

Pursue a
Ph.D. in Sciences & Engineering
Focused research opportunities in renewable energy



Renewable Energy Research Across Disciplines...

The Conn Center collaborates across academic departments for true multi-disciplinary research training. The center strives for excellence as we accelerate lab scale renewable energy research toward commercialization. Join our open research labs as you undertake targeted PhD degree studies in Chemical, Mechanical, Electrical & Computer, and Civil & Environmental Engineering as well as Chemistry, Physics, and Biology. Our research theme leaders work with you and your faculty mentor to define dissertation research projects across next generation materials and energy frontiers and technologies.

The Conn Center works with students and faculty mentors to ensure sustained student success, particularly in career development. Whether your interest is in industry research & development and applied materials, lab research, or faculty placement, the Conn Center for Renewable Energy Research will provide a platform to achieve successful transition.

Advanced Energy Materials R&D

Discovery and development of new materials and their scalable manufacturing methods are central to making transformational advances in meeting our global energy challenges. Accelerating the pace of discovery and deployment of advanced material systems within the context of renewable energy and energy efficiency technologies is of crucial importance. Conn Center utilizes materials informatics, first principles computations, and combinatorial materials synthesis approaches to accelerate the pace of discovery. Even with known materials systems,

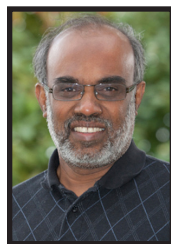


there is a greater immediate need to develop new scalable processes for growing large single crystals and large scale manufacturing of nanoscale materials in a useful format for energy devices and technologies.

Mahendra Sunkara, PhD
Theme Leader, Center Director

Energy Storage & Efficiency

We investigate various energy storage technologies including Li-ion batteries, Li-S batteries, and supercapacitors for storage at various energy and power scales as well as the use of graphene and other multilayer assemblies of 2D materials as effective electrode materials. Energy efficiency concepts include waste heat recovery from process industries (e.g., power and chemical plants). If recovered, this source can significantly reduce overall energy demand. Such technology



can also be utilized for recovering heat from automobile exhaust heat. Current efforts focus on diamond crystal doping toward thermionic emission applications as well as solar-thermionic hybrid power generation.

Gamini Sumanasekera, PhD
Theme Leader

Energy Materials Science

This research focuses on understanding of structure-property relationships at nano- or atomic scale and enables the Conn Center's energy materials development effort. We utilize resources of the Materials Characterization Facility, a well-equipped laboratory that houses advanced equipment for comprehensive structural, chemical and spectroscopic analysis of materials. Significant instrumentation includes a FEI FEG Tecnai F20 TEM/STEM with a sub-2.0 Å imaging resolution and various analytical capabilities (Z-contrast, EDS, EELS, etc.), a Discovery D8 Bruker high-resolution XRD system, as well as a VG Scientific MultiLab 3000 UHV surface science system with techniques such as XPS, Auger or UPS. Optical spectroscopy and thermal analysis methods are also available.



Jacek Jasinski, PhD
Theme Leader

Biofuels & Biomass

Our R&D focus is to develop economically viable and sustainable technologies, processes, and integrated solutions for cost-competitive production of bio-based fuels, chemicals, and other value-added products through the conversion of non-food, lignocellulosic biomass. Some example current projects are: development of C5-based biorefinery, chemical synthesis of C5 sugars to high energy density biofuels, value added co-products from residual biomass, torrefaction of wood and non-wood biomass and conversion to lignin to chemicals.



Jagannadh Satyavolu, PhD
Theme Leader

It's Happening Here

- ▶ **Interdisciplinary course offerings in materials & energy**
- ▶ **Mentoring opportunities for high school & undergraduate students**
- ▶ **Participate in solar flight competition teams**
- ▶ **Contribute to Renewable Energy & Energy Efficiency Workshop**
- ▶ **Interact with renowned & distinguished scientist visitors**

Solar Manufacturing R&D

This lab researches new materials, processes and devices to drastically reduce the costs of solar energy production via traditional printing techniques and earth abundant materials. The facility includes a number of solution phase deposition techniques for depositing nanomaterial inks supporting scalable device manufacture from lab to industry scales and features a fully configurable roll-to-roll platform with over twenty process modules. The research extends to



flexible devices offering lighter weight, lower costs and alternative device geometries and includes other renewable energy devices that rely on thin films.

Thad Druffel, PhD, PE
Theme Leader

Ultrafast Spectroscopy

The power conversion efficiency of solar cells is determined by photo-induced dynamics. Ultrafast laser spectroscopy provides a powerful tool to quantitatively measure and elucidate charge and energy transfer processes. The ultrafast transient absorption system at the Conn Center consists of laser sources that cover a broad spectral range and multiple detection systems. It is capable of monitoring sub-picosecond photo-induced processes in all varieties of



materials and providing extremely valuable information that can be used to guide design and development of novel solar cells.

Jinjun Liu, PhD
Theme Leader

Solar Fuels

As one of the most abundant and widespread energy resources available, sunlight is very attractive as a renewable energy source that could be the pillar of a sustainable energy future. To utilize energy from the sun at night, a cost-effective storage mechanism is needed. An ideal solution would be to store solar energy in the form of chemical bonds – to convert sunlight into energy-dense fuels. By pursuing artificial photosynthesis, the combination of light absorbing



semiconductors and highly active catalysts in an inorganic photoelectrolysis system, cost-effective fuel production at higher efficiency is possible.

Joshua Spurgeon, PhD
Theme Leader

Power Electronics

This theme focuses on development of new materials, materials processes, and power electronic devices using wide bandgap (WBG) semiconductors such as gallium nitride, silicon carbide, or semiconducting oxides. Research is conducted on application of these technologies in power circuits and systems to increase energy efficiency, integrate renewable energy sources onto electrical networks, and integrate energy storage onto electrical grids. Activities in the power electronics research area include WBG materials



characterization, WBG materials synthesis, device fabrication process development, physics based device design, and performance and reliability measurement.

Robert Hickman, PhD
Theme Leader



Living in Louisville

Situated on the banks of the Ohio River, America's 17th largest city boasts a cost of living that is substantially lower than the national average, with a broad range of affordable housing options from high-rise apartments and historic Victorian homes to suburban communities and rural farms.

Entertainment and recreational options include the city's highly regarded symphony, ballet and Actors Theater of Louisville, the Speed Art Museum, University of Louisville collegiate sports, The Louisville Bats minor-league baseball team and one of the nation's finest systems of urban parks, designed by Frederick Law Olmsted, the father of American landscape architecture. Louisville also plays host to a wide variety of regional celebrations, including the Kentucky Derby Festival.



A number of M.E. graduate students are actively engaged in energy research at the Conn Center. In addition to the mentorship provided by their M.E. Department faculty advisors, these students benefit from the facilities and hands-on technical expertise of this world-class research center.

Kevin Murphy, PhD
Department Chair, Mechanical Engineering
J.B. Speed School of Engineering



**CONN CENTER FOR RENEWABLE
ENERGY RESEARCH**

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Contact us today!

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