

MTSU Sustainable Campus Fee Funding Request Form

The Sustainable Campus Fee (SCF) supports projects that advance sustainability at MTSU. This form allows students, faculty, and staff to propose initiatives that contribute to a greener campus through energy efficiency upgrades, infrastructure improvements, education, research, and efforts to enhance campus biodiversity.

There are 5 sections to the application: Section I: Contact Information, Section II: Project Category, Section III: Project Description, Section IV: Project Cost, and Section V: Project Performance Information (For applicable projects).

The Sustainable Campus Fee is administered through a partnership with the Office of Student Affairs, the Center for Student Involvement & Leadership, and the Center for Energy and Sustainability (CES).

Date Wednesday, September 30, 2026

Request Number **SCFR27000100**

1. Name Keying Ding

Email keying.ding@mtsu.edu

Phone Number (615) 898-2475

SECTION II: Project Category

Please note that all proposed projects will have to comply with MTSU campus guidelines and recommendations.

1. Select the category that best describes the project. (Select One - See Descriptions Below)

Research and Innovation

CATEGORY DESCRIPTIONS

Energy Conservation/Efficiency - (e.g. installing LED light bulbs, adding insulation to walls, replacing old appliances with energy-efficient models, installing programmable lighting, etc.)

Renewable Energy - (e.g. implementing projects to harness naturally replenishing sources like wind, water, and sunlight to generate electricity - like solar-powered picnic tables, etc.)

Sustainable Transportation - (e.g. installing covered bike racks, replacing fuel vehicles with electric vehicles, etc.)

Alternative Fuels - (e.g. setting up electric vehicle charging stations, implementing hybrid or electric vehicles, purchasing electric or propane power equipment, etc.)

Recycling - (e.g. purchasing recycling bins, improving signage, recycling difficult materials, etc.)

Waste Reduction - (e.g. establishing a reuseable to-go container program, reducing food waste, installing waterbottle filling stations, etc.)

Water Conservation - (e.g. purchasing rain barrels, creating a rain garden, switching to low-flow water fixtures, installing low-flow water valves, etc.)

Biodiversity - (e.g. planting pollinator garden, tree planting, installing bird boxes, etc.)

Education - (e.g. hosting a sustainability fair to raise awareness about green practices, hosting bike repair and/or safety workshops)

Research and Innovation - (e.g. researching the effects of microplastics, solar feasibility study, etc.)

SECTION III: Project Description

Please include as much detail as possible in this section. The more information you provide, the better equipped the adjudication committee will be to fully understand your request and make an informed decision.

To expand a text box, click and drag the two diagonal lines in the bottom-right corner. This allows you to adjust the size and view of your content as you type.

1. Project Title

Visible-Light Photocatalytic Hydroboration of Alkenes and Nitriles Using Earth-Abundant Transition Metal Complexes

2. Scope: Work to be accomplished

Hydroboration converts unsaturated substrates into valuable organoboron products that serve as key building blocks for pharmaceuticals, agrochemicals, and advanced materials. Beyond simple alkenes, hydroboration is also highly valuable for reducing other unsaturated functional groups such as nitriles, converting them to boron-containing imine or amine intermediates that are otherwise difficult to access selectively. These reactions are conventionally driven thermally and rely on expensive precious-metal catalysts (e.g., Rh, Ir, Pt) or harsh stoichiometric reagents. Photocatalysis directly addresses the energy-conservation dimension of this problem: visible-light excitation can generate the reactive intermediates needed for hydroboration under mild, ambient-temperature conditions, replacing thermal heating with renewable, low-energy-input light.

In this project, we will develop photocatalytic hydroboration reactions using earth-abundant cobalt and manganese complexes supported by the multidentate phosphine (PPP-type) pincer ligands developed in our laboratory, paired with a thiol-based hydrogen-atom-transfer (HAT) co-catalyst (2,4,6-triisopropylbenzenethiol or thiophenol) and, where needed, an acid activator (HNTf₂) under blue-LED irradiation. Using a photochemical reactor, we will screen catalyst/co-catalyst combinations, then define the substrate scope over two classes: (1) alkenes (styrenes, aliphatic alkenes, allylic/homoallylic derivatives, cinnamate esters and amides, and coumarins), and (2) aromatic and aliphatic nitriles (benzonitrile derivatives, cyclic and acyclic aliphatic nitriles), using pinacolborane (HBpin) as the primary boron source, with NHC–borane, bis(catecholato)diboron, and borane–dimethyl sulfide as backup boron reagents. The requested funds will be used to purchase the substrates, boron reagents, HAT catalysts, and a commercial blue-LED photochemical reactor itemized in the attached vendor quote, totaling \$3,895.93 (sourced via Quartzzy, the purchase online platform used by our chemistry department).

