

Northern Arizona University
Green Fund
**Annual Project
Review**

August 2015



**NORTHERN ARIZONA
UNIVERSITY**

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Introduction

The student body of Northern Arizona University (NAU) established the Green Fund in March of 2010. The fund was set up in the form of a \$5.00 per student semester fee, and was established to motivate NAU's campus to pursue the goal of sustainability. The Green Fund's mission statement is as follows: "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." The Green Fund committee is a primarily student-based group and Green Fund project proposals can come from students, faculty and staff. All funded projects are required to have a goal of reducing the carbon emissions directly on campus and/or contributing to the culture of sustainability on campus. The Green Fund voting committee, which consists of six students and three non-students, vote on the proposals. The Green Fund voting committee has consisted of 50 student/faculty members since 2010.

The NAU Green fund has funded over 40 projects and has spent a total of \$794,210 to date. The results of the funded projects range from increased awareness of sustainability initiatives on campus, the creation of a more sustainable culture, and a reduction in greenhouse gas emissions. In 2012, the Green Fund committee received the Environmental Caucus' Campus Sustainability Award in the Student Group Award category for all the successful projects it has funded. In 2015 the Green Fund committee won the Environmental Caucus' Organization Sustainability Award. This award is to "recognize those who have enhanced the culture of sustainability on the NAU campus and surrounding community."

The Green Fund committee received the award based on their dedication, hard work, and leadership throughout the process of planning and negotiating the implementation of the NAU solar project with NAU's top administrators. The project consists of installing solar panels on top of the San Francisco Parking Garage. The Green Fund committee showed their passion for this mission by performing extensive research on the project and engaging the NAU community with an idea that many students saw as a win-win situation. The award is an effort to recognize the Green Fund committee's valuable initiative that ultimately led to the approval of the NAU solar project, which will provide clean energy to NAU's campus. The Green Fund is also an Arizona Forward finalist for the Governor's Award for Arizona's Future for its installation of six solar hot air heaters on the side of Property Surplus. The Green Fund will be receiving an Award of Merit on September 12, 2015.



The intent of this report is to summarize and provide updates on the projects the Green Fund have approved during the 2013 and 2014 school years and to analyze any possible carbon reductions that were achieved as a result of these projects. Eight more projects have been approved for the 2015 school year, and efforts to implement these projects around campus are already in motion. However, most of these projects are still in their infant stages and thus will not be evaluated in this report with the exception of the solar optimization project.

Sustainability practices are very important to most NAU students. According to data obtained from a student survey given in 2012 regarding the Green Fund and sustainability projects, 74% of students responded that “Integrating sustainable practices (such as use of renewable energy and energy efficiency) into university life is worthwhile”. More than half the students (55.7%) also reported that it is “Very important” that NAU should be a leader in renewable energy and energy efficiency.

Student priorities are very important to the Green Fund, so projects are planned and approved with student’s needs being the highest priority. The funded projects mentioned in this report have been broken down into categories based on the type of project as well as the importance to students, and are listed underneath each project heading. Some categories are more focused on greenhouse gas emission reduction, while other projects are more focused on creating a culture of sustainability on campus. Greenhouse gas emission reductions are stated with the project description when appropriate. The categories are listed as follows:

Renewable Energy

In the 2012 student survey, when asked to indicate the importance of “On-campus renewable energy installation (such as solar, wind, or biomass), 42.9% of students answered “Very Important” while 37.2% answered “Somewhat Important”.

Recycling/Reducing Waste

In the 2013 student survey, when asked “What type of projects the Green Fund should be funding”, 70% of students responded that they would like to see recycling-focused projects.

Energy Efficiency

In the student survey in 2012, 74% of students responded that sustainable projects, including energy efficiency, were worthwhile. 52.6% of students also responded that “Building efficiency upgrades (such as weatherization, low-flow showers and toilets” are “Very Important”, while 28.7% of students considered them “Somewhat Important”.

