Sara Sultan

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Ph.D. in Energy Sciences and minor in Energy Leadership, I advanced clean energy solutions through research innovation, policy implementation, and business development. I want to lead new ideas on the nexus of technology, nature and social responsibilities, and mentor young scientists to empower next generation of innovators and future leaders.

**Skills:** Research & Development, Science Writing, Academic Advising, Public Speaking, Data Analysis, Project Management

**Accomplishments:** DOE Solar Decathlon Juror, UTK 40 under 40 alumnus, ACEEE Linda Latham Scholar, Ph.D. Distinction

# RESEARCH EXPERTISE

**Thermodynamics, heat/mass transfer, material synthesis and characterization, and energy modeling.**

Space heating, cooling, and dehumidification for residential and commercial applications.

Building envelopes, equipment efficiency, and decarbonization for grid-interactive buildings.

Phase change materials: synthesis, characterization, and optimization.

Thermal storage systems; data-driven modeling, prototype development and experimental design.

Data analysis for diverse climate zones, using utility rates, and grid emissions for load flexibility and demand response

Nano and composite materials for solar photovoltaic systems; Chemical synthesis and SEM characterization

Market transformation and commercialization of energy innovations.

Energy policy development, including renewable integration and energy code advancements.

# RESEARCH OUTPUT METRICS

h-index 5 Scientific Publications 15

Citations (Google) 91 Peer Reviews 10

# EDUCATION

## Ph.D. Energy Science and Engineering 2018 - 2023

### The Bredesen Center for Interdisciplinary Education, University of Tennessee (UTK) – Knoxville, Tennessee

Minor Concentrations: **Leadership,** **Entrepreneurship and Science Writing**

Highlights:Department of Energy Fellow, Volunteer of Distinction, Graduate Student Senator

Thesis: Heat Pump integrated with Thermal Energy Storage for Demand Response and Decarbonization in Buildings

Graduate Courses: Micro and Nano Manufacturing, Thin Film Material Processing, Heat & Mass Transfer in Buildings

## Graduate Certificate in Mechanical Engineering 2020 – 2021

*University of Maryland (UMD) – College Park, MD*

Advance course on Steady State and Dynamic Modeling

## Master of Science in Energy Systems Engineering 2014 - 2017

### National University of Science and Technology (NUST) – Pakistan

Thesis:Solar driven water desalination system with improved dehumidification for maximum yield

Graduate Courses: Computer Applications in Energy Systems, Solar Energy, Photovoltaic Devices, Energy Resources & Technologies

## Exchange Program 2016 - 2017

*Oregon State University (OSU) – Oregon*

Graduate courses: Fluid Dynamics and Climate Assessment

## Bachelor & Master of Science in Physics 2010 - 2014

### National University of Science and Technology (NUST) – Pakistan

Advanced Courses:Nano Technology, Semi-Conductor Devices, Computational Physics, Thermal & Statistical Physics

## Graduate Certificate in Creative Writing 2012 - 2013

*University of California, Berkeley*

Completed 3 courses on “Principles of Written English”

## Bachelor of Education 2012 – 2015

*Allama Iqbal Open University – Pakistan*

Courses: Evaluation, Guidance and Research, Educational Psychology and Curriculum, Teaching of Physics

# INSTRUCTOR AND PUBLIC SPEAKING EXPERIENCE

## Invited talks

* Delivered invited talk ‘Bridging Science and Storytelling to shape future of Sustainability and Innovation’ for Scientia magazine’s educational initiatives.
* Delivered an invited lecture to a class of Ph.D. students at Bredesen Center UTK.
* Recorded an invited podcast as a guest on “Post-Ph.D. careers in industry”

## Lecturer 2017 - 2018

### University of Haripur

* Designed curriculum and assessment material for an undergraduate course of Physics
* Delivered lectures and evaluated progress reports

# RESEARCH EXPERIENCE

## Senior Advisor/Program Specialist 2024 – Present

### California Energy Commission, Sacramento, CA

* Led a research project to calculate heat transfer in metal frame walls
* Conducted research on advanced Building Envelope and current standards to inform the future updates in CA energy code

## Research Assistant 2018 – 2023

### Oak Ridge National Laboratory, Oak Ridge, TN

* Performed research on following topics through funded grants by U.S. Department of Energy (DOE):
* Price-based control strategies for demand response and decarbonization.
* Time-of-Use utility rate analysis for residential peak load shifting.
* Developing thermal storage system using salt hydrate phase change material.
* Synthesizing low-cost phase change materials and doing characterization.
* Integrating Heat pump with PCM heat exchangers and analyzing heat pump cycle.
* Load flexibility and carbon emissions analysis using utility data and marginal grid data.
* Published research papers and technical articles, advancing knowledge in thermal storage, demand flexibility, and decarbonization.
* Presented work at various conferences and translated the complex research to communicate to a diverse audience.