3. Scope: Benefit Statement

This project is submitted under the research and innovation category "for educational, training, and research purposes, to help develop an awareness of energy use, consumption, and conservation." By replacing the continuous thermal heating conventionally required for hydroboration with visible-light activation, the project directly reduces the energy input needed to drive these transformations, while also replacing scarce, toxic precious-metal catalysts with earth-abundant cobalt and manganese. Every student trained on this project will directly engage with the comparison between thermal- and light-driven reaction energetics as a core part of their research, building firsthand awareness of energy consumption and conservation in a chemical synthesis context. This work also builds on our "Bring Green Chemistry to Campus" program, which since 2013 has trained undergraduate and graduate students in sustainable catalysis. This project extends that educational mission into photocatalysis specifically, and results are intended for peer-reviewed publication and as preliminary data for future external funding.

4. Location of Project

Department of Chemistry, Science Building, Room 3021 (Ding Research Laboratory), Middle Tennessee State University.

5. Participants and Roles

Department of Chemistry.

- Dr. Keying Ding (Principal Investigator) – supervises the project
- Two graduate students in the Ding research group – conduct the experiments
- One undergraduate student – conducts experiments

6. Student Participation in the project and/or Student Benefit from the project

Students involved in this project will learn to synthesize and handle air- and moisture-sensitive organometallic complexes, gain hands-on experience with visible-light photoreactor setups and photophysical characterization, and be introduced to the principles of photocatalyst design. As part of this training, students will directly evaluate the energy-input tradeoffs between thermal and photocatalytic routes, building practical awareness of energy use and conservation in synthetic chemistry.

7. Future Operating and/or Maintenance Requirements

No significant ongoing operating or maintenance costs are anticipated. The LED photoreactor is low-maintenance and will be supported going forward by existing departmental laboratory resources.

8. Additional Comments or Information Pertinent to the Proposed Project

Results from this project will be submitted for publication in a peer-reviewed journal and will serve as preliminary data supporting a future external grant application (e.g., NSF or ACS-PRF) on earth-abundant photocatalysis for sustainable hydrofunctionalization chemistry. This funding model has a strong track record in my lab: preliminary data generated from prior MTSU Sustainable Campus Fee-supported projects (2018–2020) helped secure two subsequent extramural awards, an NSF grant (\$172,182, 2021–2024) and an ACS Petroleum Research Fund grant (\$70,000, 2021–2024), both focused on earth-abundant metal catalysis. An itemized chemical and equipment quote (Quartzy, total \$3,895.93) is attached in support of this request. The proposed work is scoped to be completed well within the December 31, 2027 project deadline.

Any supporting documents or attachments will be on the pages following the SCF Request.

Note, all projects are expected to be completed by December 31, 2026.

SECTION IV: Project Costs

1. Project Cost Estimate 3895

2. Source of Estimate

Quartzy is the procurement platform used by the Chemistry Department to order chemicals from various vendors. Sigma Aldrich serves as our primary vendor; however, if a chemical is unavailable through Sigma Aldrich, we source it from alternative vendors listed on Quartzy. Quote is attached with this application.

3. Has previous funding from this source been awarded?

No

If Yes, please explain how this request differs from previous funding request.

SECTION V: Project Performance Information

If your project is expected to reduce energy consumption (e.g. through lighting upgrades or HVAC improvements etc.), please provide an estimate of potential savings. Feel free to contact the Center for Energy and Sustainability for help making these calculations at ces@mtsu.edu.

1. Estimated Annual Energy Savings (Estimated in kW, kWh, Btu, etc.)

Not applicable. This is a laboratory research project, not a facility or utility infrastructure upgrade, so it does not produce a quantifiable reduction in campus energy consumption (kW/kWh/Btu). Its energy-conservation contribution is at the level of synthetic methodology: replacing continuous thermal heating with visible-light photocatalysis in the chemical reactions studied, as described in prior Sections.