Sustainable Lifestyle

According to the 2012 student survey, when asked “How strongly you agree or disagree with the following items”, 45.4% of students answered “Strongly Disagree” to “Learning about sustainable practices is irrelevant to my college experience.”

Reduced carbon emissions calculated in this report are based off of EPA eGRID emission factors and can be found at http://www.epa.gov/cleanenergy/documents/egridzips/eGRID_9th_edition_V1-0_year_2010_Summary_Tables.pdf. However, NAU’s electricity emission factors may be slightly lower than the EPA eGRID emission factors since NAU purchases more than eight million kilowatt-hours (kWh) of green power, which powers 13% of NAU’s electricity. NAU buys a combination of renewable energy certificates (RECs) and utility green power products from Arizona Public Service (APS) and Renewable Choice Energy.

Funded Projects

Biomass Feasibility

Approval Budget: \$10,000

Approval Date: April 15, 2013

Project Advisor: Nick Koressel (928) 532-0443 Nick.Koressel@nau.edu

Category: Renewable Energy



This project was a research study funded by the Green Fund along with the Ecological Restoration Institute (ERI), Enrollment Management and Student Affairs, Finance and Administration, the Office of the Provost, and the Office of Research. The goal of this project was to provide better understanding of the potential for biomass energy production, using locally available forest waste, utilizing local labor, and supporting the regional economy while reducing NAU's consumption of fossil fuels. The university retained TSS Consultants to perform the feasibility study.

The study reviewed three project scenarios that increased proportionally in size and complexity to allow visualization of multiple levels of project effort and the resulting economy to scale. Each of these projects was focused on supplying the university its energy needs with an alternative to fossil based fuels. Techniques focused on cogeneration strategies of producing electricity and using the waste heat for campus energy needs. The three scenarios were as follows:

Project	Project Size	Project Focus
1) Biomass to Heat	20 MMBtu/hr	South Campus Heating and Cooling Plant
2) Biomass to Electricity - Behind the Meter	2.5 MW	To Feed the North Campus Electric Meter
3) Biomass to Electricity Total Campus Power Generation	10 MW	To Provide All NAU Campus Electricity

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The study focused on biomass from two main sources, which were forest-source material and byproducts of forest products manufacturing. The study did not consider household waste biomass or urban wood sources. An adequate source of biomass was found to be available for all three projects, with an expected average cost of \$28/BDT.

The potential for greenhouse gas offsets were estimated as follows:

Project	Potential Carbon Reduction (MT CO₂e)	Percent Reduction¹
1	3,292	5.3%
2	10,111	16.4%
3	33,155	53.8%

¹ Calculated with Clean Air-Cool Planet Campus Carbon Calculator based on APS average electricity blend and the projected load displacement per the Energy Load Assessment.

Due to the current low cost of natural gas and electricity, only Project 1 was found to be economically feasible at this time given the current energy rates. The payback period is noted below:

Natural Gas Price (\$/Therm)	Internal Rate of Return	Simple Payback Period (Years)
\$0.56 ²	1.8%	23.6
\$0.80 ³	9.3%	12.7
\$1.81 ⁴	55.8%	4.3

² The lowest Therm price paid since 2000 based on NAU's price structure.

³ The current Therm price as directed by NAU's project team.

⁴ The highest Therm paid price since 2000 based on NAU's price structure.

The three projects were all found to have a proportionally similar impact on carbon emissions and show a way forward to carbon neutrality, but only if this goal is placed above the incentive for economic returns. Biomass also has various societal benefits and has a positive impact on forest health. For more information and recommendations for taking the next step, please visit the full biomass feasibility report at

<http://nau.edu/Green-NAU/Forms/Biomass-report/>.

