

University of Nevada, Las Vegas (UNLV)

Howard R. Hughes College of Engineering

Overview of Renewable Energy Research



Howard R. Hughes College of Engineering at UNLV



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For more than a decade, UNLV researchers have been conducting a world-class effort in various aspects of renewable energy. This research program has been funded by various federal and state agencies as well as many industrial partners. Our researchers have addressed questions related to many fields including, solar and wind energies in addition to fuel cells and smart grid.

We would like to introduce you to some of our researchers. Please feel to contact us if we can help with future collaboration.

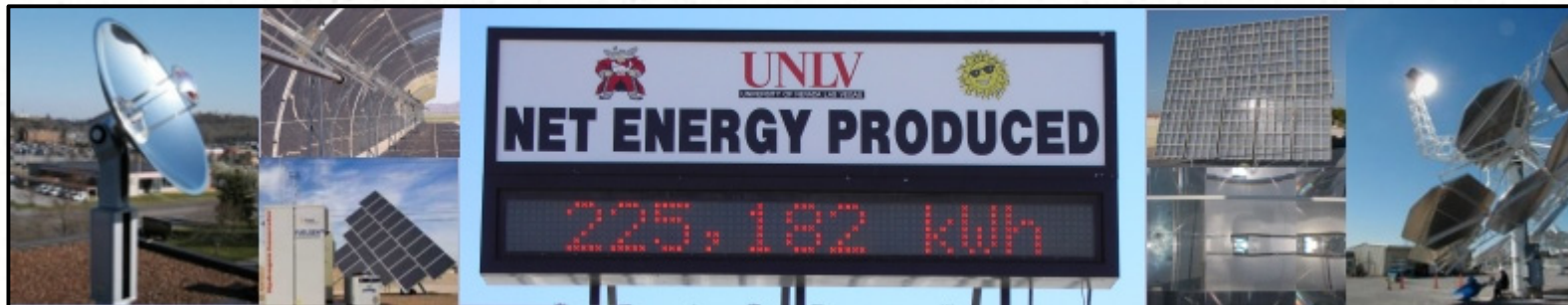
Why UNLV?

- UNLV is a leader among the state's public entities dedicated to advancing renewable energy in the region and beyond.
- UNLV's outstanding achievements in renewable energy research, its success in forging public/private partnerships, and its excellent academic programs place the university at the forefront of the field.
- UNLV is the host site of the National Clean Energy Summit for the past three years and other important international meetings, UNLV is now considered a convening center for renewable energy leaders throughout the nation and world.
- UNLV has acquired more than \$99 million in research funding in the past decade on wide-ranging subjects in the clean energy area, including solar and geothermal power; biofuels; photonics; nuclear energy, including reprocessing of nuclear waste; and hydrogen production, storage, and use.
- UNLV is located at a central location in the West that is close to many renewable energy resources including, solar, wind, and geothermal energies.



Renewable Energy Research at UNLV

- Our researchers have been involved in the evaluation of many key technologies that helped introduce them to the market.
- Renewable energy research is a collaborative effort among faculty of the:
 - Center for Energy Research
 - Center for Materials and Structures
 - Department of Electrical and Computer Engineering
 - Department of Mechanical Engineering

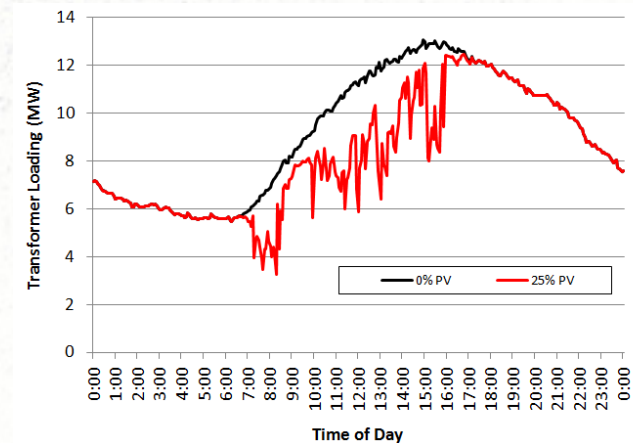
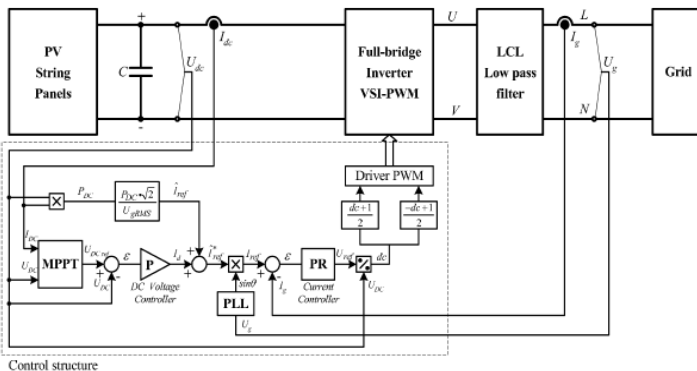
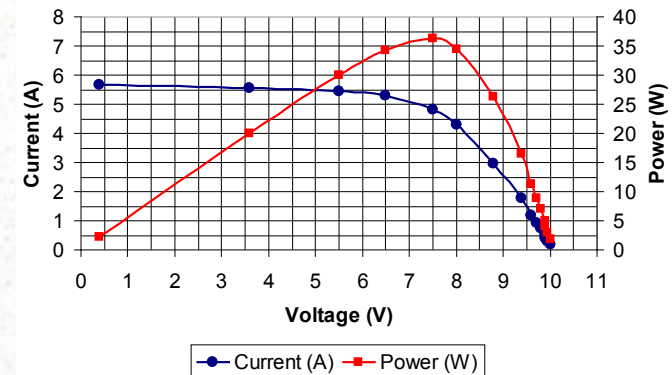