2. Annual Energy COST Savings (\$)

Not applicable, for the same reason

3. Annual Operating Cost Savings or Other Cost Savings. Specify in dollar amount, if applicable. (\$)

Not applicable. No ongoing operating cost savings are anticipated.

4. Matching or Supplementary Funding (Identify and explain, if applicable)

None at this time.

Acknowledgment

I acknowledge that a project summary and photo must be submitted, if I am awarded funding and upon completion of the project.

Supporting Documentation or Attachments if provided.

Hydroboration chemicals and supplies — Quartzzy prices

ID	Chemical / item	CAS number	Supplier and catalog number	Pack / proposed pack	Packs	Pack price (USD)	Line total (USD)	Product / source URL	Category
1	Styrene	100-42-5	Sigma-Aldrich S4972-5ML	5 ML	1	\$33.45	\$33.45	https://app.quartzzy.com/groups/87926/products/3075671?source=shop_search	Substrate
2	4-Methylstyrene	622-97-9	Sigma-Aldrich M80806-10ML	10 ML	1	\$44.89	\$44.89	https://app.quartzzy.com/groups/87926/products/3075308?source=shop_search	Substrate
3	4-Chlorostyrene	1073-67-2	Sigma-Aldrich C71203-10G	10 G	1	\$119.07	\$119.07	https://app.quartzzy.com/groups/87926/products/3079194?source=shop_search	Substrate
4	3-Methylstyrene	100-80-1	Chemscene CS-0110437	1 g	1	\$19.83	\$19.83	https://app.quartzzy.com/groups/87926/products/20609963?source=shop_search	Substrate
5	1-Octene	111-66-0	Sigma-Aldrich 74900-5ML	5 ML	1	\$80.27	\$80.27	https://app.quartzzy.com/groups/87926/catalog?query=111-66-0	Substrate
6	Allylbenzene	300-57-2	Sigma-Aldrich A29402-25ML	25 ML	1	\$90.79	\$90.79	https://app.quartzzy.com/groups/87926/catalog?query=300-57-2	Substrate
7	Allylcyclohexane	2114-42-3	Sigma-Aldrich 662844-5G	5 G	1	\$82.98	\$82.98	https://app.quartzzy.com/groups/87926/products/3115075?source=shop_search	Substrate
8	5-Bromo-1-pentene	1119-51-3	Sigma-Aldrich 253901-5G	5 G	1	\$108.95	\$108.95	https://app.quartzzy.com/groups/87926/catalog?query=1119-51-3	Substrate

9	Allyltrimethylsilane	762-72-1	Beantown Chemical 123875-10G	10 g	1	\$83.43	\$83.43	https://app.quartzy.com/groups/87926/catalog?query=762-72-1	Substrate
10	1,5-Hexadiene	592-42-7	Sigma-Aldrich 128554-25G	25 G	1	\$58.11	\$58.11	https://app.quartzy.com/groups/87926/catalog?query=592-42-7	Substrate
11	alpha-Methylstyrene	98-83-9	Sigma-Aldrich M80903-5ML	5 ML	1	\$56.01	\$56.01	https://app.quartzy.com/groups/87926/catalog?query=98-83-9	Substrate
12	trans-beta-Methylstyrene	873-66-5	Sigma-Aldrich 111848-1G	1 G	1	\$44.48	\$44.48	https://app.quartzy.com/groups/87926/products/3092790?source=shop_search	Substrate
13	trans-2-Octene	13389-42-9	Sigma-Aldrich 111236-5G	5 G	1	\$92.61	\$92.61	https://app.quartzy.com/groups/87926/catalog?query=13389-42-9	Substrate
14	Methyl trans-cinnamate	1754-62-7	Sigma-Aldrich 173282-100G	100 G	1	\$34.23	\$34.23	https://app.quartzy.com/groups/87926/catalog?query=1754-62-7	Substrate
15	Ethyl trans-cinnamate	4192-77-2	Sigma-Aldrich 112372-100G	100 G	1	\$44.20	\$44.20	https://app.quartzy.com/groups/87926/products/3092824?source=shop_search	Substrate
16	n-Butyl cinnamate	538-65-8	Ambeed Inc. A823145-5g	5 G	1	\$11.17	\$11.17	https://app.quartzy.com/groups/87926/catalog?query=538-65-8	Substrate
17	Methyl 4-bromocinnamate	3650-78-0	AstaTech F14966	5 G	1	\$33.98	\$33.98	https://app.quartzy.com/groups/87926/products/6523895?source=shop_search	Substrate