## Visiting Research Scholar 2016 – 2017

### Hydro and Climate Lab, OSU, Corvallis, OR

* Designed and performed experiments on pico-hydropower system to enhance electric efficiency.
* Contributed to a broadened understanding and application of sustainable practices through projects and cultural exchange.

## Research Assistant 2014 – 2017

### National University of Science and Technology (NUST) – Pakistan

* Conducted thermal energy systems analysis for USAID funded projects using MATLAB, TRNSYS, and RETSCREEN.
* Led research and authored scientific publications for solar water desalination, solar thermal power, and thin-film solar cells projects.

# ADDITIONAL PROJECTS

* **Utility Rate Analysis & Load Management:** Analyzed Time-of-Use (TOU) utility rate structures to model a smart thermostat and shifted the peak load to off-peak hours for various ASHRAE Climate Zones.
* **Carbon Mitigation**: Designed rule-based control strategy using marginal grid emissions data to reduce building’s carbon footprint.
* **Building Design:** Designed an IECC compliant 2-floor single-family home and incorporated storage. Analyzed the load profile through utility bills and sized the house for solar photovoltaic system installation.

# PROFESSIONAL EXPERIENCE

## Senior Advisor/Program Specialist 2024 – Present

### California Energy Commission, Sacramento, CA

* Leading the development of 2028 energy code as a senior advisor in Building Standards Unit, focusing on:
  + Building envelopes for energy efficiency and decarbonization
  + Thermal energy storage for load management and heat recovery
* Reviewed the Compliance Manuals and Reference Appendices for the 2025 code cycle
* Rectified errors in the 2025 code for fenestration requirements and updated tables
* Reviewed applications for EPIC grant solicitations and provided expert opinion on:
  + “Testing Bird-friendly windows for decarbonized buildings” project group under solicitation *GFO-24-301 - Environmental Sustainability of a Clean Energy Transition (Enviro-SET)*
  + “Applied Research and Development (R&D) to Improve Energy Storage Value, Safety, and Sustainability” under *GFO-23-317 - Energy Storage Innovations to Support Grid Reliability*
* Managed diverse team of stakeholders to oversee the progress and timely completion of deliverables.
* Led projects of high priority to plan for software integration, resources and data availability.

## Senior Analyst 2023 – 2024

### Optimal Energy at NV5, Sacramento, CA

* Conducted research and data analysis for diverse initiatives, including income-eligible programs, EnergyStar appliances, retrofits, and new construction for state energy efficiency councils in Rhode Island, Delaware, Massachusetts and Vermont.
* Analyzed and strategized on electrification, decarbonization, and rebate programs, improving state energy policies and operations.
* Engaged with stakeholder committees, delivering critical presentations, detailed data reports, technical briefs, and memos.
* Reviewed technical reference manuals, annual reports, potential studies, and contributed to grant writing for request for proposals
* Designed and produced the council’s quarterly newsletters using Canva, covering important meetings, events, and news gathered from various websites, webinars, and conferences.
* Planned and implemented AI solutions to streamline administrative, business, and research tasks, enhancing team productivity and operational efficiency. Created guides and custom GPTs.

## Research Assistant 2018 – 2023

### Oak Ridge National Laboratory, Oak Ridge, TN

* Led the project on Thermal Energy Storage; Organized meetings and ensured timely delivery of milestones.
* Prepared milestone reports, and developed presentations for DOE Building Technology Office Peer Reviews
* Analyzed weather, utility, and grid data using various tools, creating visualizations tailored for diverse stakeholders.
* Brainstormed innovative research ideas and formulated research questions to draft proposals and develop business models.

