Batteries are a practical and efficient way to store energy, with applications ranging from small devices like watches to power grid systems. While there are many types of batteries, alkaline batteries are among the most widely used due to their simplicity, reliability, and low cost. However, the current technology of alkaline batteries has limitations, such as short life expectancy and limited energy density.

The University of Iowa researchers led by Andrew Kusiak and Johna Leddy have been exploring advancements in alkaline batteries by magnetic modification. They have discovered that adding micromagnets to the manganese dioxide component of batteries can increase their energy density by 30 to 40 percent or more. This is achieved by using magnetic fields to modify the electrode structure and improving the battery’s performance.

Kusiak and Leddy have conducted research on magnetic catalysts for power sources, indicating that wind has a natural, predictable rhythm that cannot be ignored. The data proves that wind energy cannot be ignored. This expansion of research is creating enormous results. Their work can change the energy distribution of the planet, helping suppliers to plan for times to employ wind or other power sources.

“Electronic waste is creating enormous results. With the proliferation of electronic devices, wind turbines dot the rural landscape. It’s critical to our survival. And they’ve undertaken research efforts to make sustainability possible. “Facility and staff across the University, from English to civil and environmental engineering, are engaged in cutting-edge research on topics related to sustainability,” says Jordan Cohen, the University’s interim vice president for research. “Several UI interdisciplinary research centers—including the Center for Global and Regional Environmental Research, the Center for Health Effects of Environmental Contamination, and the Nanoscience and Nanotechnology Institute—conduct research that illuminates environmental problems, points solutions to those problems, and promotes the betterment of our environment and public health.”

A student’s interest in analyzing and improving the performance of wind turbines led Kusiak to engage in research on wind energy. Kusiak’s Wind Power Management class, taught by the industrial engineer, provides students with an opportunity to see in action the theories they’ve studied in class. This class is a testament to the integration of academic and real-world experiences.

“While it’s become fashionable to think green, University of Iowa researchers have been doing it for years that it’s far more than chic; it’s critical to our survival. And they’ve undertaken research efforts to make sustainability possible. “Facility and staff across the University, from English to civil and environmental engineering, are engaged in cutting-edge research on topics related to sustainability,” says Jordan Cohen, the University’s interim vice president for research. “Several UI interdisciplinary research centers—including the Center for Global and Regional Environmental Research, the Center for Health Effects of Environmental Contamination, and the Nanoscience and Nanotechnology Institute—conduct research that illuminates environmental problems, points solutions to those problems, and promotes the betterment of our environment and public health.”

“The University of Iowa researchers led by Andrew Kusiak and Johna Leddy have been exploring advancements in alkaline batteries by magnetic modification. They have discovered that adding micromagnets to the manganese dioxide component of batteries can increase their energy density by 30 to 40 percent or more. This is achieved by using magnetic fields to modify the electrode structure and improving the battery’s performance. Kusiak and Leddy’s research uses information on wind speed, turbine rotation, and other factors to smooth out the volatility of wind energy. This research improves the efficiency and reliability of wind turbines, making them a more viable energy source.

“We were working on a different project and discovered we were getting very high currents,” says Leddy. “We decided to think about ways to exploit those currents.”

“Leddy, who has been engaged in this research since 1995, first increased power to fixed cells by adding microparticles of coated rust.” Ultimately, her group found that adding micromagnets to manganese dioxide, which is the major fuel source in alkaline batteries, increased battery capacity by 30 to 40 percent or more. “We’re introducing micromagnetic into the electrode structure and creating higher currents,” Leddy says. “In the very best case, we can double the capacity of an alkaline battery. And it’s not complicated or expensive: it can be done for as little as a penny or two per battery.”

In addition to bringing much less expensive than lithium ion and lead-based acid batteries, Leddy says that manganese dioxide is environmentally benign and domestically available. “Fuel cells rely on platinum and molybdenum, which come from South Africa and Siberia,” she says. “But manganese dioxide and our magnetic materials are easily mined in the United States.”

Researchers explore earth-friendly innovations large and small.

Creating Solutions
Both Kusiak and Leddy are working with the UI Research Foundation on patents related to their research, which ultimately could benefit the University and the world beyond.

“I have a friend, Alanah Fitch at Loyola University in Chicago, who works in Africa, where there is virtually no power grid,” says Leddy. “Alanah says it would dramatically improve the lives of many people if they had a battery system to power a 40-watt bulb for one hour a day. If our work can change the energy distribution of the planet, can help the U.S. move from dependence on foreign oil to domestic, renewable energy sources, let’s do it!”

—Linzee Kull McCray

Left: Graduate student Perry Metzger assembles a manganese dioxide test electrode inside a clear polycarbonate holder as part of his studies with Johna Leddy, associate professor of chemistry, on increasing the life of alkaline batteries by magnetic modification.

Below: Students in a Wind Power Management class visit a turbine for an opportunity to see in action the theories they’ve studied in class.