Wind Turbine

Approval Budget: \$61,037

Approval Date: April 15, 2013

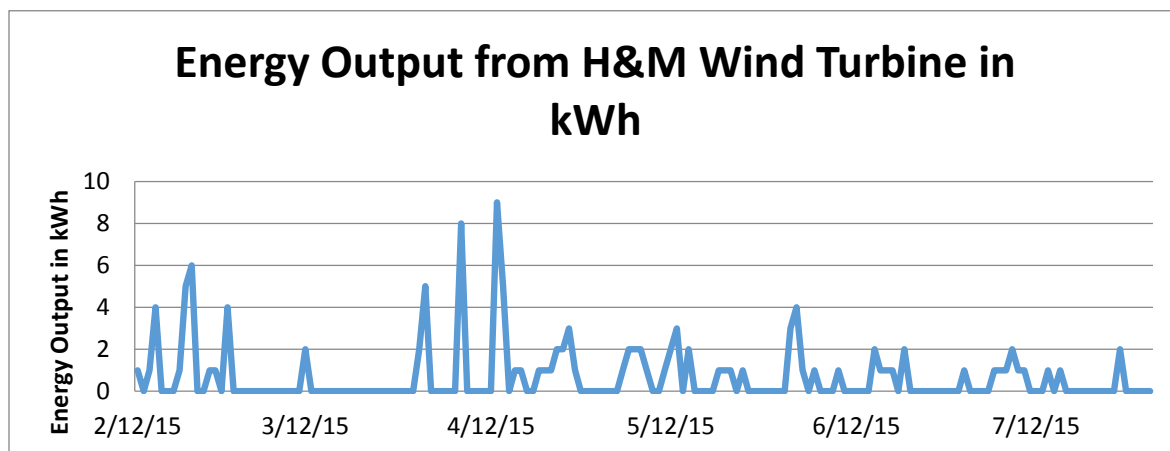
Project Advisors: Marilla Lamb (610) 334-0418 marilla.lamb@gmail.com
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Category: Renewable Energy



This project consisted of the installation of a 2.4 kW Skystream 3.7 wind turbine on a 45-foot tower near the Hotel and Restaurant Management Building on the north campus of Northern Arizona University. This turbine is similar to the other wind turbine that was installed on campus at the Applied Research and Development (ARD) building in 2011. Onsite generation of renewable energy is crucial in regards to reducing carbon emissions, and turbines serve as a visible symbol of the University's commitment to carbon neutrality. Wind turbines can also serve as an opportunity to educate students about green energy, helping them understand renewable energy systems.

The graph below shows the Energy Output recorded from the wind turbine through July 2015.



The H&M Wind turbine total kWh the wind turbine has produced to date is 234 kWh. The carbon equivalent emissions prevented from this wind turbine were calculated using EPA eGRID emission factors. These eGRID factors are based off of environmental attributes of Eclectic power systems and are divided by region. The eGRID factor used for these calculations is the 2010 AZ/NM region and the numbers can be found at http://www.epa.gov/cleanenergy/documents/egridzips/eGRID_9th_edition_V1-0_year_2010_Summary_Tables.pdf.

Using these eGRID factors and converting the CO₂, CH₄, and NO₂ emissions into CO₂e the estimated carbon saved by this wind turbine as of the end of July 2015 is 277 lbs CO₂e.

Oil Refinery

Approval Budget: \$3,500

Approval Date: February 5, 2014

Project Advisors: Chris Johnson (928) 523-2469 Christopher.Johnson@nau.edu
Ellen Vaughan (928) 523-1791 Ellen.Vaughan@nau.edu

Category: Recycling/Reducing Waste



The purpose of this project was to provide the Facility Services Transportation Department containers and pumps to purchase oil from Eco Power, a recycling oil company. Previously, the department was using new oil from a vendor that supplied them with containers and pumps, and in order to switch over to EcoPower they needed to provide their own equipment.

EcoPower uses oil that is reclaimed motor oil, which can be refined, recycled, and reused indefinitely, helping to preserve our limited resources. EcoPower ensures that the oil is not improperly disposed, which keeps motor oil out of our precious land and water. EcoPower also uses the least amount of plastic possible to keep plastic out of landfills. The company achieves this by distributing 95% of their motor oil in bulk. EcoPower only has one packaged product, which is a 5-quart bottle, and is only for dealers who do not have enough of the necessary bulk storage space.