## Lead Market Analyst 2020 – 2021

### Shift Thermal, Knoxville, TN

* Served as researcher and advisor to the tech start up in thermal energy storage
* Led the team to perform market transformation analysis and customer discovery
* Provided conclusions and presented results to various stakeholders and industry experts

## Program Coordinator 2017 – 2018

### Higher Education Commission, Pakistan

* Served as a program coordinator for exchange program cohort through HEC project.
* Developed course curriculum, evaluation documents, and report summaries for the project.
* Managed 3 cohorts of 150 students; delivered lectures and seminars, reviewed their performance, and created plans to ensure the completion of their successful programs.

# PROFESSIONAL SERVICE

* Invited as an expert to review proposals through EPIC grant for the **Energy Research and Development Division at CEC**.
* Invited as a judge on panel to evaluate **DOE Solar Decathlon** semi-final competition at NREL
* **Peer reviewed** for journals and at conferences including 2024 ACEEE summer study, and 2023 IEA Heat Pump Conference
* **Co-advising** two students at UC Davis Energy Graduate Group for their Ph.D. research
* ASHRAE full member and committee member for Thermal Storage and Occupant Behavior in buildings Technical Committees

# WRITING AND PUBLICATIONS

## Research Publications

Published [work](https://www.osti.gov/search/author:%22Sultan,%20Sara%22) through grants funded by the Department of Energy (under Contract No. DE-AC05-00OR22725)

### Journal articles

1. “Techno-Economic Assessment of TES Integrated with Heat Pump for Residential Heating and Cooling,” *published* in “Energies”.
2. “The state of art of Heat-Pump integrated Thermal Energy Storage for Demand Response,” *published* as a topical article for The HPT Magazine issue 2/2021 under the Topic, “Heat pumps with thermal storage”

### Co-authored journal articles

### “Understanding supercooling mechanism in sodium sulfate decahydrate phase-change material,” published in “Journal of Applied Physics,” 2021

1. “Empirical analysis of turbine and generator efficiency of a Pico hydro system,” *published* in “Sustainable Energy Technologies and Assessments,” 2020

### Peer reviewed Conference papers

1. “Equity, Electrification, and Time of Use (TOU) rates: Coupling Thermal Energy Storage with Heat Pumps for Improved Operational Efficiency” *published* at 2024 ACEEE Summer Study
2. “Carbon Mitigation Potential of Heat Pump Integrated with Thermal Storage for Grid-Interactive Residential Buildings” *published* at 2023 IEA Heat Pump Conference
3. “Analysis of Residential Time-of-Use Utility Rate Structures and Economic Implications for Thermal Energy Storage” *published* at 2020 Buildings Conference by Purdue University

## Policy writing

* Wrote policies for grid interactive energy storage and fossil fuels replacement in buildings for renewable energy generation.
* Wrote policy memos and presented to stakeholders from state government and utilities.
* Wrote legislations as a graduate senator for mentoring program policies

## Grants and others

* Helped write proposals to fund research through USAID and DOE projects
* Wrote articles about Ph.D. research, [science](https://scientiamag.org/climate-change-and-residential-buildings-the-way-forward/), and personal development.
* Wrote an independent report at CEC for building envelope energy standards

# PRESENTATIONS AND FEATURES

* “Economic value of HVAC-mediated thermal storage under TOU tariffs,” presented at **IEA HPT Annex 55** Experts Meeting
* Presented ‘Building Energy Annual Portfolio’ to **Rhode Island State Energy Efficiency Council**
* Presented ‘Grid Integrated Energy Storage’ policy to Tennessee’s former governor **Phil Bredesen**
* Work on TES [featured](https://www.energy.gov/sites/default/files/2023-06/bto-peer-2023-31450-low-ornl-turnaoglu.pdf) in **BTO peer review** and publications [featured](https://www.energy.gov/eere/buildings/stor4build-publications) in the **DOE Stor4Build** consortium

# ORIGINAL CONTRIBUTIONS AND IMPACT

## Experimentally validated and Optimized Thermal Energy Storage in various climates

Simulated thermal storage system integrated with heat pump and experimentally validated it. The designed system was used for further research at ORNL and helped secure funding for new projects. Performed parametric analysis and demonstrated more than 50% demand impact and load shifting in various climates. Published research papers that have been cited 18+ times combined.

## Thermal Energy Storage for California Energy Code

Led project to include Thermal Energy Storage for 2028 code that uses a similar configuration as of my research. Managed external stakeholders and scientists at Berkeley Lab to incorporate TES into EnergyPlus.

