GREEN FUND

Sustainability Through Student Innovation

Project Application

Green Fund Mission Statement: "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 on-campus."

Requirements for Funding:

- The project must be implemented on campus.
- The person submitting the project must be a NAU student, faculty, or staff member.
- Projects must provide all necessary documents, letters of support, and authorizations prior to submission.
- The Green Fund distributes funding on a **reimbursement basis**. Project teams should partner with an administrative office to provide upfront funding for the project. Once the project has been successfully completed, the Green Fund will reimburse the administrative partner.
- All project applications should be submitted to greenfund@nau.edu for review.

Disclaimer: All applications will go through a comprehensive vetting process. We highly recommend meeting with a Green Fund Committee member prior to submitting the application. The Green Fund Committee member will assist you with every step of writing your project application. If your project is approved, you may be asked to provide more detailed information regarding specific deliverables. The Green Fund is not responsible for acquiring the necessary permits, permissions, or approval for a project, although we are happy to assist with this process if needed. Additionally, the Green Fund does not provide any ongoing maintenance costs. A sponsoring department must take responsibility for operations and management.

Review Process: Upon project application submission, the Green Fund will review your project within two weeks. At this time, the Green Fund will provide comments on the project. Incomplete applications will not be reviewed until all components are submitted. **Note:** The Green Fund Committee only meets during the academic year. All projects submitted outside of the regular academic year will be reviewed at the start of the next academic session.

Contact Information

Project Leader Name: Joseph Thomas Phone: 302-650-6715 E-mail: jt2286@nau.edu

Additional Project Leads: Stephanie Arcusa: sha59@nau.edu, Anona Miller: alm778@nau.edu

Project Advisor Name: Dr. Deborah Huntzinger Phone: 928-523-1669 E-mail: deborah.huntzinger@nau.edu

Additional Project Advisors: Nick McKay: nicholas.mckay@nau.edu, Kevin Gurney: kevin.gurney@nau.edu

Sponsoring Department: School of Earth Sciences and Environmental Sustainability

Project name: Campus Environmental Monitoring Station

NAU Department/Unit for funding reimbursements (Attach letter of commitment from departmental representative): School of Earth and Sustainability (SES)

Project Overview

Executive Summary

Please provide a brief overview of your proposal. Please address how this project will support the goals of the Green Fund (student involvement, creating a culture of sustainability, and lessening NAU's impact):

The Campus Environmental Monitoring Station (CEMS) will provide a sophisticated weather station and air quality monitor to Northern Arizona University's Flagstaff Mountain Campus. This station itself will collect real time data on weather variables (such as air temperature, precipitation, wind speed, wind direction, solar radiation, lightning detection, humidity, and air pressure) and air quality (particulate matter (PM 2.5 and 10), nitrogen dioxide, sulfur dioxide, carbon monoxide, ozone, and carbon dioxide). Currently, Northern Arizona University does not have a weather station or air quality meter that collects data on all of these variables simultaneously.

Microclimate conditions across the city of Flagstaff result in disparate weather, necessitating a campus focused environmental monitoring system. For example, a recent snowstorm (December 23-26, 2019) provides evidence of this disparity with 14.1 in of snow accumulating at the Flagstaff airport, 5-10 in. in west Flagstaff, and only 2-3 in. in east Flagstaff despite these locations being only 1-3 miles away from each other (National Weather Service Flagstaff). A highly advanced environmental monitoring station, as proposed in this application, will provide a long term data set of each of the variables described above, specific to campus, and at high resolution. Current weather stations on campus collect simple weather data such as temperature, wind speed, wind direction, and humidity. The primary weather station that collects year round data is run by the School of Earth and Sustainability (https://www.cefns.nau.edu/~nauws/index.html). The Campus Environmental Monitoring project seeks to expand on NAU's current capabilities and provide more sensitive sensors for each of these variables as well as collect new ones such as solar radiation, lighting detection, doppler radar capabilities, and air quality measurements.

