Wisconsin Energy Institute
UNIVERSITY OF WISCONSIN–MADISON

FORWARD IN ENERGY

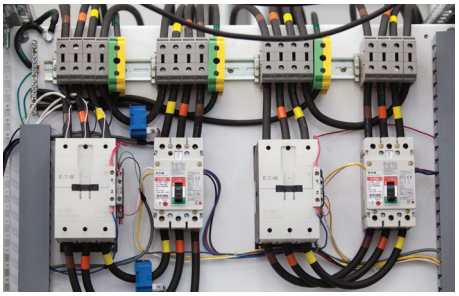
Who we are

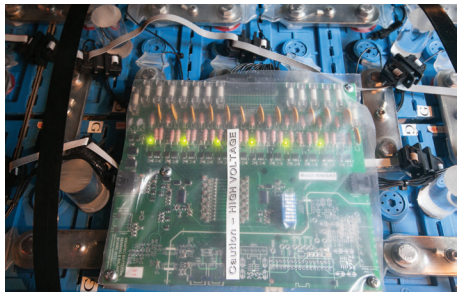
From biofuels to batteries, the Wisconsin Energy Institute is driven by UW-Madison's legacy of solving society's most pressing challenges. Our teams of scientists, engineers and scholars work across traditional research boundaries to make transformative energy discoveries in collaboration with industry leaders. As a nationally recognized leader in developing real-world energy innovations, our discoveries have the potential to transform Wisconsin's economy and the health and wellbeing of its citizens. Positioned to harness the energy-related research, teaching, and industry expertise on the UW-Madison campus, WEI provides a public forum in which to learn about and discuss energy challenges, educate future energy leaders, and moves new technology toward commercialization.

Why energy?

Our reliance on fossil fuel-derived energy is causing a rise in world temperatures that is taking a toll on human health, the environment, and local and global economies. Fortunately, transitioning our energy systems to "clean" or low-carbon energy sources is both feasible, and full of opportunities for innovation. In pursuing a new suite of clean energy technologies, we create a dynamic marketplace and a more robust economy, offer new competitive advantages and products for a number of Wisconsin industries, protect the environment and its many benefits, and build healthier, more resilient communities.

MICROGRID RESEARCH IN WISCONSIN





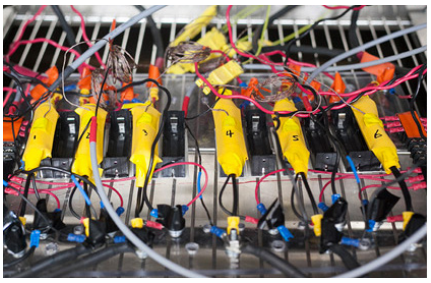
Microgrids provide a powerful solution for enabling the transition of the electric grid to a more distributed architecture and providing greater resilience of electricity service to customers. Microgrids are small, self-contained electric-power grids, including both sources and loads. Microgrids have the capability to connect and disconnect seamlessly from the traditional grid. They incorporate all of the components and functions of traditional electric grid infrastructure, but with sizes and ratings that are easily scalable to hospitals, military bases, office buildings, universities, neighborhoods, or communities.

Wisconsin is an international leader in microgrid research & development. UW–Madison researchers have played a major role during the past 15 years in defining the microgrid and developing its features. In WEI's new state-of-the-art Advanced Systems Test Laboratory, WEI researchers are dedicated to pursuing microgrid and grid integration technology, including a wide variety of renewable and conventional power sources. We are working closely with many industry partners to help mature and commercialize the technology.

At UW–Madison, we have a unique combination of academic and industrial expertise to lead the way in building stronger, more efficient distributed energy systems built on microgrid concepts.

ADVANCED SYSTEMS TEST LAB

In 2014, WEI began a rewarding partnership with Milwaukee-based company Johnson Controls to advance research, development, and commercialization of energy storage technologies. The Fortune 500 company's investment at UW–Madison funds the Johnson Controls Energy Storage Research Lab at WEI where energy experts test, evaluate, and optimize how battery systems perform and interact with a vehicle's powertrain and electrical architecture.