Faculty involved in Energy Research

- **Dr. Yahia Baghzouz**
*Professor of Electrical Engineering
Associate Director, UNLV Center for
Energy Research*
- **Dr. Robert Boehm, P.E.**
*Distinguished Professor of Mechanical
Engineering
Director, UNLV Center for Energy
Research*
- **Dr. Yitung Chen**
*Professor of Mechanical Engineering
Associate Director, UNLV Center for
Energy Research*
- **Dr. Samir Moujaes, P.E.**
Professor of Mechanical Engineering
- **Dr. Brendan J. O'Toole**
*Associate Professor of Mechanical
Engineering
Director, UNLV Center for Materials
and Structures*
- **Dr. Darrell Pepper**
*Professor of Mechanical Engineering
Director, Nevada Center for
Advanced Computational Methods*
- **Dr. Hui Zhao**
*Assistant Professor of Mechanical
Engineering*

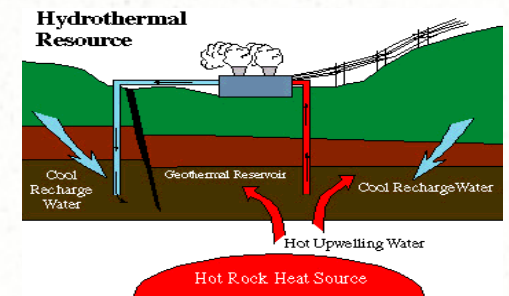
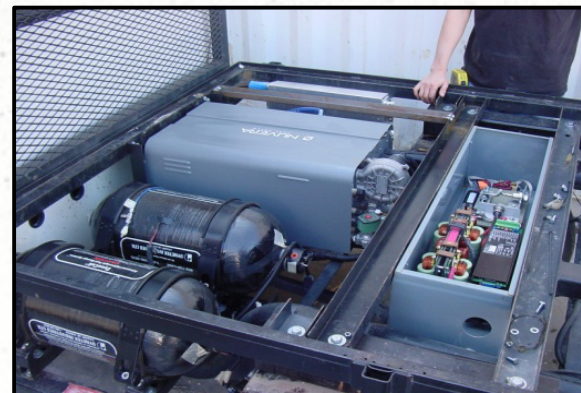
Dr. Yahia Baghzouz, Professor Associate Director, Center for Energy Research

- Electric power systems, power quality, and static power converters
- Design of grid-tied and stand-alone photovoltaic systems
- Impact of partial shading on PV array performance,
- Impact of distributed generation in electrical distribution systems
- Hybrid electric vehicles and battery charging systems
- Demand Side Management, and smart grid applications.



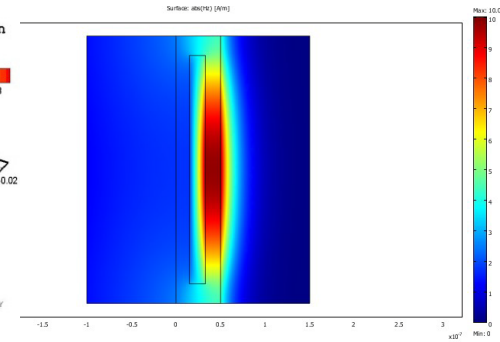
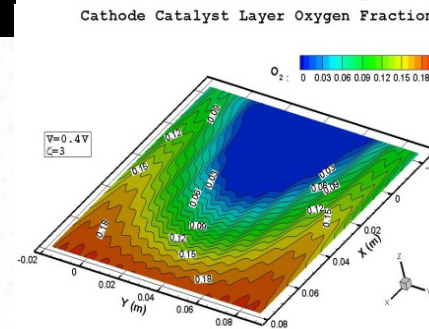
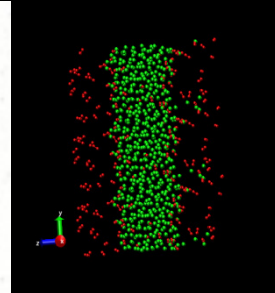
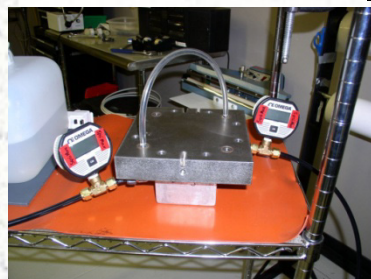
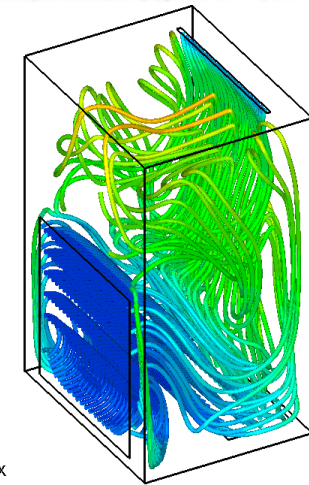
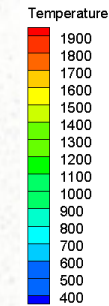
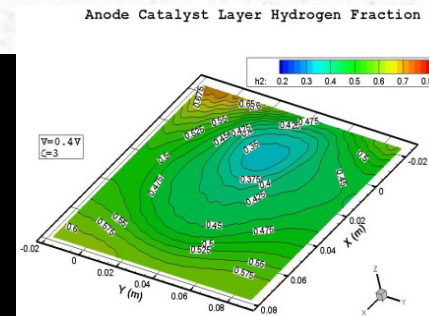
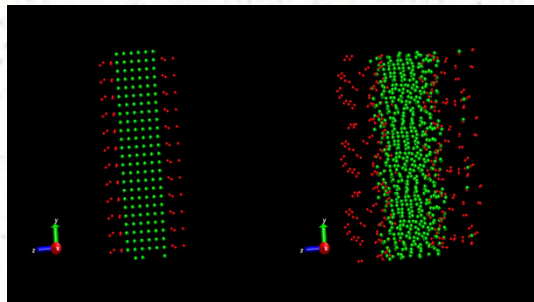
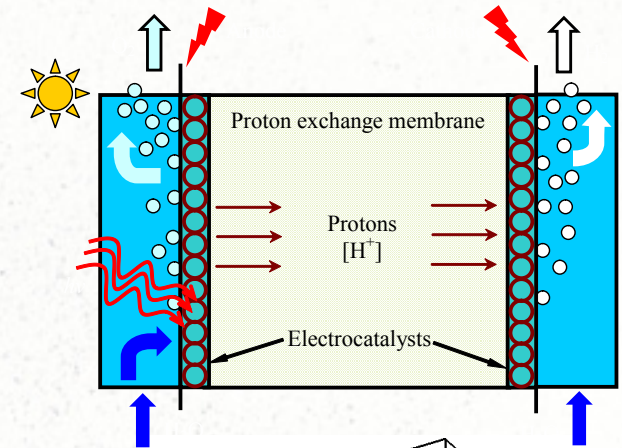
Dr. Robert Boehm, Distinguished Professor Director, Center for Energy Research