The Pulsar 800 weather station proposed in this application is a top of the line piece of equipment from Columbia Weather (https://columbiaweather.com/products/weather-stations/fixed-base/pulsar/) and the highest quality version from the Pulsar product line. The station is an all-in-one device with no moving parts, significantly reducing any type of maintenance and allowing for easy installation. Sensors included in the device measure temperature (-50 to +60℃; ±0.2°C), relative humidity (0-100%; ±2%), precipitation type (drop size 0.3-5 mm; resolution 0.01 mm), precipitation intensity accumulation (responding resolution of 0.01 mm), air pressure (300-1200 hPa; ±0.5 hPa), wind direction (1-359.9°; ±3°), wind speed (0-75 m/s; ±0.3 m/s), solar radiation (response time < 1s, accuracy of 5%), lightning detection (coverage area of 5-10 km), and contains an electronic compass. Sensors for climatic parameters that are continually measured (temperature, humidity, and air pressure) collect data at 5 second intervals. Other sensors that are detection based (wind speed and precipitation) are collected at extremely low thresholds (0.2 mph and 0.002 mm respectively).

The Orion AQM Plus air quality monitor proposed in this application is also a top of the line device produced by Columbia Weather (https://columbiaweather.com/products/air-quality/). The monitor measures suspended particles (PM 2.5 and PM 10; 0.3 - 10 µm; sampling time = 60s, sampling interval = 10 min), concentration of gases (NO_2, 5-2,000 ppb, ±25 ppb; SO_2, 5-2,000 pbb, ±60 ppb; CO, 10-10,000 ppb, ±200 ppb; and O_3, 5-2,000 ppb, ±50 ppb). Additionally a CO_2 sensor has been proposed as an addon to the air quality monitor (0-1000 ppm, ±40 ppm). Sampling time of each gas is 10 minutes. A significant advantage of ordering a dual system such as the combination Pulsar 800 and Orion AQM Plus sensor systems from Columbia weather is that both systems seamlessly share data on the same microserver (Weather MicroServer), both mounted on the same tower, and can share a solar power system. FTP output of data from the Weather MicroServer allows for university network communication, web display of live data, and SQL storage of long term data.

Long-term, high resolution weather and air quality measurements on campus would provide a vital dataset to help improve understanding about campus weather and air quality patterns, and can be used to inform future sustainability related projects. For example, highly accurate wind speed and direction measurements will

benefit future campus wind power projects, of which there is an already existing and robust wind power research group (https://in.nau.edu/clean-energy-research/wind-for-schools/). Measurements of solar radiation intensity and timing over the course of a year will improve the ability to implement campus specific solar panel projects. Data collected on the timing, volume, and type of precipitation throughout the year will assist in understanding hydroclimate variability and potential wildfire risk. Measurements of particulate concentration in the air will allow the university to understand the impacts of wildfire activity and transportation emissions on student health. Additionally, long term campus specific datasets will improve the efficiency and management of both vegetable and native plant gardens on campus (https://in.nau.edu/green-nau/gardens/).

An environmental monitoring station that collects extremely high resolution and highly accurate data will also provide an excellent learning tool for students from a variety of disciplines. Specifically, ENV360 (Physical and Chemical Processes in the Atmosphere and Hydrosphere) has committed to utilizing data provided through this project to develop lab activities based on individual sensors. More generally, statistics or environmental science courses can utilize the data sets collected to practice statistical analysis. Engineering students can use the wind speed and solar radiation data to develop alternative energy infrastructure projects. Environmental studies and science students can utilize the general weather data to further understand how weather is changing on campus. Health or biology students will be able to utilize the particle size and air quality data to understand potential human health effects of air quality on campus during different times of the year. Because of the precision of the proposed environmental monitoring station, data collected will be able to be used by undergraduate students completing capstone projects as well as graduate students and faculty conducting research. Additionally, high precision data could help facility services forecast energy usage and adjust heating and cooling services. Currently, a faculty member is assigned the task of reporting campus weather conditions to the administration during snow storms, requiring a physical presence on campus. A high precision weather station would provide campus specific weather conditions and allow for remote access to snow accumulation data.

The proposed location for the CEMS is the roof of the International Pavilion. This site has been selected for two reasons. First, the site is located geographically near the center of campus, 0.8 miles from W. Butler Ave (north end of campus) and 0.8 miles from interstate 40 south of facility services (south end of campus). A central location will allow the station to collect weather data that more likely represents an average of campus conditions. Secondly, the International Pavilion is a LEED Platinum status (the highest possible LEED certification) building and is an important facility for Northern Arizona University's commitment to sustainability. Placing the weather station on top of this building will improve its visibility to campus guests and solidify its place as the hub of sustainable building on campus.

