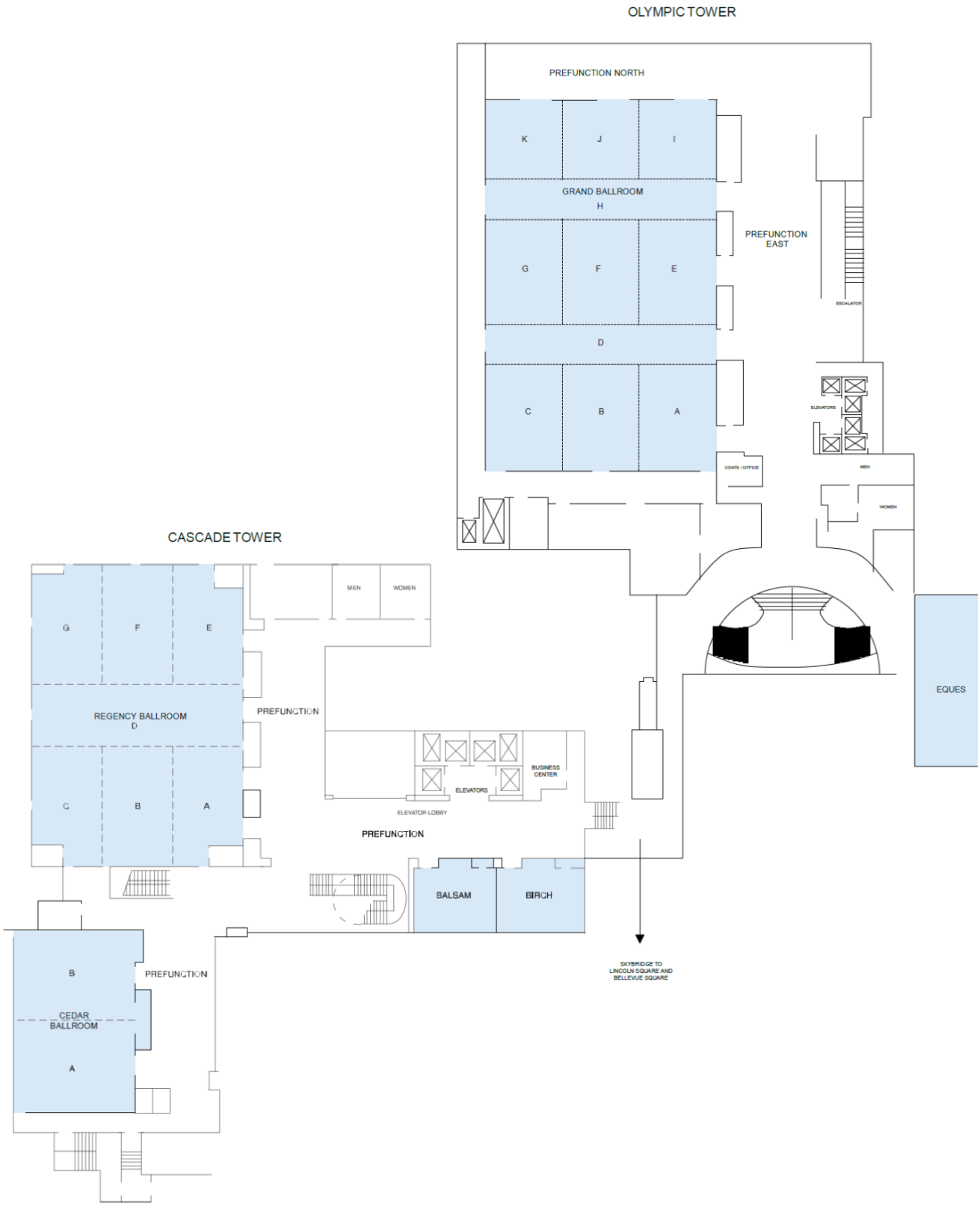

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