Orcas 2024

International Conference on Energy Conversion & Storage

August 5-7, 2024
Islandwood - Bainbridge Island, WA

2024 Conference Program

Sponsored By:

CLEAN ENERGY INSTITUTE
UNIVERSITY *of* WASHINGTON

FOM TECHNOLOGIES

Monday, August 5

12:00 – 2:45 pm **Arrival & Check-In**

2:45 - 3:00 pm Welcome Address with **David Ginger**

Session 1: Energy Storage & Sustainability

3:00 - 3:35 pm **Todd Emrick**, University of Massachusetts
Tailoring Polymer-Semiconductor Interfaces for Energy Output in Hybrid Materials and Devices

3:40 - 4:15 pm **Abraham Anapolsky**, Toyota Research Institution
Accelerating the Research to Production Cycle for Clean Energy

4:20 - 4:55 pm **Mark Thurber**, Standford University
Market Models for Battery Storage in Mature and Emerging Energy Markets

5:00 **Check into housing**

6:00 - 7:30 pm **Dinner**

7:35 – 8:30 pm **Break**

8:30 – 10:00 pm **S'mores at the Friendship Circle**

Tuesday, August 6

7:00 – 8:00 am **Breakfast in the dining hall**

Session 2: Energy Conversion

8:10 - 8:45 am **Michael McGehee**, University of Colorado Boulder
Energy Efficient windows with adjustable tinting based on reversible metal electrodeposition

8:50 - 9:25 am **Chih-Hung (Alex) Chang**, Oregon State University
Transformation, Reaction and Organization of Functional Nanostructures using Microreactor-Assisted Nanomaterial Deposition

9:30 - 10:05 am **Julia Hsu**, University of Texas – Dallas
Sustainable Fabrication of Perovskite Solar Cells And Transparent Conducting Electrodes on Plastic Substrates Using Flash Lamp

10:05 - 10:35 am	30-minute break

Session 3: Just Energy Transitions

10:35 – 11:10 am	**Ahlmahz Negash**, Tacoma Power *Energy Justice Considerations in Utility Cost Recovery*
11:15 – 11:50 am	**Mike Dioha**, Pacific Northwest National Lab *Energy For All in Africa Under Climate Constraints*
11:55 - 12:30 pm	**Lauren Culver**, World Bank *Defining Finance Needs for Energy Transition and Development*
12:30 – 1:30 pm	Lunch in the dining hall
1:30 – 2:05 pm	**Keynote presentation with Ken Caldeira**, Carnegie Science / Gates Ventures *Macro-Energy Modeling Perspectives on Energy Conversion and Storage*
2:30 – 6:00 pm	Free time
2:30 – 4:30 pm	Forest Hike at IslandWood (optional)
2:30 – 4:30 pm	Canopy Tower Hike at IslandWood (optional)
6:00 – 7:30 pm	Dinner in the dining hall
7:30 – 8:30 pm	Break
8:30 – 10:00 pm	Student Poster Session

Wednesday, August 7

7:00 – 8:00 am	Breakfast in the dining hall
8:00 - 10:15 am	Free time
10:15 - 11:00 am	Professional development: Developing Strategies for Resilience & Well-Being, Megan Kennedy, Director of UW Resilience Lab
	Professional development: Interviewing & Networking, Michael More, UW Career Center
11:05 – 11:50 pm	Professional development: Developing Strategies for Resilience & Well-Being, Megan Kennedy, Director of UW Resilience Lab
	Professional development: Interviewing & Networking, Michael More, UW Career Center
2:00 - 1:00 pm	Sack lunch available in the dining hall
1:00 pm	Departure from IslandWood

Speaker Abstracts

Keynote Presentation

Macro-Energy Modeling Perspectives on Energy Conversion and Storage

Ken Caldeira
Senior Scientist, Carnegie Science / Gates Ventures

Electricity systems that are reliant on variable wind and solar generation require some form of dispatchable power and/or load management to cost-effectively meet electricity demand. Complex problems require complicated analysis, yet conceptual understanding can often be developed through the use of simple, highly stylized, models.

Over the past years, we have done a number of studies looking at deeply decarbonized energy systems reliant on wind and solar generation and have come to appreciate the important roles that long-duration energy storage can play in these systems. Low energy-capacity costs are key to cost-effective long-term storage, and round-trip efficiencies and power-capacity costs are often less critical. The value of long-duration storage increases with the stringency of carbon constraint, especially if low-cost, dispatchable, zero-emission generation does not become available.