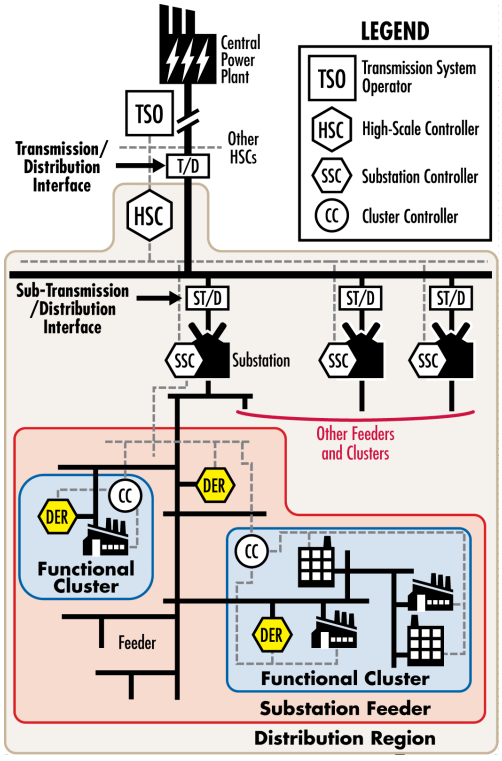


Exploring how to manage, track and enhance energy storage systems to ensure better performance over their entire life cycle, WEI researchers examine how batteries behave while drawing or charging with constant currents.
WEI engineers also observe how vehicle batteries react to drawing constantly changing currents in simulated driving experiments.

In concert with these advancements, WEI chemists are perfecting the electrochemical reactions of rechargeable lithium ion batteries. Developing imaging techniques that could eventually lead to a tripling the amount of energy these batteries can hold, discoveries in this area pave the way for improvements in energy storage of everything from portable electronics to microgrids.

DYNAMIC DISTRIBUTION SYSTEMS

One way to facilitate the transition from electric grid to a more distributed system is to introduce a new power grid architecture specifically designed to integrate large numbers of distributed energy sources. The Wisconsin Energy Institute is currently developing a Dynamic Distribution System (DDS) architecture consisting of many different types of small power sources (e.g., rooftop solar arrays) and energy storage units (e.g., batteries) that would reorganize today's electric power grid and make it capable of absorbing much higher penetration levels (e.g., >50% of DERs).



This DDS architecture dramatically changes the way the electric grid is structured by moving many of the grid control functions from high-voltage transmission levels into the distribution system, where they can remain closer to electricity users and provide greater grid stability and resilience. Moving from "centralized" control to "distributed" control also enables development of a local electricity market in which customers who install DERs can sell and receive payments for the electricity they produce.

This technology creates a unique opportunity to design a new system from the bottom-up, starting with homes, businesses, campuses, and communities, to best integrate DERs and consider how they connect to what will remain of current energy infrastructures. Locating energy sources near power users also has the added advantage of reducing losses associated with sending electricity over long power transmission lines and improving overall grid efficiency.

This new system connects central and local electricity generation to a marketplace that enables energy to be bought and sold at the local distribution level. DDS thus provides a promising framework for DERs to deliver the same services at a better price, with decreased power losses, reduced emissions, and better reliability. The presence of this local marketplace is critical to making DERs appealing to developers and investors who can aggressively expand the number of installed DER units. This market also provides paths for utilities, which can compete for opportunities to develop their own DER installations, to generate revenue.

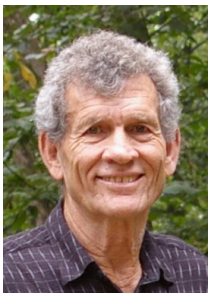
OUR TEAM

Tom Jahns
Grainger Professor of Power Electronics and Electrical MachinesProfessor of Electrical and Computer Engineering
Dr. Jahns' research interests span the technical fields of distributed energy systems, electrical machines, power electronics, and adjustable-speed drives. He spent 15 years working at GE's Corporate R&D laboratories before joining the UW–Madison faculty 17 years ago. His current microgrid research focuses on integrating distributed renewable energy sources and energy storage into robust microgrids. Dr. Jahns is the co-director of WEMPEC, a large industry-university consortium with more than 85 sponsors and a member of the National Academy of Engineering.