According to EcoPower, their refining process is better for the environment, and takes up to 85% less energy to produce compared to oil refined from crude. One gallon of their reclaimed motor oil equates to the same amount of engine oil as 42 gallons of crude. Their refining process produces 300,000 metric tons less greenhouse gas

emissions per year, compared to traditional refining. Apart from being more efficient, EcoPower meets or exceeds the toughest North American standards for engine protection, including the Society of Automotive Engineers (SAE), the American Petroleum Institute (API), and the International Lubricant Standards Advisory Committee (ILSAC). *

Transitioning NAU's vehicle oil usage from new to recycled oil requires less crude oil to be extracted, transported, and disposed into the waste stream. This transition allows NAU to reuse resources by using readily available practices, ultimately improving sustainability and reducing carbon emissions.

The oil purchased from EcoPower is not only better for the environment, but it is also cheaper. It is estimated that NAU purchases over 1,500 gallons of oil per year. Previously, NAU was spending \$5,100 per year on oil, but after switching to EcoPower, oil only costs around \$3,900 per year. With \$1,300 in yearly savings, the Green Fund project has an estimated payback period of only three years.

* For more information, please visit <http://www.ecopoweroil.com>

Eco-Reps

Approval Budget: \$24,085

Approval Date: March 5, 2014

Project Advisor: Cori Cusker (928) 523-5063 cori.cusker@nau.edu

Category: Sustainable Lifestyle



Eco-Reps are student role models that provide peer-to-peer education on how to live more sustainably in NAU residential communities. This includes increasing students' awareness of their everyday lifestyle choices as well as increasing their understanding of the effects an individual can have on the environment. The Eco-Rep program's primary goal is to promote behavior changes that will continue throughout the students' time living on campus and beyond.

The funding for this project was allocated to continue the Eco-Rep program and increase funding for additional projects. One project aimed to increase waste minimization efforts in residence halls, expand recycling education, and enhance the responsibilities of Eco-Reps. This was done in an effort to help facilitate the collection of items that are inconvenient to recycle, such as glass, CFLs, and batteries. Eco-Reps also began participating in the Terracycle program, which consists of collecting hard-to-recycle items and mailing them to the Terracycle company to be recycled. During the spring 2014 semester, the Eco-Reps submitted 2,738 items to Terracycle, which resulted in earning 6,076 points from the company that will be used to benefit a non-profit agency with a cash donation. The Terracycle program will be expanded and continued during the 2015 – 16 academic year. Eco-Reps also recycled ink cartridges and batteries through Facility Services.

On March 27, 2015 the Eco-Reps went around campus in teams to confirm that unoccupied class rooms and common spaces had their lights turned off and that the appropriate equipment had been powered down both for the weekend and also in anticipation of the campus Earth Hour event the following day.

Eco-reps used the additional funding they received to also learn about and provide information to residents on Waste Minimization, Energy Conservation, Food Systems, Water Conservation, and Conscious Conservation. The Eco-Reps completed 45 tabling events, made contact with approximately 1,107 residents, implemented 48 passive education campaigns, and completed 18 “Did You Know slides for the residence hall E-bulletin boards.

Eco-Reps are also in charge of the Eco-Fashion show that has been held for three years in a row. The 2015 Eco-Fashion show was another successful event, and had 200 people in attendance, showcasing student musicians and dancers along with almost 20 creative student costume designs.

Educational programs such as Eco-Reps are important to promoting a sustainable culture on NAU’s campus. Educating students about the importance of sustainability during their freshmen year is important to minimizing greenhouse gas emissions on campus through making students cognizant about the topic and encouraging them to continue living a sustainable lifestyle.