- Solar Power Generation (PV, CPV, CSP)
- Power Plant Dry Cooling
- Solar Thermal Applications: domestic hot water, process heat, cooling
- Energy Conservation and Solar Applications in Buildings
- Solar Hybrid Lighting
- Renewable Hydrogen Generation
- Vehicle Design with Fuel Cells and Alternative Fuels
- Geothermal Power Production



Dr. Yitung Chen, Professor Associate Director, Center for Energy Research

- Computational fluid dynamics
- Numerical heat and mass transfer related to thermal system design
- Renewable energy
- High temperature heat exchanger and decomposer design
- Corrosion modeling
- Fuel cells (PEMFC and SOFC)



Dr. Samir Moujaes, P.E., Professor Department of Mechanical Engineering

- Phase studies for alternative fuels derived from coal
- Flow studies for solid particle solar receivers
- Computer simulation of thermosiphon-driven solar heaters
- Two and three phase flow thermal hydraulics studies

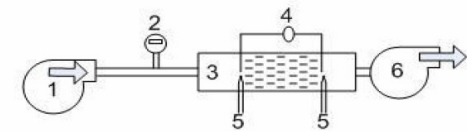


Fig. 1 Schematic diagram of experimental rig.
1. Inlet Fan. 2. Flow Meter. 3. Test Section.
4. Pressure Transducer. 5. Thermocouples.
6. Outlet Fan.

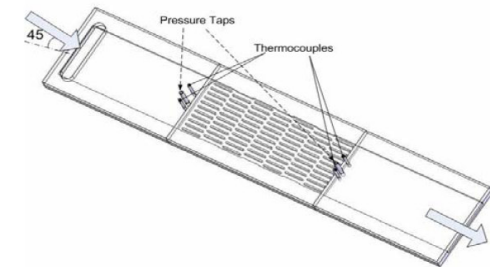


Fig. 2 SolidWorks drawing of test section

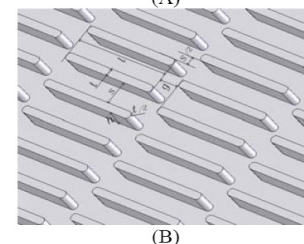
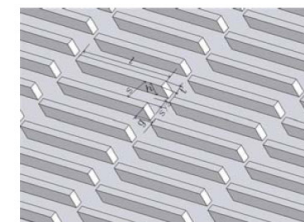


Fig. 3 Geometry of fins.
A. Square-edge-fins. B. Round-edge-fins.

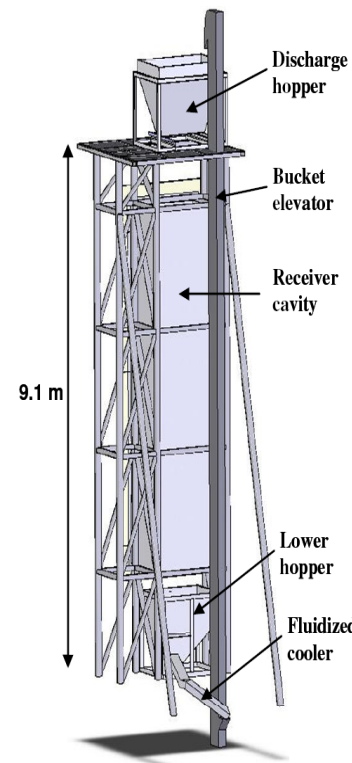
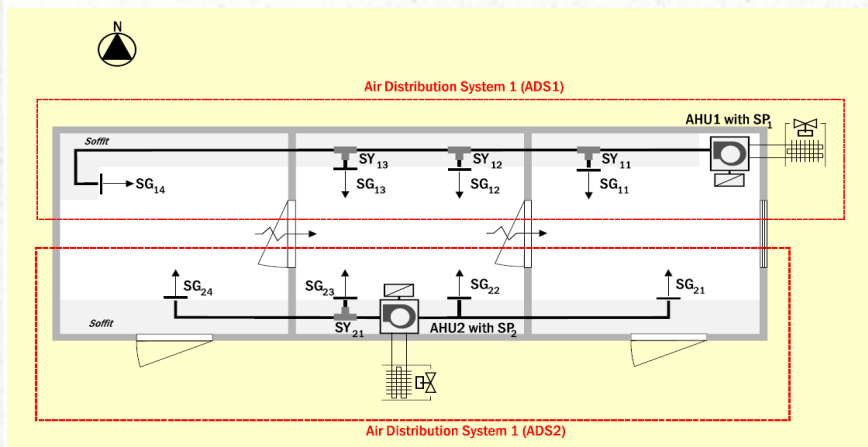
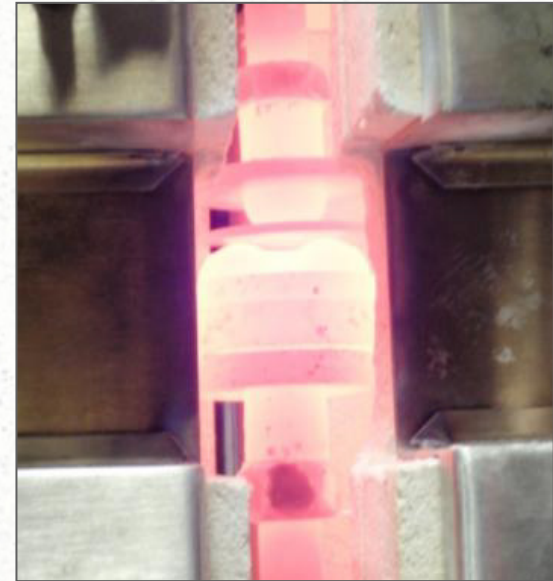