This talk will survey results from a number of recent studies and try to draw some broader conclusions about possible roles of energy storage in facilitating a transition to a net-zero emission electricity system.

Tailoring Polymer-Semiconductor Interfaces for Energy Output in Hybrid Materials and Devices

Todd Emrick
Professor of Polymer Science and Engineering
University of Massachusetts Amherst

The ability to tailor materials interfaces involving organic/polymer and semiconductor structures is central to advancing the output and efficiency of a range of devices, including solar cells and emitting displays that benefit from the application of similar design principles. This talk will highlight the organic and polymer components of such interfaces, with focus on macromolecular design and functionality that enhances the stability or efficiency of energy output. Building on prior work on functional polymeric and fullerene components of organic solar cells, we now find that perovskite-based nanoparticulate structures are stabilized against degradation and sintering with functional polymers, including polyelectrolytes and polymer zwitterions. The ionic lattice of perovskite nanocrystals presents unique opportunities in hybrid materials, as will be described for examples in color tuning and lithographic patterning in conjunction with multifunctional polymers that contribute nanoparticle-stabilizing and film-forming properties.

Accelerating the Research to Production Cycle for Clean Energy

Abraham Anapolsky
Director of Advanced Manufacturing Research, Toyota Research Institute

The world is more accepting of clean energy than ever. As scientists and engineers, our job is to make our work relevant and get it out to the people and the planet. The problem I have repeatedly run into in my 20+ years of R&D is translating promising research into widespread use.
The traditional model of market-research-development-scaling-production-market has been problematic in e.g. adopting new chemistries into Li ion batteries. The reason? Sunk cost, cost to adopt, and risk of unknown unknowns in a low margin business. Additionally, scaling can introduce compromise and new problems into a previously well understood achievement. In other words, what's achievable in the lab is governed by physics, what's achievable as a technology is governed by human behavior.

I will discuss some successes (and failures) that I have had in my career and discuss what I think are possible novel ways to improve the situation. The 21st century brings peril and promise, my belief is that the promise is only accessible with new thinking and new ways of working together.

Market Models for Battery Storage in Mature and Emerging Energy Markets

Mark Thurber
Associate Director of the Program on Energy and Sustainable Development
Stanford University

Through the use of a regulatory mandate, California has brought online massive amounts of grid-level battery storage in the last several years. Emerging markets like Kenya are looking to California's battery boom as a model for balancing their own growing fleets of wind and solar. But California's storage buildout has benefited from legacy flexible generation, on which the state still depends, as well as competitive markets for energy and ancillary services that incentivize the efficient utilization of grid-level batteries. In a mirror image of California's trajectory, the most promising near-term model for storage adoption in emerging markets may actually be the unsubsidized uptake of batteries in the residential context, where they provide significant value by time shifting home solar to reduce dependence on unreliable and expensive grid power.

Energy Efficient windows with adjustable tinting based on reversible metal electrodeposition

Michael McGehee
James M & Catherine Patten Chair in Chemical Engineering
University of Colorado Boulder

Windows with adjustable tinting not only reduce glare without blocking views, but can also reduce energy use for lighting, heating and cooling by 20 %. Decades of research in electrochromic materials have not yet resulted in windows that are color neutral, sufficiently durable and cost effective. A new approach based on reversible metal electrodeposition will be presented. RME window are color neutral, have superb dynamic range and inexpensive at scale. Tynt Technologies is commercializing this device, which could be thought of as a battery that is transparent in one of its states.

Transformation, Reaction and Organization of Functional Nanostructures using Microreactor-Assisted Nanomaterial Deposition

Chih-Hung (Alex) Chang
Professor of Chemical, Biological and Environmental Engineering, Oregon State University

Nanomaterials have revolutionized fields such as medicine, electronics, sensing, energy storage and harvesting, catalysis, and more. As such, a key goal towards unlocking the application of nanomaterials in these fields starts with the ability to tune nanomaterial properties such as size, shape, morphology, and composition to selectively improve material performance for targeted applications. Chemical synthesis of nanomaterials is often complex and sensitive to the process conditions. Process intensification can potentially control the spatial, thermodynamic, functional, and temporal domains to intensify the chemical manufacturing of nanomaterials. Guided by process intensification principles, Microreactor-assisted nanomaterial deposition (MAND) has been demonstrated as a promising platform for scalable nanomaterial synthesis of molecule and nanoscale building blocks at the point of use to manufacture functional nanostructured materials. In this talk, I will discuss the use of MAND systems to tailor the reacting flux, transporting to substrate surfaces via controlling process parameters on the formation and transformation of intermediary reactive molecules, nanoclusters, nanoparticles, and structured assemblies to fabricate functional materials and devices.