Mark Anderson
Professor of Engineering Physics
Dr. Mark Anderson studies the physics, thermal hydraulic performance and material corrosion issues of several diffrent fluids (salts, liquid metals, SCW, S-Co2). He is also currently the U.S. representative to the International Atomic Energy Agency (IAEA) for the coordinated research project on supercritical fluids and has active research on the SCO2 Brayton cycle for nuclear, solar and fossil advanced power generation. Dr. Anderson was recently awarded the Young Investigator Engineering Achievement Award from the American Nuclear Society for his work on liquid salts and supercritical fluids.

Chris DeMarco
Grainger Professor of Power Engineering, Electrical and Computer Engineering
Dr. DeMarco researches nonlinear stability and control theory for application in electric power systems. His work focuses on indicating in real time the vulnerability of the power system to such phenomena as voltage collapse. His most recent research pursuits involve obtaining a means of guaranteeing stable operation of the power system over a range of operating points, as well as examining the development of algorithms for application in large-scale systems.

Robert Lasseter
Emeritus Professor of Electrical and Computer Engineering
Dr. Lasseter is recognized internationally as one of earliest and most influential pioneers in the microgrid field. His professional career during the past 40 years has been dedicated to the application of power electronics to utility systems. He is the technical lead of the Consortium for Electric Reliability Technology Solutions' (CERTS) Microgrid Project, which has led to the development and wide acceptance of the CERTS microgrid architecture that is recognized for its plug-and-play flexibility, requiring no special communications among the distributed sources or electric grid in order to operate.



Bernard Lesieutre
Professor of Electrical and Computer Engineering
Dr. Lesieutre's research activities involve the development of tools to advance the design of reliable electric power systems and energy policies to support system reliability. He has published numerous reports in support of activities at the U.S. DOE and FERC, and he was a member of a team that helped investigate the August 14th, 2003 Northeast blackout.

OUR PROGRAMS

Giri Venkataramanan
Professor of Electrical and Computer Engineering
Dr. Venkataramanan's research focuses on the combination of technological, social, and environmental factors that shape electrical power systems around the world and how those systems evolve. He has made major contributions to the development of microgrid technology and has succeeded in demonstrating economical approaches to using renewable sources to provide electricity in remote and developing areas of the world in order to improve energy accessibility and sustainability.

Victor M. Zavala
Richard H. Soit Assistant Professor of Chemical and Biological Engineering
Before joining UW-Madison, Dr. Zavala was a computational mathematician in the Mathematics and Computer Science Division at Argonne National Laboratory. He is currently the recipient of a Department of Energy Early Career Award under which he develops scalable optimization algorithms. He is also a technical editor of the Mathematical Programming Computation journal. His research interests are in the areas of mathematical modeling of energy systems, high-performance computing, stochastic optimization, and predictive control.

Bruce Beihoff
Technical Director of Industry Relations, Wisconsin Energy Institute
Bruce Beihoff is a leader of the Center for Renewable Energy Systems, and specializes in power electronics technology applied to integrated renewable energy systems. Beihoff's work focuses on understanding how new energy sources, like wind or solar, can be utilized together in hybrid multi-domain energy systems for the creation of more dependable renewable energy primarily through the implementation of microgrids and integrated systems.

Gary Radloff
Director of Midwest Energy Policy Analysis, Wisconsin Energy Institute
Gary Radloff is a researcher at the UW–Madison and the Director of Midwest Energy Policy Analysis for the WEI. He is an Honorary Associate/Fellow with the Nelson Institute, Center for Sustainability and the Global Environment (SAGE). Radloff's research focus is on state and federal energy policy analysis and development. His research includes the interplay of energy policy with other state and federal policy including the areas of land use, agriculture, environmental and health. The work is designed to utilize an energy systems approach to complement work in energy modeling and economics, and stakeholder engagement.