Figure 2. The SPR system layout



Dr. Brendan O'Toole, Associate Professor
Director, Center for Materials and Structures

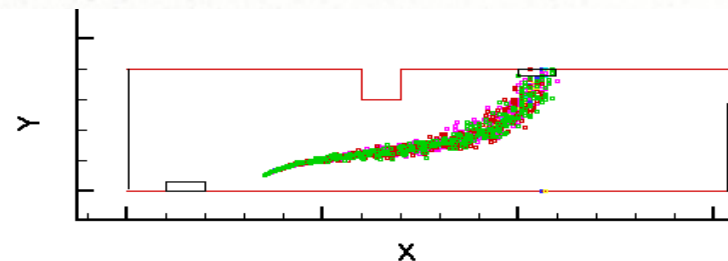
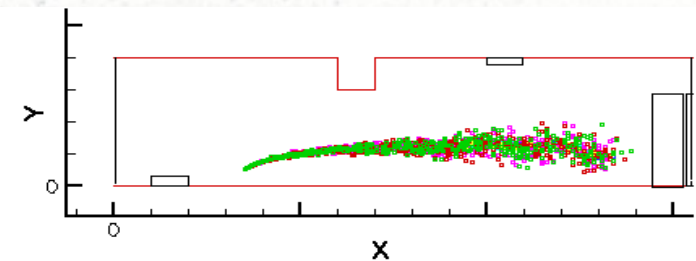
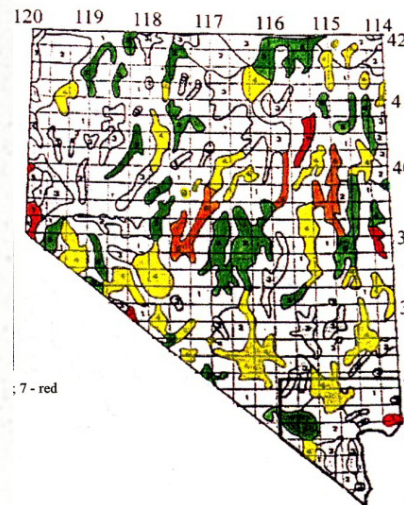
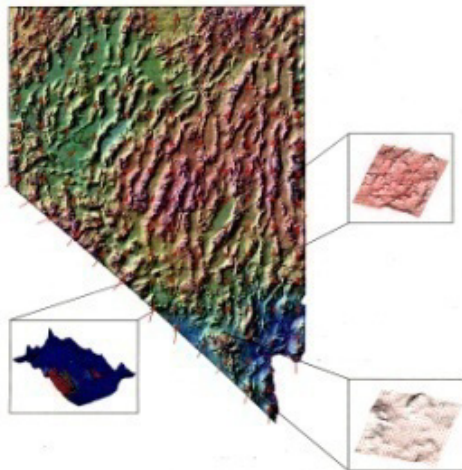
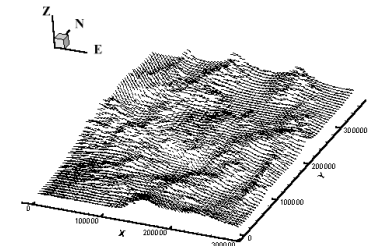
- Properties of polymer foams
- Identification of dynamic properties of materials under impact conditions
- High-temperature deformation of Alloy EP-823
- Hydrogen-induced embrittlement of materials
- Delayed hydride cracking of nuclear fuel rods
- Photoelastic stress analysis of crack tip stress concentration factors
- Buckling analysis of grid stiffened panels
- Failure Analysis of curved composite beams