This project will also benefit the greater community of Flagstaff, by adding an additional high quality weather monitoring station. Current weather forecasting for the community of Flagstaff is primarily from the Flagstaff Pulliam Airport weather station. The nearest doppler radar station is next to Blue Ridge Reservoir to the southeast of Flagstaff. The CEMS seeks to expand upon these current capability, but at a finer scale resolution specific to campus itself.

Baldauf, R.W., Wiener, R.W., and Heist, D.K., 2002, Methodology for sitting ambient air monitors at the neighborhood scale: Journal of the Air & Waste Management Association, 52:12, 1433-1442, doi: 10.1080/10473289.2002.10470870.

Please answer the following questions detailing the components of your project:

1. Does your project require space or construction on campus? If so, where? Please review the "Space Committee Document" located on our webpage and follow the steps to begin requesting a location.

Yes, the proposed location of the CEMS (weather station and high precision air quality monitor) is the roof of the International Pavilion. Space committee form has been sent to appropriate parties and attached to this packet of documents.

2. Have you obtained all necessary approval for this project? Please attach all letters of support to this application. Letters of support should include confirmation from the sponsoring department that the sponsoring department will cover all upfront expenses and work with the Green Fund Business Manager to acquire reimbursement after project completion. If any ongoing operations and maintenance is required of your project, provide a letter of support from the entity that will be covering those costs and/or services.

   Yes, we have provided a letter of support from both the lead faculty member and the SES department.

3. Will this project provide funding for student wages?

   No.

4. Please list all additional sources of funding you have pursued. Include departments, grants, ASNAU, Graduate Student Government, etc.

   Initial funding before Green Fund reimbursement will be done by the School of Earth and Sustainability.

5. Have any of the Green Fund Committee members been involved in this project?
   a. If Yes, please identify all committee members:

   Yes. Joseph Thomas, the Green Fund Graduate Student Representative is the project leader.

Project Specifics

Please address the following questions. One or more of these questions may not apply to your particular application. Answer as many questions as are applicable to your project.

Relationship to NAU Climate Action Plan (CAP)

1. How does your project align with one of the seven CAP categories (Energy, Water, Transportation, Waste Minimization, Sustainable Landscaping, Environmental Justice, Communication)?

The CEMS meets several of the NAU Climate Action Plan goals including energy, water, sustainable landscaping, and communication. Data from the station will provide a high quality foundation for the development of alternative energy projects and research. These projects will then improve the energy usage of the university and reduce net carbon emissions. High quality information about precipitation volume and timing will inform facilities services as to the timing and volume of water applied to green spaces across campus. This data will allow for a reduction in the amount of water utilized by the university and prevent unnecessary watering. Sustainable landscaping projects will benefit from the long term weather data collected by the station. High quality information about average daily temperatures, the timing and volume of precipitation, and timing of first and last freeze each year will improve maintenance and development of landscaping projects. As a publically available data set, the environmental monitoring station will provide both the university community and the public with high quality data to be used in a variety of ways. Public web displays of this data will also serve as communication between the research community at NAU and the general population of Flagstaff.

Community

2. Is there a public outreach plan? How will faculty, staff, and students learn about this?

The CEMS project is working in conjunction with the Campus Dashboard project (official name yet to be decided). Data collected from both the weather and air quality sensors will be displayed on the dashboard and available to any interested party. Outreach about the monitoring station will be bundled into outreach about the campus dashboard as a whole.

3. Are you working with other groups on or off campus? If so, describe your partnership.

This project is being proposed as a portion of the Campus Dashboard project is a collaborative effort between the Graduate Student Government and the Green Fund. Additionally, faculty sponsors of the project include representatives of two departments (College of Earth and Sustainability and School of Informatics, Computing, and Cyber Systems). Each of these partnerships have contributed ideas and support to this specific application as part of a broader approach of improving sustainability on campus.