18	trans-Cinnamic acid	140-10-3	Sigma-Aldrich C80857-5G	5 G	1	\$45.84	\$45.84	https://app.quartzy.com/groups/87926/products/3167189?source=shop_search	Substrate
19	Cinnamamide, predominantly trans	621-79-4	Sigma-Aldrich C80806-5G	5 G	1	\$68.90	\$68.90	https://app.quartzy.com/groups/87926/catalog?query=621-79-4	Substrate
20	trans-Benzalacetone	1896-62-4	Sigma-Aldrich 241091-50G	50 G	1	\$65.46	\$65.46	https://app.quartzy.com/groups/87926/products/3098437?source=shop_search	Substrate
21	Ethyl crotonate, trans	623-70-1	Alfa Aesar A12529-22	100 G	1	\$91.29	\$91.29	https://app.quartzy.com/groups/87926/products/3495828?source=shop_search	Substrate
22	Phenyl vinyl sulfone	5535-48-8	Sigma-Aldrich 241717-1G	1 G	1	\$47.03	\$47.03	https://app.quartzy.com/groups/87926/products/3098460?source=shop_search	Substrate
23	1,1-Diphenylethylene	530-48-3	Sigma-Aldrich D206806-5G	5 G	1	\$57.11	\$57.11	https://app.quartzy.com/groups/87926/products/3167871?source=shop_search	Substrate
24	Coumarin	91-64-5	Sigma-Aldrich C4261-50G	50 G	1	\$67.33	\$67.33	https://app.quartzy.com/groups/87926/products/3166851?source=shop_search	Substrate
25	6-Methylcoumarin	92-48-8	Sigma-Aldrich M36203-5G	5 G	1	\$39.49	\$39.49	https://app.quartzy.com/groups/87926/products/3171427?source=shop_search	Substrate
26	7-Methoxycoumarin (herniarin)	531-59-9	Chemscene CS-0016775	25 G	1	\$79.31	\$79.31	https://app.quartzy.com/groups/87926/products/6825170?source=shop_search	Substrate

7- 27	Hydroxycoumarin (umbelliferone)	93-35-6	Sigma-Aldrich H24003-10G	10 G	1	\$42.04	\$42.04	https://app.quartzy.com/ groups/87926/products/3 079457?source=shop_se arch	Substrate
28	Benzonitrile	100-47-0	Sigma-Aldrich B8959-1L	1 L	1	\$81.35	\$81.35	https://app.quartzy.com/ groups/87926/products/3 079569?source=shop_se arch	Substrate
4- 29	Methylbenzonitril e (p-tolunitrile)	104-85-8	Sigma-Aldrich 132330-25G	25 G	1	\$58.11	\$58.11	https://app.quartzy.com/ groups/87926/products/3 093645?source=shop_se arch	Substrate
30	4- Fluorobenzonitrile	1194-02-1	Sigma-Aldrich 139416-5G	5 G	1	\$51.30	\$51.30	https://app.quartzy.com/ groups/87926/products/3 093940?source=shop_se arch	Substrate
31	4- Bromobenzonitril e	623-00-7	Sigma-Aldrich B58407-10G	10 G	1	\$53.65	\$53.65	https://app.quartzy.com/ groups/87926/products/3 165925?source=shop_se arch	Substrate
32	4-Iodobenzonitrile	3058-39-7	Sigma-Aldrich 579157-1G	1 G	1	\$60.01	\$60.01	https://app.quartzy.com/ groups/87926/products/3 112369?source=shop_se arch	Substrate
33	4- (Trifluoromethyl)b enzonitrile	455-18-5	Sigma-Aldrich 196681-5G	5 G	1	\$25.88	\$25.88	https://app.quartzy.com/ groups/87926/products/3 096949?source=shop_se arch	Substrate
34	4- Fluorophenylacet onitrile	459-22-3	Sigma-Aldrich 102407-25G	25 G	1	\$77.25	\$77.25	https://app.quartzy.com/ groups/87926/products/3 092391?source=shop_se arch	Substrate
35	Terephthalonitrile (1,4-dicyanobenzene)	623-26-7	Sigma-Aldrich D76722-25G	25 G	1	\$33.41	\$33.41	https://app.quartzy.com/ groups/87926/products/3 168241?source=shop_se arch	Substrate