Dr. Darrell Pepper, Professor

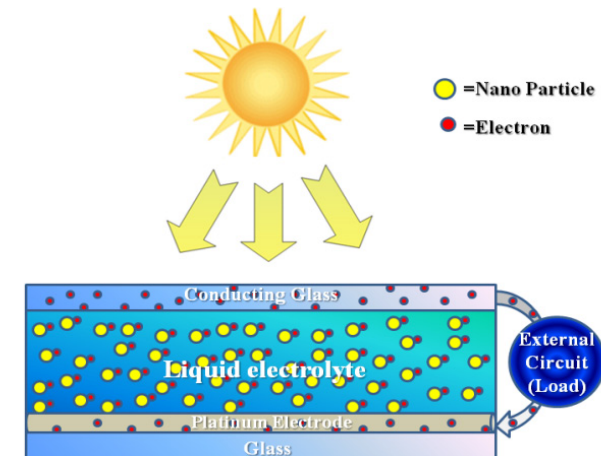
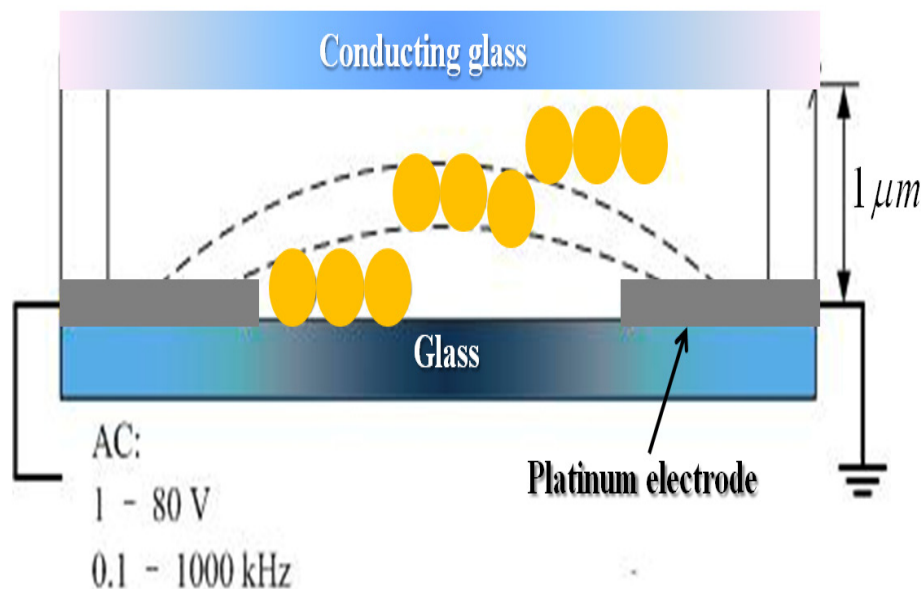
Director, Nevada Center for Advanced Computational Methods

- Computational Fluid Dynamics, heat transfer and species transport
- Advanced computational techniques
- Wind energy assessment
- Groundwater modeling and transport through porous media
- Supersonic aerodynamics
- Design of long-flight UAV utilizing thin-film solar panels
- KIVA combustion code modeling (with LANL)



Dr. Hui Zhao, Assistant Professor
Department of Mechanical Engineering

- Energy: Nano-crystal based solar cells
- Micro/nanofluidics energy conversion
- Micro/nanofluidic phenomena
- “Lab on a chip” technology





Renewable Energy Research

CV and Publications



Dr. Yahia Baghzouz

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Associate Director , UNLV Center for Energy Research*

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Specialties

- *Power system analysis*
- *Operation, protection, and control*
- *Power quality and volt/vat controls*
- *Impact of distributed generation and integration on the power grid*
- *Static power converters*
- *Demand side management and smart grid applications*
- *Hybrid electric vehicles*

Dr. Yahia Baghzouz

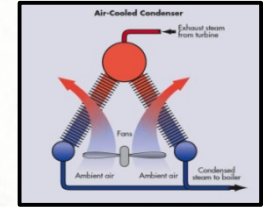


Recent Publications

- “Evaluation of Harmonic Current Reduction for the Purpose of Energy Savings – A Case Study”, *IEEE/ICHQP VIII*, 2010 (with J. Sanguinetti)
- “Battery Storage System Sizing in Distribution Feeders with Distributed Photovoltaic Systems,” *IEEE PowerTech*, 2009 (with R. Morrison, P. Ribeiro, C. Duque,)
- “Charge/Discharge Control of Battery Energy Storage System for Peak Shaving,” *EESAT*, 2009.
- “Probabilistic Aspects of Time-Varying Harmonics, *Time-Varying Waveform Distortions in Power Systems*,” John Wiley, 2009, Part I, Chap. 1, pp. 3-19.
- “Time-Varying and Probabilistic Considerations: Setting Limits, *Time-Varying Waveform Distortions in Power Systems*,” John Wiley, 2009, Part IV, Chap. 10, pp. 131-137 (with T. Ortmeyer, W. Xu).
- Fundamental-Frequency Components in Single-Phase Motors with SCR Voltage Controllers, *IEEE/ICHQP VIII*, 2008.
- “On the Impact of Partial Shading on PV Output Power,” *Int. Conference on Renewable Energy*, 2008 (with D. Sera)
- “On the optimal efficiency of split-phase induction motors under light load”, *IEEE/PES Annual Meeting*, Pittsburgh, PA, July 15, 2008. (with F. Bouzidi)
- “Power loss in single-phase induction motors with SCR voltage controllers”, *IEEE/SPEEDAM*,, 2008. (with F. Bouzidi)
- “Evaluation of a Fuel Cell for Powering the Electrical Load of ICE Vehicles”, *Int. Conf. on Clean Electrical Power*, 2007, (with R. Hurt, and R.F. Boehm,)
- “Hydrogen APU System Analysis & Bootstrap Battery Charging Method”, *NHA Annual Meeting*, 2007 (with YM. Popek, R.F. Boehm, R. Hurt)

Dr. Robert F. Boehm

*Distinguished Professor, Department of Mechanical Engineering
Director , UNLV Center for Energy Research*



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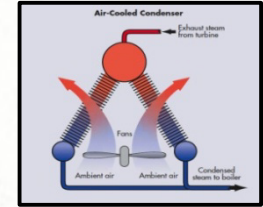
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Website: <http://www.me.unlv.edu/GeneralInfo/faculty/boehm.htm>

