NAU NORTHERN ARIZONA UNIVERSITY

Green Fund

# 2020 Green Fund Approved Research Grants

## What is a Green Fund Grant?

*"The NAU Green Fund promotes student participation in and provides funding for projects that reduce NAU's negative impact on the environment and create a culture of sustainability."*

In support of the Green Fund's Mission Statement and goals of improving sustainability on campus, the Green Fund accepted proposals for research projects that help to reduce the university's environmental impact and have the potential to create future Green Fund project proposals.

All applications met the following requirements:

1. Research must be primarily conducted by either an **undergraduate or graduate student** who is currently enrolled full time at NAU.
2. Research must be conducted under the guidance and approval of a full time faculty member.
3. Design and goals of the research project must focus on improving sustainability on NAU's campus.

## Justin Case

**Project: Testing Effectiveness of PET Plastic-eating microbes at NAU**

**Approved Amount of Funding $2500**

**Abstract**Polyethylene terephthalate (PET) is a commonly used thermoplastic polymer resin found in everyday items such as clothing and containers for liquid and food. With the increase in consumerism of the everyday person has led to an abundance of plastic waste. Commonly used plastics have poor biodegradability and tend to persist in landfills for a long period of time. Recent studies have shown the plausibility of using biological organisms to break down these materials, such as Ideonella sakalensis, a common bacterium with enzymes capable of hydrolyzing PET

using an enzyme known as PETase. Understanding the functionality of I. sakalensis and similar microorganisms and their ability to enzymatically degrade PET and other polymers can provide more effective ways of treating large quantities of plastic waste in landfills and college campus such as Northern Arizona University (NAU). Our research into these microbes and their enzymes can allow us to assess the viability and cost-effective nature of degrading PET and other plastics produced at NAU. Previous publications have shown the feasibility of using I, sakaiensis to break down polymers in a laboratory setting. Our research intends to examine the effects of scaling the previous experimental values found to a size that would benefit NAU and how the efficiency of the microorganisms containing the PETase enzyme would react to this scaling. The enzyme has been seen to degrade low-crystallinity PET within 6 weeks. We are expecting to see similar results to previous laboratory testing, but likely over a longer time period with both low-crystallinity and high-crystallinity PET. If the hydrolysis of high-crystallinity PET proves successful and practical its application along with the breaking down of low-crystallinity PET, we could decrease the quantity of plastic waste extruded by NAU.

## Christina Osterink

**Project: NAU Office Food Waste Collection for Vermicomposting Program**

**Approved Amount of Funding $2815.80**

**Abstract**:In this project I will evaluate the feasibility of reducing NAU's negative impact on the environment through an office food waste composting program on the NAU campus. The research will be conducted over the 2020 year starting with designing instructional materials and soliciting participation from 15 offices on campus. The food waste will be collected using a bike trailer during a six-week period of July to August of 2020 and will be brought to Roots Micro Farm to be used in multiple composting systems. These composting systems utilized both tradition composting and vermicomposting methods. Vermicomposting uses earthworms in the mpositing process to breakdown food waste. Data will be collected on offices' willingness to participate in the composting program; participants' compliance with our provided guidelines for composting; costs of supplies, personnel, and transportation for collection of compost from offices; the mount of compostable waste collected; and any unexpected challenges encountered along the way. The final phase of this project will be to analyze the data collected and write a report on whether this is a feasible way to help create a culture of sustainability at NAU. This report will be presented to the Green Fund Committee and at the Undergraduate Research Symposium.

## Galen Dennis

**Project: NAU Office Carbon Sequestering Algae Bioreactor Project Proposal**

**Approved Amount of Funding $2675.00**

**Abstract**:As carbon dioxide levels continue to rise and cause noticeable changes throughout the United States and global community it has become critical to develop ways to combat the continuous expulsion of waste gas into the atmosphere. Using plant-based technology to fix waste carbon in the form of biomass has been shown to be an effective carbon neutral method of fuel production. Microalgae specifically show great promise in terms of space and resource usage. However, extensive research must still be conducted in order to develop the technology's potential into viable systems. This research project will use the resources present at Northern Arizona University to explore how algae growth and carbon dioxide absorption rate can be optimized by varying its contributing factors. It will show how local algae species naturally develop and how biomass concentration changes the effectiveness of carbon dioxide absorption from exhaust sources. Further, it will explore several potential ways to control the growth and productivity by changing contributing factors such as pH level. This information will be necessary in designing new bioreactors in order to maximize efficiency, making it critical in future projects on the NAU campus that will utilize bioreactors.

