$12.6 MILLION

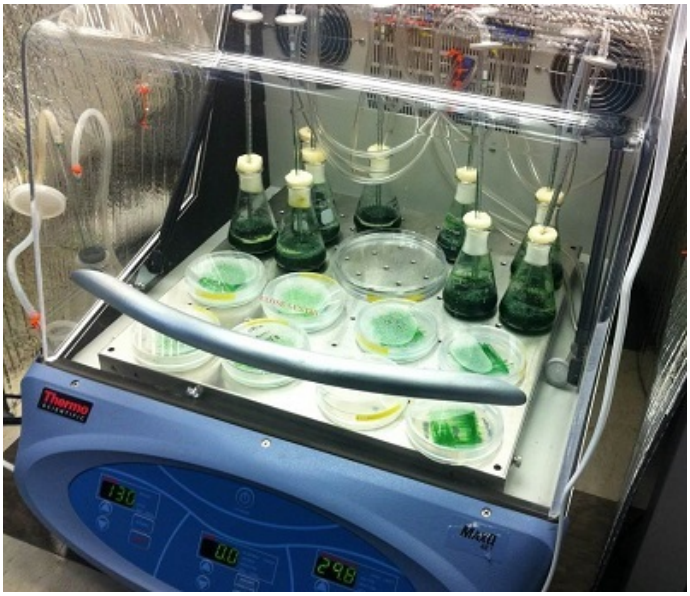
DOE Funding at Vanderbilt in FY 2021

Partnering with Oak Ridge National Laboratory

Oak Ridge National Laboratory is the largest national laboratory in DOE's system. Vanderbilt is one of the UT–Battelle Core University Partners, a select group of seven southeastern universities that work closely with ORNL to jointly appoint faculty with common scientific interests, support collaborative research, train graduate students, and provide regional support for ORNL in the state of Tennessee. Padma Raghavan, vice provost for research, serves as Vanderbilt's representative on the UT–Battelle Board of Governors, which oversees management of ORNL and works closely with ORNL leadership to promote collaborations. Jason Valentine, associate professor of mechanical engineering and of electrical engineering, is the core university liaison with ORNL. Vanderbilt and ORNL are strongly committed to their ongoing research partnership.

Current activities by Vanderbilt researchers at ORNL include use of the Spallation Neutron Source, the nanotechnology laboratories, and the TITAN and SUMMIT supercomputers for engineering, chemistry, physics, biochemistry, and cell biology research. These growing collaborations leverage the institutions' complementary strengths and have the potential to drive innovation and address challenges of national importance. In tandem with ORNL, an engineering professor, whose research involves building statistical models of whole-brain data sets, received a competitive research grant from Oak Ridge Associated Universities—a consortium of American universities that provide innovative scientific and technical solutions to advance national priorities in science, education, security and health.

A team of researchers led by an ORNL microscopist and a Vanderbilt theoretical physicist used a new Scanning Transmission Electron Microscope technique to image the electron distribution in ionic compounds known as electrides. This work directly visualizes and quantifies these electrons that behave like an atom with no nucleus, providing a unique tool to investigate electrides. The team anticipates that this work will be used in both experimental and theoretical analysis of the exotic properties in electrides and the role that hydrogen may have in their behavior. These and other properties make their development attractive for an array of emerging technologies.



Cyanobacteria engineered for high yields of a fatty acid are a potential platform for biofuel production that does not compete with food sources and agricultural land. (Vanderbilt University)

Vanderbilt students selected by the Office of Science Graduate Student Research program

Two graduate students in the Department of Physics and Astronomy were selected for the DOE's Office of Science Graduate Student Research program. Both will pursue their research on high-energy nuclear physics at Los Alamos National Laboratory—one of the world's largest STEM research institutions doing formative research in space exploration, nuclear fusion, renewable energy, medicine, nanotechnology and supercomputing. Research projects of SGSR awardees are of significant importance to the Office of Science's mission to address societal challenges at national and international scale. The Vanderbilt students are studying the quark gluon plasma, a state of matter that existed in the first microseconds of the universe that exhibits nearly perfect fluid behavior. They expect to obtain unique physics results that will deepen the understanding of how a perfect fluid emerges from nuclear matter under extreme conditions.

Consortium for Risk Evaluation with Stakeholder Participation

The Consortium for Risk Evaluation with Stakeholder Participation is one of the nation's leading independent, interdisciplinary research groups focused on the waste management and environmental legacy from production of defense nuclear materials and nuclear energy. Vanderbilt leads this multi-university consortium of engineers, scientists, and legal and policy experts who have contributed over the past 25 years to the progress being made in addressing the nation's largest environmental liability. With the support of DOE, these nuclear waste experts leverage their knowledge to help the U.S. find safe ways to effectively manage nuclear waste from both defense nuclear materials production and civilian nuclear power sources. They see this as a crucial component of environmental responsibility, including as a needed foundation for future nuclear power generating capabilities. The work at CRESP requires engineers, scientists and policy experts to understand the complete life cycle of nuclear power generation, weapons production and environmental impacts from nuclear weapons tests. Academic research through CRESP educates undergraduate and graduate students and postdoctoral scholars while carrying out foundational research needed to improve the efficiency and effectiveness of the cleanup program.

Advancing isotope production critical for U.S. science, medicine and industry

A $4 million DOE Office of Science-funded initiative to advance research in isotope production includes a Vanderbilt engineering researcher's work on separation technologies and scaling up processes. The funding is part of a key federal program that produces essential isotopes otherwise unavailable or in short supply for U.S. science, medicine and industry. Isotopes, or variations of the same elements with the same number of protons but different numbers of neutrons, have unique properties that can make them useful in medical diagnostic and treatment applications. They also are important for applications in quantum information science, nuclear power, national security and more. Separation of one isotope from another is inherently challenging, but this project aims to use fundamental understanding of separation processes using novel membranes to enable process design and scale up for isotope separation.

Engineering cyanobacteria as a biofuel production platform

A $1.5 million DOE Office of Science grant at Vanderbilt University's School of Engineering is bringing together experts from three institutions to parse the metabolism of a blue-green algae that holds great promise for biofuel production. The team will take a systems biology approach to identify how cyanobacteria, also known as blue-green algae, can be engineered to produce large amounts of lipids, in the form of free fatty acids, which then can be used as a biofuel. Cyanobacteria are already capable of producing lipids directly from sunlight and atmospheric carbon dioxide using photosynthesis, but not at the rates and quantities necessary to sustain a commercial biofuel process. The organism's flexibility makes it especially attractive to DOE as a biomanufacturing host because its growth does not compete with production of crops or other food sources. The species can be grown using wastewater resources and without organic sources of carbon, such as sugar, on land that is unsuitable for agriculture. The focus of this research is to take the tools that were developed for analyzing and controlling cyanobacterial metabolism and leverage them toward optimizing an important metabolic pathway for producing renewable fuels and chemicals.

Transforming grid management with risk metrics for renewables

Vanderbilt risk and reliability experts in the School of Engineering are part of a $3.25 million DOE ARPA-E-funded project to develop new machine learning algorithms that support decision-making in near real time on how system operators plan and operate the U.S. grid and leverage renewable energy sources, while minimizing the system risk. This is important because historical methods that predict supply and demand of the electricity market are not accurate. The price of electricity on the wholesale market fluctuates every minute based on demand and adding renewable energy to the mix greatly complicates matters. The goal of the project—Risk-Aware Market Clearing—is a blueprint for an end-to-end, data-driven approach that balances cost and minimizes system-level risk. Market clearing is the process that keeps the supply level to the demand with no leftover of either.

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