Specialties

- *Solar power*
- *Thermal system analysis*
- *Storage concepts*
- *System simulation*
- *System performance evaluations*
- *Dry cooling*

Dr. Robert J. Boehm

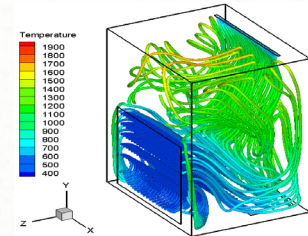


Recent Publications

- “An Estimation of Performance Limits and Improvement of Dry Cooling on Trough Solar Thermal Plants,” APPLIED ENERGY, 88, 2011, pp. 216-225 (with H. Deng)
- “Comparison of Two-Tank Indirect Thermal Storage Designs for Solar Parabolic Trough Power Plants,” PROCEEDINGS OF THE ASME CONFERENCE OF ENERGY SUSTAINABILITY, San Francisco, CA 2009 (with J. Kopp)
- “Wet or Dry Cooling,” Paper ISEC2006-99082, 2006 International Solar Energy Conference (with I. Kahlil and A. Sahm)
- “Simulation and Optimization of a Concentrated Photovoltaic System,” JOURNAL OF SOLAR ENERGY ENGINEERING, May 2006, pp. 139-145 (with I. Mahderekal and C. Halford)
- “Incorporating Thermal Storage into a SEGS Plant Using TRNSYS – A Status Report,” ISEC SOLAR 2004 CONFERENCE, Paper 65027 (with J. Braithwaite)
- “Modeling of a Solid/Liquid Thermal Storage System,” PROCEEDINGS OF THE 2003 NATIONAL HEAT TRANSFER CONFERENCE (with J. Mulvey)
- “Direct Contact Heat Transfer,” Chapter 19 in HANDBOOK OF HEAT TRANSFER (A. Bejan and A. Kraus, Eds.), John Wiley and Sons, 2003
- “The UNLV Solar Dish – Stirling Project,” PROCEEDINGS FOR SOLAR FORUM, ASES, June 2002 (with C. Halford, R. Hurt, Y. Baghzouz, S. Moujaes, and D. Pepper)
- DEVELOPMENTS IN THE DESIGN OF THERMAL SYSTEMS, (editor and author of one chapter) Cambridge University Press, 1997

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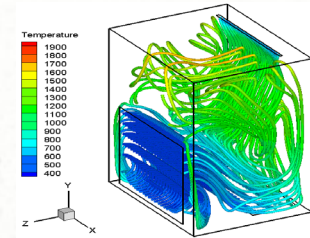
Specialties

- *Computational fluid dynamics*
- *Heat and mass transfer*
- *Nuclear and renewable energy*
- *Thermal systems*
- *Hydrogen production and utilization*
- *Corrosion modeling*
- *Fuel cells*

Dr. Yitung Chen

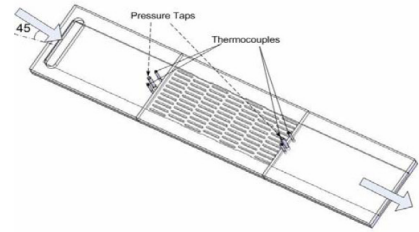
Recent Publications

- “Review of Study on Solid Particle Solar Receivers,” *Renewable and Sustainable Energy Reviews*, 14 (2010), pp. 265-276 (with T. Tan).
- “Wind Effect on the Performance of Solid Particle Solar Receivers with and without the Protection of an Aerowindow,” *Solar Energy*, 83 (2009), pp. 1815-1827 (with T. Tan, Z. Chen, N. Siegel, and G. Kolb).
- “Simulations of Metal Oxidation in LBE at a Mesoscopic Level,” *Journal of Engineering for Gas Turbines & Power*, May 2009, Vol. 131, 032903/pp. 1-11 (with T. Tan).
- “CFD Modeling and Experimental Validation of Sulfur Trioxide Decomposition in Bayonet Type Heat Exchanger and Chemical Decomposer for Different Packed Bed Designs,” *International Journal of Hydrogen Energy*, 34 (2009), pp. 2543-2557 (with V. Nagarajan, V. Ponyavin, M. Vernon, P. Pickard, and A. Hechanova).
- “Scale removal cellular automaton oxidation models of metals in lead bismuth eutectic,” *Journal of Electroanalytical Chemistry*, 626 (2009), pp. 89-97 (with T. Tan).
- “A Diffusion Controlling Oxidation Model with Scale Removal in Oxygen Containing Liquid Flow,” *Computational Material Science*, 44, (2008), pp. 750-759 (with T. Tan and H. Chen).
- “Numerical of High Temperature Shell and Tube Heat Exchanger and Chemical Decomposer for Hydrogen Production,” *International Journal of Hydrogen Energy*, 33, (2008), pp. 5460-5468 (with G. Kuchi, V. ponyavin, S. Sherman, and A. Hechanova).
- “Oxidation Companioned by Scale Removal: Initial and Asymptotical Kinetics,” *Journal of Nuclear Science and Technology*, Vol. 45, No. 7, pp. 1-6, 2008 (with T. Tan and H. Chen).
- “A Lattice Boltzmann Modeling of Oxygen Transport and Corrosion Behavior in the Nature Convection Lead-alloy Flow,” *Nuclear Engineering and Design* 237 (2007) pp. 1987-1998 (with H. Chen and J. Zhang).



Dr. Samir Moujaes, P.E.