## Technology commercialization and entrepreneurship

* Performed market analysis for “Shift Thermal” to commercialize their thermal storage and expand into a business from startup.
* Participated in ICORPS energy program and advised a startup working on semi-conductors to improve their business model by delivering concluded recommendations through market analysis and customer discovery.
* Competed in DOE Jump into STEM, developed business model and impact analysis for “Thermal Storage for Demand Response”

# AWARDS AND FEATURES

* Named **40 under 40** alumnus by University of Tennessee Knoxville
* Received 2023 **Volunteer of Distinction** [award](https://provost.utk.edu/vod/) by UTK Provost on graduation for academic and professional achievements
* Received **Linda Latham Scholarship** to attend the ACEEE Summer Studies conference 2022
* Selected in **IMPEL 2022** Innovator Cohort for "Digitalization" of building technologies through Berkeley Lab
* Won **3rd place award** at Southeastern Energy Conference Research Showcase by Georgia Institute of Technology
* **Runner up award** at Duke Energy Week in November 2020
* Selected for a prestigious **U.S. Department of Energy** **fellowship** for Ph.D. at University of Tennessee-Oak Ridge Institute
* Received Rector’s **Shield of Honor** for academic leadership through National University of Science and Technology.
* Semifinalist “**Hult Prize Business Competition by Clinton Global Initiative**” for business model in educational initiatives
* Profile featured in [Scientia](https://scientiamag.org/sara-sultans-groundbreaking-research-on-thermal-energy-storage-inspires-millions-of-pakistani-girls/) Magazine, [ORNL](https://www.ornl.gov/media/82856) Magazine, and Arizona State University[news](https://uspcase.asu.edu/2019/10/23/building-a-network-of-energy-engineers-for-pakistans-future/).

# LEADERSHIP AND VOLUNTEER WORK

## Graduate Student Senator 2018 – 2023

### University of Tennessee, Knoxville, TN

* Outreached and coordinated with speakers for invited talks to the department’s weekly seminar.
* Served on Student Advisory Council, and Sustainability council for Student Government Organization at University
* Advocated for access to research tools and got proposals approved for graduate housing and increasing stipends

## Program Manager 2019 – 2021

### NUSTIAN USA

* Created a coaching program and employed a team of 50+ members to facilitate 300+ students through the program.
* Developed program policies and guidelines, and directed plans to execute 1-1 coaching initiatives, website and educational material.

## Executive “Campus Events Board”

* Developed ideas to bring more diversity on campus and improved the turnout through the events’ marketing

# SKILLS

* **Data analysis, Modeling and Visualization**: MS Excel, MATLAB, TRNSYS, EnergyPlus
* **Project Management**: Asana, Trello, and Notion
* **Research**: Research Survey (Qualtrics), Citation Management (Mendeley, EndNote, Zotereo), Market Analysis
* **Writing**: Technical Report Writing, Creative Writing, Policy Writing, Research Writing
* **Design and Editing**: Canva, PowerPoint, Adobe Express, Wordpress, Final Cut Pro
* **Leadership**: Public speaking, Product and Business development, Innovation, Commercialization, Stakeholder engagement
* **Other Skills**: Problem solving, Critical thinking, Attention to detail, Adaptability and independent learning, Conflict management

# REFERENCES

## Colleagues and Industry Experts:

*National Labs* - Tugba Turnaoglu, Lingshi Wang, Borui Cui, Jason Hirschey, Tim Laclair

*California Energy Commission* - Payam Bozorgchami, Muhammad Saeed, Sahar Daemi

Dr. Lee Redinger, Former Vice Chancellor *University of Tennessee*

Levon Atoyan, Cofounder *Shift Thermal*

Adrian Ceaser, Senior Analyst at *NV5*

## Academic and Program Advisors:

Dr. [Kyle R. Gluesenkamp](https://www.ornl.gov/staff-profile/kyle-r-gluesenkamp), R&D Staff Scientist at *Oak Ridge National Laboratory*

Dr. [Yanfei Gao](https://tickle.utk.edu/mse/faculty/yanfei-gao/), Director Energy Science Engineering, *University of Tennessee*

## Research Sponsor:

[Sven Mumme](https://www.energy.gov/eere/buildings/person/sven-mumme)*,* Technology Manager at *U.S. Department of Energy*