Project Parameters

4. What are the environmental costs and benefits associated with your project?

The CEMS produces minimal environmental costs. The sensors will be placed on the top of an academic building, removing any ecological impacts, and will be completely powered by solar power, reducing any potential greenhouse gas emissions. The primary environmental costs are in the production and shipping of the sensors themselves, which are a challenge to quantify but thought to be minimal. While there are no direct

environmental benefits of implementing this system, as its primary goal is data collection, the data collected from this project will have substantial benefits to the university community as described above.

5. Provide an economic cost/benefit analysis for your project. Focus on identifying specific cost savings.

Although less expensive weather and air quality measurement stations exist, they do not provide such high quality data as the system proposed in this application. An example is the AcuRite ATLAS Weather Station (https://www.acurite.com/acurite-atlastm-weather-station-with-lightning-detection.html) which retails for $319.97. This station measures similar (but not all) weather variables that the Pulsar 800 does (temperature, humidity, wind speed, wind direction, rainfall, solar intensity, and lightning) but at a reduced quality and time interval. For example the air temperature measurement is >3.5x more accurate and precipitation volume is 25x more sensitive on the Pulsar 800. Because of this difference and the potential use of the monitoring station in research, a more expensive and more accurate station is necessary.

6. Is this a one-time expense or will you require future funding?

One-time expense.

7. When your project members no longer attend NAU, who will be responsible for running the project?

Dr. Deborah Huntziner of SES has committed to maintaining the Campus Environmental Monitoring Project in the future. This is supported through a letter of recommendation for this project.

8. How will you monitor the impact of your project after implementation?

Impacts of the project will be monitored in conjunction with the Campus Dashboard project and quantified through a combination of page views and data downloads. Additionally a survey will be sent out to all students and faculty once a year to both improve general awareness of the weather station and collect information about the number of system users.

Project Budget

Please include a thorough breakdown of all project costs, **as well as a 5% line item for contingency**.

Example:

NAU Campus Environmental Monitor			
Item	**Price**	**Quantity**	**Total**
Pulsar 800 Weather Station	6,233.40	1	6,233.40
Orion AQM Plus Air Quality Transmitter	8,986.50	1	8,986.50
Carbon Dioxide Sensor with 50ft cable	1,113.30	1	1,113.30
Weather MicroServer	1,193.40	1	1,193.40
WeatherMaster Software - Windows	394.20	1	394.20
Lightning Arrester - surge protection	748.80	1	748.80
RS-232 to RS-485/422 Converter with power supply	299.70	1	299.70
Weatherproof Enclosure for MicroServer, DC Power	421.20	1	421.20
Solar Power System, 40Watt	1,465.20	1	1,465.20
Tripod, 10-ft telescoping sensor mast with guywire kit and tiedown kit	544.50	1	544.50
Weather Station / Air Quality Monitor Shipping Charges	335.00	1	335.00
Installation (IT and Facility Services)	500.00	2	1,000.00
Subtotal			**$22,735.20**
Taxable Portion			**$21,735.20**
Taxes	(9.181%)	1	1,995.51
5% Contingency			1,136.76
Total Campus Environmental Monitoring Station Cost			**$25,867.47**

Project Timeline

The timeline should include significant implementation dates for your project. Please add information such as shipping time and consider any holidays or breaks.

Campus Environmental Monitoring Station Timeline		
Action	**Parties Involved**	**Month/Year**
Purchase station materials.	Project Leaders, Faculty Supervisor, Green Fund Committee Member	March, 2020
Install the weather station with assistance from IT and facility services. (There is currently a 10 week lead time for shipment of the weather station and air quality monitor)	Project Leaders, Faculty Supervisors, IT services, Facility service	mid May, 2020

Project Checklist

Please ensure you have completed all of the following items before submitting your application:

☐ Meet with a Green Fund Committee member
- Completed

☐ Obtain all necessary letters of support (sponsoring department, ongoing maintenance, etc.)
- Completed

☐ Project Overview
- Completed

☐ Project Specifics
- Completed

☐ Project Budget
- Completed

☐ Project Timeline
- Completed

☐ Complete Project Checklist
- I completed the complete checklist of completion.

Thank you for your submission. We deeply appreciate your commitment to sustainability at NAU, and we look forward to working with you.