Professor, Department of Mechanical Engineering



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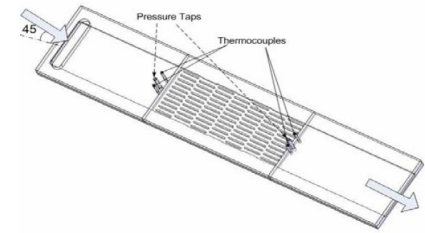
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Specialties

- *HVAC*
- *Thermal engineering*

Dr. Samir Moujaes, P.E.

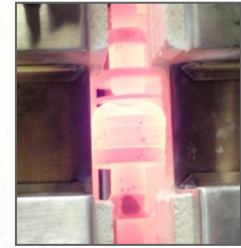


Recent Publications

- "Experimental and Simulation Study on Wind Affecting particle Flow in a Solar Receiver", *Solar Energy* 2010, v.84, p. 263-270 (with K. Kim and G. Kolb).
- "A Study of Solid particle Flow Characterization in a Solar Receiver", *Solar Energy*, 2009, v 83, n 10, p 1784-1793 (with K. Kim, N. Siegel, G. Kolb, and V. Rangaswamy).
- "Two Phase Upflow in Rectangular Channels", *International Journal of Multiphase Flow* Vol. 11 No. 4 pp. 503-513, 1985 (with R. S. Dougall)
- "Comparative Predictions of a Computer Simulation to Experimental Data of a Thermosiphon Driven Domestic Solar Heater", *International Journal of Energy Environment and Economics*, Vol 2 No. 4, p.289-304, 1994 (with C. Willems).
- "Experimental Measurements of Local Axial Gas Velocity and Void Fraction in Simulated PWR Steam Generator Rod Bundles", *The Canadian Journal of Chemical Engineering*, Vol. 68, April, 1990, pp. 211-219 (with R. S. Dougall).
- "Testing of a Spherical Dual Tipped Optical Fiber Probe for Local Measurements of Void Fraction and Gas Velocity in Two Phase Flows", *The Canadian Journal of Chemical Engineering*, Vol.68, June 1990, pp. 504-510 (1990).
- "Measurement of Slurry Concentration and Flow Rates in Shell and Tube Slurry Heat Exchangers", *The Canadian Journal of Chemical Engineering*, Vol. 62, pp.62-67, 1984.
- "Experimental Investigation of Concurrent Two Phase Flow in a Rectangular Channel", *The Canadian Journal of Chemical Engineering*, Vol. 65, pp. 705-715(1987) (with R. S. Dougall).
- "Analysis of Falling Particles in Solid Particle Solar Receiver", *AIChE- Annual Meeting*, November 4-9 (2007), Salt Lake City, Utah, USA (with B. R. Vijayarangan).
- "Solid Particle Receiver Flow Characterization Studies", *ASME-Energy Sustainability International Conference*, June 24-27(2007), Long Beach, California, USA (with N. Siegal, G. Kolb, K. Kibum, and B. R. Vigayarangan).

Dr. Brendan O'Toole

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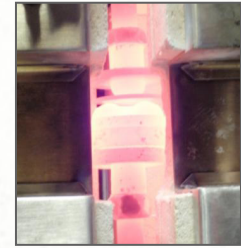
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Specialties

- *Composite*
- *Mechanics*
- *Vehicle design*



Dr. Brendan O'Toole

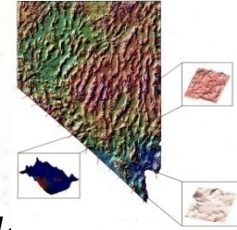
Recent Publications

- “Simulation of Blast Loaded Foam and Honeycomb Sandwich Structures”, Proceedings of the 11th International Symposium on Plasticity, Kauai, HI, January 2005 (with M. Mullin and D.Lee).
- “Cell Morphology, Density, and Mechanical Property Relations in Rigid Polyurethane Foam”, Proceedings of the Polyurethanes Conference 2004, Alliance for the Polyurethanes Industry, Las Vegas, NV, October 18-20, 2004 (with M. Nelson and D. Jackovich)
- “Energy Absorbing Sandwich Structures Under Blast Loading”, Proceedings of the 8th International LS-DYNA user’s Conference, Detroit, MI, May 2004 (with D. Lee).
- “Simulation of Energy Absorbing Materials In Blast Loaded Structures”, Proceedings of the 8th International LS-DYNA user’s Conference, Detroit, MI, May 2004 (with M. Mullin).
- “Identification of the Dynamic Tensile Properties of Metals under Moderate Strain Rates”, Proceedings of the 16th Engineering Mechanics Conference (EM 2003), July 16-18, Seattle WA (with K. Zobotkin and M. Trabia).
- “Identification of Dynamic Properties of Metals under Moderate Strain Rates and Elevated Temperatures”, Abstract, Proceedings of the 2003 ASME Mechanics and Materials Conference, Scottsdale, AZ, June 17-20, 2003 (with S. Dusi, H. Wang, and M. Trabia).
- “Effect of Stress Concentration on Cracking Behavior of Cladding Materials”, Proceedings of the American Nuclear Society Accelerator Applications in a Nuclear Renaissance, San Diego CA, June 1-5, 2003 (with S. Pothana, H. Aquino, and A. Roy)
- “Environment-Induced Degradation of Spallation Target Materials”, Proceedings of the American Nuclear Society Accelerator Applications in a Nuclear Renaissance, San Diego CA, June 1-5, 2003 (with A. Roy, R. Prabhakaran, M. Hossain, and S. Sama).
- “Microbial treatment increases colonization and decreases mechanical strength of wood and metal samples”, Abstract, Proceedings of the 103rd General Meeting of the American Society for Microbiology, May 18 -22, 2003 (with C. Pantle, T. Else, and P. Amy).