## Trong-Doan Nguyen

**Project: Data-driven Analytics of Building Utility Demand**

**Approved Amount of Funding $2419.20**

**Abstract**:In demand response operation of energy infrastructure such as the electrical grid, it is crucial to accurately predict the energy demand of buildings. It supports operational departments like NAU Facility Services to operate the NAU Campus more efficiently, reduce the total amount of electric consumption as well as reduce CO2 emission in the era of climate change, global warming, since fossil resources are gradually exhausted. Over the past year, we have been investigating different machine learning (ML) techniques for short-term forecasting of building electricity demand. We have developed several predictive electricity demand models using five ML techniques (namely linear regression, k-nearest neighbor, random forest, neural network, and Gaussian Process) in two model architectures (autoregressive and non-autoregressive). The developed models were trained on real data of Building 60 (SAS) on the NAU campus, using only simple features such as the weather conditions (outside air temperature and relative humidity), time, day-of-week, and past demands. We thoroughly tested these models for short-term energy demand forecasting (up to 24 hours), compared their accuracy, and derived insightful conclusions on their advantages and disadvantages. In our experiment with Building 60, the best model achieved a 96.2% prediction accuracy over 24 hours. The proposed project will extend the current work to other NAU buildings (for which reliable data are available), extend the prediction capability to other utilities such as gas and water consumption in addition to electricity, and develop core algorithms & backend services to enable AI-based decision-making capabilities to assist some utility-related facility operations at NAU. This work will help NAU Facility Services to operate the campus more efficiently in terms of energy and cut energy costs, especially during peak demand periods. Furthermore, by reducing the amount of energy consumption, we also will lessen CO2 emissions and reduce our environmental footprint on the earth.

## Miles Dunlap

**Project: NAU Fleet: Path to Carbon Neutrality**

**Approved Amount of Funding $2700**

**Abstract**:In general, a fleet should always strive to function at an optimal size and in an efficient manner. Currently the NAU fleet does neither and there is ample opportunity to save the university significant amounts of money, fuel, and emissions.

My project has three main goals: Right-size the NAU Fleet, begin the initial fleet electrification process, and develop a Carbon Neutrality plan that includes an EV procurement policy for the university.

Through the attainment of each of these goals I except to see fleet efficiency increase through increased vehicle sharing via software and selling off extremely low utilized vehicles. In general, electric vehicles are much more efficient than fossil fuel vehicles and electricity is significantly cheaper than gas or diesel. I expect the university fleet and facility services to begin experiencing significant annual fuel, maintenance, and emissions savings through starting the phase out of fossil fuel vehicles. Lastly, I expect improvement in air quality and reduction in noise pollution as fewer fossil fuel vehicles are found on campus. This project should ultimately lead to broader impacts within the university. Through implementation of an electric vehicle procurement policy and making more sustainable choices, I believe NAU will start choosing to seek out alternative solutions and shift the culture. This has the potential to cement NAU as a university leader on the path towards a truly sustainable campus and create a blueprint for other universities to model. Lastly, funding this work will help create a more resilient, independent campus as we head into an uncertain future affected by climate change. It would be wise for university leaders to establish energy independence from potential future oil shortages and volatile changes in gas prices from civil unrest and displacement as the world faces a warming climate. I truly hope you choose to help turn this into action.

## Jordan Masayesva

**Project: Data Acquisition System for Small Wind Turbines**

**Approved Amount of Funding $5000**

**Abstract**:The purpose of this research is to design and build a suitable data collection system for small wind turbines in controlled air flow. This device will effectively reduce random errors and correct for systematic errors in the processing of sensor inputs into analog outputs and interface. Growing interest in renewable energy and the Collegiate Wind Competition Capstone CWC) project are requiring a need for accurate and reliable data collection system used in competition. A data collection device that mimics the point of common coupling (PCC) similarly used by the Department of Energy to evaluate CWC wind turbines. This requires the device to provide a minimum sampling frequency of 200 Hz, detect noise turbine power output, and measure open circuit voltage when the turbine is disconnected from PCC (see figure 1). The construction of this system will provide useful parameters to characterize the unique turbine designs that undergraduate engineering students are continuing to improve upon.The conclusion of the project will provide a device to produce accurate, complete and consistent data representative of built in data quality assistance. The device will also provide useful parameters to characterize the unique turbine designs that undergraduate engineering students are continuing to improve upon. Additionally, useful impacts of this device to Northern Arizona University range from a research tool to outreach. A research tool for future and old CWC capstone projects is invaluable for NAU to remain competitive. An utreach tool used at NAU and the surrounding community to inform and demystify the conversion of renewable to usable energy.

## Sarah Pytleski

**Project: Is an In-Vessel Composting Feasible at NAU?**

**Approved Amount of Funding $1890**

**Abstract**:I propose to conduct initial research on in-vessel composting units that could potentially be used at NAU or off-campus in restaurants and homes. The results will be a determination of which in-vessel composting systems may be most efficient in terms of cost and time to create compost. After this research, I will either buy a unit or construct one on campus.Impacts of this project will be reduction of food going into landfills, educating students about composting, making compost for a greener campus, starting a data set for a BIO 499 or a cross-listed capstone class, and building the foundation of a network of in-vessel composting units across Flagstaff.