

**Annual Report: Academic Year 2023-2024**  
**Richard and Bonnie Robbins Endowed Chair in Sustainable Use of Materials**  
**David R. Shonnard, Ph.D.**

Leadership in Sustainability Research

Professor Shonnard is engaged in sustainability research on advanced recycling technologies for plastic waste with support from the National Science Foundation, Department of Energy, and the Department of Defense (DARPA). In this research the Shonnard research team is converting military solid waste materials into valuable products such as lubricants and electricity, and investigating effects of contaminants in the feed on product quality. In the field of life cycle assessments (LCA) and techno-economic analyses (TEA) his team is investigating the environmental impacts and economic feasibility of bioprocess technologies for production of biofuels and bioproducts, as well as for products from upcycling of waste plastics, and energy storage with funding from industry. His current portfolio of projects is valued at \$3 million in federal funds to support his own research, with a total of all projects value of \$10 million of federal support.

These funds support several graduate and undergraduate students and professional research staff:

- Utkarsh Chaudhari (PhD candidate in Chemical Engineering),
- Kamand Sedaghatnia (PhD candidate in Chemistry),
- JoAnn Henry (undergraduate researcher in Chemical Engineering),
- several undergraduate students in the Alternative Energy Enterprise-Biofuels Team,
- Dr. Robert Handler (senior research engineer),
- Dr. Ali Zolghadr (Asst. Research Professor),
- Dr. Sarvada Chipkar (postdoctoral researcher),
- Topher Taylor (BS chemical engineering) and
- Dr. Daniel Kulas (temporary research engineer).

On these projects, active research collaborators include,

- Dr. Rebecca Ong (Chemical Engineering-MTU),
- Dr. Stephen Techtmann (Biological Sciences-MTU),
- Dr. David Watkins (Civil-Environmental Engineering-MTU).
- Dr. Barbaa Reck (Yale University)
- Dr. Mary Lidstrom (University of Washington)
- Dr. Vicki Thompson (Idaho National Laboratory)
- Dr. Damon Hartley (Idaho National Laboratory)
- Dr. Tasmin Hossain (Idaho National Laboratory)
- Anne Johnson (Resource Recycling Systems-RRS)
- Carson Potter (AMP Robotics)
- John Aston (Idaho National Laboratory)
- Miranda Kuns (Idaho National Laboratory)
- Dr. Mark Thies (Clemson University)
- Dr. Kristen Cetin (Michigan State University)
- Dr. Ting Lu (University of Illinois -Urbana Champlain)
- Dr. Teng Bao (University of Illinois -Urbana Champlain)

On these projects, collaborating institutions and companies include Yale University, Clemson University, Michigan State University, University of Washington, University of Illinois -Urbana Champlain, Idaho National Laboratory, Gas Technology Institute, Resource Recycling Systems, Chemstations, RedoxBlox, and AMP Robotics. In the last academic year, the output from this research activity includes 7 peer-reviewed publications and 10 conference/workshop presentations.

Dr. Shonnard is also working with staff in the Office of Innovation and Commercialization to successfully commercialize sustainable materials process technology being developed using the mentioned federal support to commercial practice via a new company Resurgent Innovations.

*National Science Foundation*

*“LCA support for the project: CAS-CLIMATE: DIRECT METHANE CAPTURE IN AIR BY AEROBIC METHANOTROPHS”*

*MTU Co-PI (Shonnard), MTU PI (Handler)*

\$200,000 subaward from the University of Washington (Mary Lidstrom). Total of \$500,000.

*Department of Energy (BETO)- DOE BETO FOA DE0002396-1563*

*“Novel Electric Reformer for Drop in Fuels from Biogas or Waste CO<sub>2</sub>: MTU Projects”,  
10/01/2022 – 9/30/2025*

PI (Shonnard), \$199,983 subaward from GTI. (Terry Marker, PI). Total award \$2.9 million.

*Department of Energy (Industrial Assessment Center)- DOE DE-EE0009734*

*“Industrial Assessment Center at Michigan State University, 2452-1551”*

*08/01/2021 – 7/31/2026*

*PI (Shonnard), MTU Co-PI (Handler)*

\$202,016 subaward from MSU. (Kristen Cetin, PI). Total award \$1.75 million.

*Department of Energy (BETO)- DOE BETO FOA DE0002423-1568*

*“Artificial Neural Network for MSW Contamination Characterization: MTU Projects”,  
02/01/2024 – 7/31/2026*

PI (Shonnard), \$236,113 subaward from AMP Robotics. (Carson Potter, PI). Total award \$1.9 million.

*Department of Energy - REMADE Institute 20-01-SA-4014*

*“Dynamic Systems Analysis for PET and Olefin Polymers in a Circular Economy”*

*PI (Shonnard); Co-Investigators; Robert Handler (MTU), David Watkins (MTU), Barbara Reck (Yale), Jim Frey (RRS), Anne Johnson (RRS),*

*\$458,000+458,000 cost share; (DRS portion is \$250K) 09/01/2021 – 8/31/2024*

*DARPA ReSource – HR001119S0084-ReS-FP*

*“BioPROTEIN - Biological Plastic Reuse by Olefin and Ester Transforming Engineered Isolates and Natural Consortia”, 09/01/2020 – 08/31/2024*

*Co-PI (Shonnard), \$1,700,000, (PI S. Techtmann), Total award \$8,220,936.*

*Gas Technology Institute / Department of Energy: SUBCONTRACT NO. S549*

“Environmental Life Cycle Carbon Footprint and Energy Analysis of Drop-in Hydrocarbon Jet Fuels using the IH2 Plus Cool GTL Process”, (DE-EE0008507-GTI Project No. 22530)”

PI (Shonnard), Co-PI (Handler), subaward from GTI (\$199,999 + 49,999 in MTU cost share; 01/01/20 - 01/30/25)

*RedoxBlox*

“Environmental Life Cycle Assessments of Thermal and Thermochemical Energy Storage Technologies”,

06/01/2023 – 6/30/2024

PI (Shonnard), \$12,000

#### Leadership in Sustainability Teaching

Professor Shonnard leads the Graduate Certificate in Sustainability and Resilience, a 9-credit certificate program hosted by the Department of Chemical Engineering serving students in the College of Engineering and in other Colleges at MTU. Last academic year, approximately 80 students enrolled in the required courses for this certificate. The numbers of certificates granted last academic year are currently being tallied as of this submission.

#### Leadership in Sustainability Service

Professor Shonnard served as chair of the Institute of Sustainability at the American Institute of Chemical Engineers for the last 4 years. He recently stepped down to focus on his research program in sustainable use of materials. Dr. Shonnard serves on the editorial advisory board for the journal *ACS Sustainable Chemistry and Engineering*, a high impact factor research journal in the American Chemistry Society family of journals. He also serves as manuscript reviewer for this journal and several other sustainable materials-related journals. Professor Shonnard recently accepted an invitation to serve on the Education and Research Advisory Group for the American Institute for Packaging and the Environment, which is a coalition of stakeholders dedicated to improving packaging and the environment through public policy and advocacy.