36	Furan-2-carbonitrile (2-furonitrile)	617-90-3	Sigma-Aldrich	159573-5G	5 G	1	\$85.33	\$85.33	https://app.quartzy.com/groups/87926/products/3095246?source=shop_search	Substrate
37	Thiophene-2-carbonitrile	1003-31-2	Sigma-Aldrich	154385-10G	10 G	1	\$85.79	\$85.79	https://app.quartzy.com/groups/87926/products/3094858?source=shop_search	Substrate
38	Cyclohexanecarbonitrile	766-05-2	Sigma-Aldrich	168041-25ML	25 ML	1	\$86.33	\$86.33	https://app.quartzy.com/groups/87926/products/3095884?source=shop_search	Substrate
39	Acetonitrile	75-05-8	Sigma-Aldrich	34851-100ML	100 ML	1	\$36.24	\$36.24	https://app.quartzy.com/groups/87926/products/3073691?source=shop_search	Substrate
40	Adiponitrile	111-69-3	Alfa Aesar	43679-AE	100 ML	1	\$56.67	\$56.67	https://app.quartzy.com/groups/87926/products/3492972?source=shop_search	Substrate
41	Cyclopropanecarbonitrile	5500-21-0	Sigma-Aldrich	C117609-5G	5 G	1	\$39.76	\$39.76	https://app.quartzy.com/groups/87926/products/3166552?source=shop_search	Substrate
42	Pinacolborane (HBpin)	25015-63-8	Sigma-Aldrich	655856-5G	5 g	1	\$67.40	\$67.40	https://www.sigmaaldrich.com/US/en/product/aldrich/655856	Boron reagent
43	1,3-Dimethylimidazol-2-ylidene borane (NHC-BH3)	1211417-77-4	TCI America	D5679 (1G)	1 g	1	\$222.00	\$222.00	https://www.tcichemicals.com/US/en/p/D5679	Boron reagent

44	Bis(catecholato)diboron (B2cat2)	13826-27-2	Sigma-Aldrich	473286-1G	1 g	1	\$241.00	\$241.00	https://www.sigmaaldrich.com/US/en/product/aldrich/473286	Boron reagent
45	4,4,5,5-Tetraethyl-1,3,2-dioxaborolane (HBEpin)	1571909-21-1	001CHEMICAL	DY824502	Small est practi cal 1–5 g or mL pack (assu mptio n)	1			https://www.001chemical.com/chem/1571909-21-1	Boron reagent
46	2,4,6-Triisopropylbenzenethiol	22693-41-0	Aaron Chemicals	AR01KMJU	1 g	1	\$25.00	\$25.00	https://www.aaronchem.com/prod/22693-41-0	HAT catalyst
47	Thiophenol (benzenethiol)	108-98-5	Sigma-Aldrich	T32808-100G	100 g	1	\$79.30	\$79.30	https://www.sigmaaldrich.com/US/en/product/aldrich/t32808	HAT catalyst
49	Bistriflimide (HNTf2; bis(trifluoromethanesulfonyl)amine)	82113-65-3	Sigma-Aldrich	464635-5G	5 g	1	\$122.00	\$122.00	https://www.sigmaaldrich.com/US/en/product/aldrich/464635	Acid activator
51	Pinacol	76-09-5	Sigma-Aldrich	221171-5G	5 g	1	\$67.30	\$67.30	https://www.sigmaaldrich.com/US/en/product/aldrich/221171	Derivatization reagent

52	Tetraethylsilane	631-36-7	Sigma-Aldrich 510874-5ML	5 mL	1	\$49.60	\$49.60	https://www.sigmaaldrich.com/US/en/product/aldrich/510874	NMR standard
53	Borane–dimethyl sulfide complex (BH ₃ ·SMe ₂)	13292-87-0	Sigma-Aldrich 179825-25ML	25 mL	1	\$88.50	\$88.50	https://www.sigmaaldrich.com/US/en/product/aldrich/179825	Boron preparation reagent
54	Aldrich® Micro Photochemical Reactor, blue LED lights	Not applicable (equipment)	Sigma-Aldrich ALDKIT001-1EA	1 each	1	\$460.50	\$460.50	https://www.sigmaaldrich.com/US/en/product/aldrich/aldkit001	Equipment
Total		Total				\$3,895.93			