Sustainable Fabrication of Perovskite Solar Cells And Transparent Conducting Electrodes on Plastic Substrates Using Flash Lamp

Julia Hsu
Professor - Materials Science & Engineering, University of Texas – Dallas

Industrial manufacturing uses heat to convert raw materials to final products, induce the desired crystalline phase, or improve the materials' properties. Heat usage accounted for 1/5 of 2018 global energy and 1/3 of 2020 US's primary energy consumption. Because it primarily uses fossil fuels, industrial heat produced 9% of US CO2 emissions in 2020. In addition to a large carbon footprint, conventional thermal annealing using hot plates or ovens raises the temperatures of both the film and substrate. The high temperatures required to activate metal oxides can damage the substrate, while the different coefficients of thermal expansion between the film and substrate can produce mechanical failures in the brittle oxide films. Here, we propose a novel approach called photonic curing as a novel alternative to thermal annealing. Photonic curing uses short pulses of broadband light to selectively induce chemical reactions or phase transformation in the film while keeping the substrate cool. Since the light pulses are short and have high intensity, the peak temperature in the film can be high, leading to fast rates due to exponential temperature dependence according to the Arrhenius law. However, the short duration means low total energy and minimal substrate damage or thermal stress in the film, in addition to little energy being wasted in heating the environment. The result is reduced processing time and better mechanical properties. In this talk, I will showcase the use of photonic curing in fabricating flexible halide perovskite solar cells and transparent conducting electrodes (TCEs) on polyethylene terephthalate (PET) substrates. I will also discuss adopting machine learning approaches to accelerate experimental optimization.

Defining Finance Needs for Energy Transition and Development

Ahlmahz Negash
Principal Analyst, Tacoma Power

The COP 28 pledge to triple global renewable power capacity and double the annual rate of energy efficiency improvement by 2030 demonstrates governments' commitment to energy transition. Transforming the world energy system will create new jobs, enhance lives and livelihoods, empower people, and foster resilient communities. A just energy transition underpins achievement of the UN Sustainable Development Goals (SDGs), particularly SDG 7 - universal access to affordable, reliable, sustainable, and modern energy for the 685 million people currently without. Keeping global temperature rise to 1.5°C in line with the Paris Agreement, while achieving universal access to electricity and ensuring energy security and affordability, requires accelerated action and ambitious policy implementation this decade. Low- and middle-income countries (LICs and MICs) need increased support and investment from multiple sources including the private sector, multilateral development banks like the World Bank, and philanthropy.

Energy For All in Africa Under Climate Constraints

Michael Dioha
Senior Energy Researcher, Clean Air Task Force

Africa faces a formidable challenge in the 21st century: providing universal energy access to its rapidly growing population while minimizing carbon emissions in a world increasingly constrained by climate targets. This talk will begin by conceptualizing the meaning of energy access and establishing a framework for understanding its multifaceted implications. Subsequently, a comprehensive overview of Africa's current energy landscape will be presented, underscoring the urgent need for reliable and affordable energy solutions. Utilizing research case studies, this talk will illustrate the potential impacts of achieving universal energy access on climate targets and, conversely, how climate goals might influence energy access. The talk will delve into innovative approaches for striking a balance between expanding modern energy access in Africa and meeting global climate commitments. Key strategies to be discussed will include the deployment of renewable energy systems and advanced energy-efficient technologies. Furthermore, the discussion will encompass the critical role of policy in driving the transition to a sustainable energy future in Africa.

Defining Finance Needs for Energy Transition and Development

Lauren Culver
Senior Energy Specialist, World Bank

The COP 28 pledge to triple global renewable power capacity and double the annual rate of energy efficiency improvement by 2030 demonstrates governments' commitment to energy transition. Transforming the world energy system will create new jobs, enhance lives and livelihoods, empower people, and foster resilient communities. A just energy transition underpins achievement of the UN Sustainable Development Goals (SDGs), particularly SDG 7 - universal access to affordable, reliable, sustainable, and modern energy for the 685 million people currently without. Keeping global temperature rise to 1.5°C in line with the Paris Agreement, while achieving universal access to electricity and ensuring energy security and affordability, requires accelerated action and ambitious policy implementation this decade. Low- and middle-income countries (LICs and MICs) need increased support and investment from multiple sources including the private sector, multilateral development banks like the World Bank, and philanthropy.