Dr. Darrell Pepper

Professor, Department of Mechanical Engineering

Director, Nevada Center for Advanced Computational Methods



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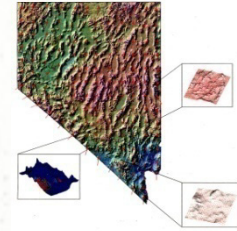
Fax: (702) 895-0498

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Specialties

- *Computational Fluid Dynamics, heat transfer and species transport*
- *Advanced computational techniques*
- *Wind energy assessment*
- *Groundwater modeling and transport through porous media*
- *Supersonic aerodynamics*
- *Design of long-flight UAV utilizing thin-film solar panels*
- *KIVA combustion code modeling (with LANL)*

Dr. Darrell Pepper

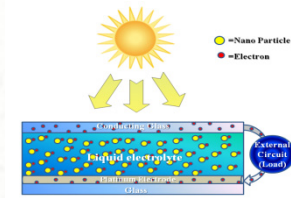


Recent Publications

- Pepper, D. W., A. Kassab, and E. Divo (to appear 2011): Finite Element, Boundary Element, and Meshless Methods, ASME Press, NY, NY.
- Pepper, D. W. (to appear 2011): *Environmental Fluid Mechanics*, McGraw-Hill Yearbook
- Pepper, D. W. (2010): *Meshless Methods*, Scholarpedia
- Pepper, D. W. and D. B. Carrington (2009): Modeling Indoor Air Pollution, Imperial College Press, London, UK, 346 p.
- Pepper, D. W. and J. C. Heinrich (2006): The Finite Element Method: Basic Concepts and Applications, Taylor and Francis, New York, NY, 2nd Ed., 312 p.
- Pepper, D. W. (2006), "Chapter 7: Meshless Methods," Handbook of Numerical Heat Transfer, 2nd Ed., W. J. Minkowycz et al (Eds.), John Wiley and Sons.
- Pepper, D. W. and J. M. Lombardo (2006), "Chapter 27: High Performance Computing for Heat Transfer," Handbook of Numerical Heat Transfer, 2nd Ed., W. J. Minkowycz et al (Eds.), John Wiley and Sons.
- Pepper, D. W. and X. Wang (2009), "An h-adaptive Finite Element Technique for Constructing 3-D Wind Fields," J. Appl. Meteor. & Climatology.
- Wang, X. and D. W. Pepper (2009), "An Adaptive Numerical Model for Contaminant Dispersion in Air," Int. J. Num. Meth. in Fluids.
- Wang, X. and D. W. Pepper, D. W. (2009), "An hp-Adaptive Procedure for Modeling Indoor Contaminant Dispersion," Comput. Modeling in. Engr. and Sci., Tech Science Press.
- Pepper, D. W. and X. Wang (2009), "An hp-adaptive Finite Element Model for Heat Transfer within Partitioned Enclosures," Int. J. Num. Meth. Fluid Flow and Heat Transfer.

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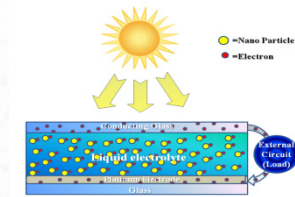
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Specialties

- Micro-fluidics
- Nano-fluidics
- 'Lab-on-chip' technology
- Nanotechnology
- Micro-energy conversion
- Nano-energy conversion

Dr. Hui Zhao



Recent Publications

- “Electro-osmotic flow over a charged superhydrophobic surface,” *Physical Review E*, 2010, 81, 066314.
- “On the Influence of Ion Excluded Volume (Steric) Effects on the Double Layer Polarization of a Non-Conducting Nano Particle in an AC Field,” *Journal of Physical Chemistry C*, 2010, 18, 8389-8397.
- “On the Effect of Hydrodynamic Slip on the Polarization of a Non-conducting Spherical Particle in an AC Field,” *Physics of Fluids*, 2010, 7, 072004.
- “The Polarization of Nanorods Submerged in an Electrolyte Solution and Subjected to an AC Electric Field,” *Langmuir*, 2010, 26, 5412-5420 (with H. Bau).
- “The Polarization of a Non-conducting Nano Spherical Particle in the presence of a thick Electric double layer,” *Journal of Colloid and Interface Science*, 2009, 333, 663-671 (with H. Bau).
- “The Effect of Double Layer Polarization on the Forces that Act on a Nanosize Cylindrical Particle in an AC Electric Field,” *Langmuir*, 2008, 24, 6050-6059 (with H. Bau).
- “The Effect of Secondary Flows on Taylor-Aris Dispersion,” *Analytical Chemistry*, 2007, 79, 7792-7798 (with H. Bau).
- “A Microfluidic Chaotic Stirrer Utilizing Induced-Charge Electro-osmosis,” *Physical Review E*, 2007, 75, 066217 (with H. Bau). (selected for the July 9, 2007 issue of *Virtual Journal of Nanoscale Science & Technology*).
- “On the Effect of Induced Electro-Osmosis on a Cylindrical Particle Next to a Surface,” *Langmuir*, 2007, 23, 4053-4063 (with H. Bau).
- ‘Suppression of Rayleigh-Bénard Convection with Proportional-Derivative (PD) Controller,’ *Physics of Fluids*, 2007, 19(1): Art. No. 017102 (with M. Remillieux and H. Bau).

Additional Resources

- Center for Energy Research: <http://www.cer.unlv.edu>
- Center for Materials and Structures:
http://www.egr.unlv.edu/~bj/CMS/CMS_Home.htm
- Nevada Center for Advanced Computational Methods:
<http://www.ncacm.unlv.edu/HTML/research/gwt/index.html>
- Solar Energy Initiative at UNLV: <http://research.unlv.edu/solar/>