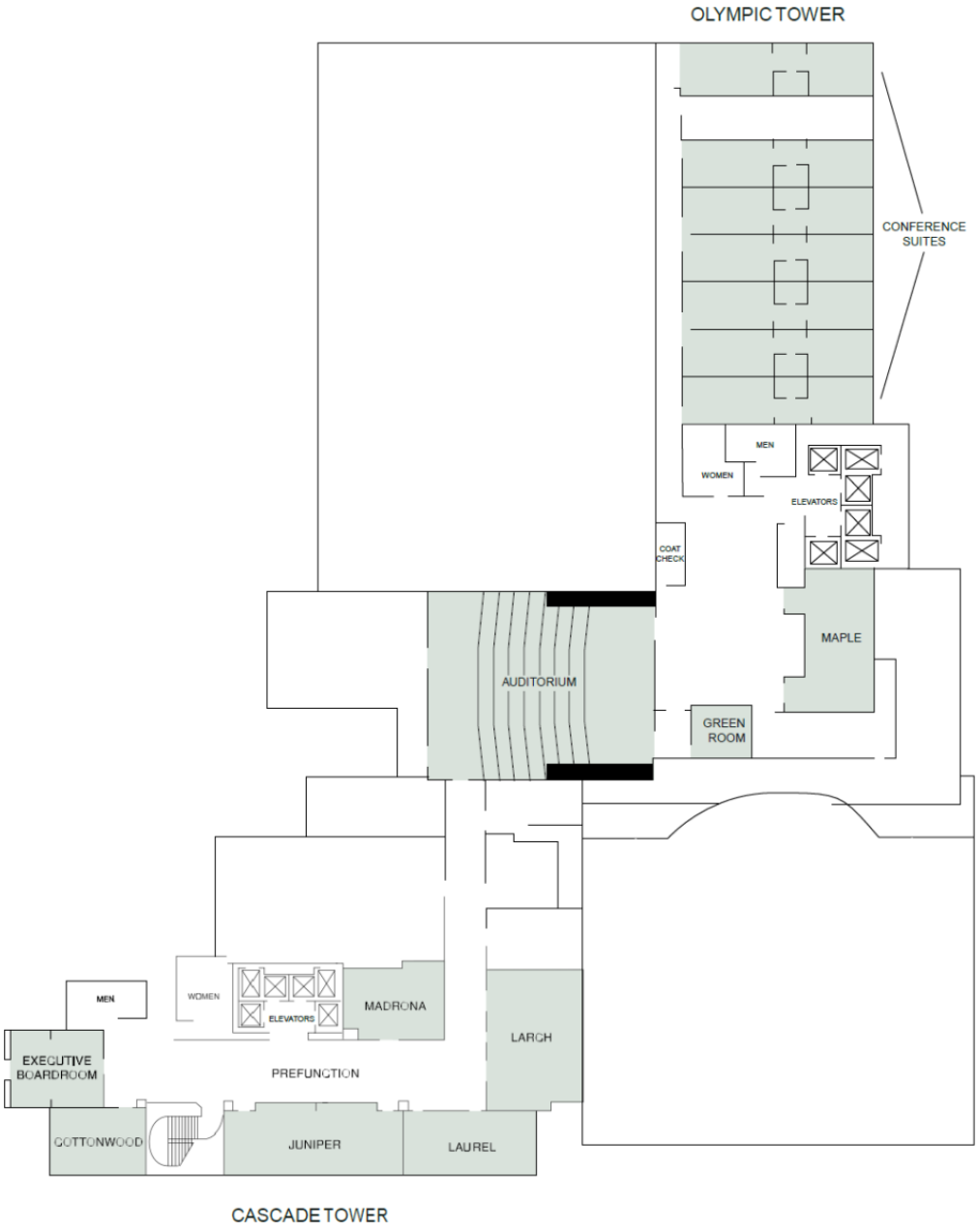

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