Greening SI

Approval Budget: \$8,689

Approval Date: March 5, 2014

Project Advisors: Alicia Krzyczkowski (928) 523-9190 Alicia.Krzyczkowski@nau.edu

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Category: Recycling/Reducing Waste

Supplemental Instruction (SI) is a series of peer-facilitated weekly review sessions for students that need extra help with challenging courses. SI sessions are an opportunity for students to discuss and review important concepts from class, develop study strategies, and ask questions. SI leaders commonly use paper handouts such as worksheets and assist with test review during their sessions. The funding for this project was used to help cut back on paper usage during SI sessions, and instead use energy efficient projectors.

The project consisted of providing four dedicated SI rooms that previously had no projector technology with a computer, podium, and LED projector. Before implementing the projectors, SI leaders printed out over 60,000 handouts per semester. SI staff created a survey for the SI leaders, and found that that leaders who were using handouts, expressed that, if they had a projector it would make it easier to print fewer handouts. Apart from installing the projectors, this project also integrated Sustainable Behavior Change components into SI leader trainings. These trainings helped SI leaders learn to create interactive (paperless) activities and to utilize electronic “handouts” in and beyond SI sessions to facilitate learning, and to use the projectors/electricity responsibly.

Although projectors do consume energy resources, the LED projectors that were chosen consume only 145 watts of energy opposed to 240 watts in a standard LCD projector. The table below shows that in total these four projectors will contribute .12 tons of CO₂ emissions to the atmosphere per semester and that 60,000 handouts a semester produces a carbon footprint of 0.41 tons of CO₂*.

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Handouts for SI attendees (Fall 2013)		LED Projector	
Location	Handouts/semester	Location	Projector KWH/semester
SI Office (HLC)	23,721	DuBois - Hopi	58
South SLC	5,000	DuBois - Yavapai	58
College of Business Student Services	18,000	Biology 224	58
Biology Office	6,000	Chemistry 117	58
Chemistry Office	10,000		
Total SI Leader copies	62,721	Total KWH	232
Total reams of paper	126		
CO2 emissions			
Paper copies	.41 tons	LED projectors	.12 tons

*CO2 emissions calculated at <http://www.climatefriendly.com/Business/BusinessCalculators/>

Originally, the goal of this project was to reduce SI leader handouts by 30% in the fall 2014 semester, and to achieve a 50% reduction by the end of the academic year (AY) 14-15, as compared to the AY 13-14 numbers. These goals were exceeded instead, with a 68% reduction in the fall 2014 semester and an 86% reduction in the spring 2015 semester, with an overall reduction of 77%. This reduction leads to a carbon footprint reduction of 0.21 tons per semester, which includes the paper still being used and the new projectors. This relatively small investment in technology along with education and sustainable behavior change has already reduced the carbon footprint down to half of what it was previously. Eventually, the SI sessions may cease the use of paper completely, and could potentially reduce their carbon footprint down to only 0.12 tons of CO₂ per semester, a 23% reduction in CO₂ emissions.

Weigh Scales

Approval Budget: \$78,771

Approval Date: April 2, 2014

Project Advisor: Avi Henn (928) 523-6024 abraham.henn@nau.edu

Category: Recycling/Reducing Waste



In order for NAU to quantify the tonnage of solid waste and recycling generated on campus, it was necessary to install front loading scales on four City of Flagstaff trucks and provide funding for operation maintenance for three years. Knowing the tonnage of solid waste and recycling generated on campus provides a baseline that allows NAU to quantify the greenhouse gas emissions associated with solid waste generations, and to evaluate the effectiveness of any future waste reduction strategies.

After discussing other options for measuring waste, it was agreed upon that the front-loading scale system was the most efficient choice. The front load scale takes an initial weight before the contents are tipped into the dump truck, and then it records the weight after the tip. This process ensures that the waste in the truck is the only thing being measured. The data is automatically uploaded to a database housed in Facility Services where it is kept and maintained. This system also allows for a building-by-building breakdown of waste produced on campus providing NAU with a better picture of how and where solid waste is generated on campus. After three years of funding, the project will be reevaluated and if deemed useful will be funded long-term.

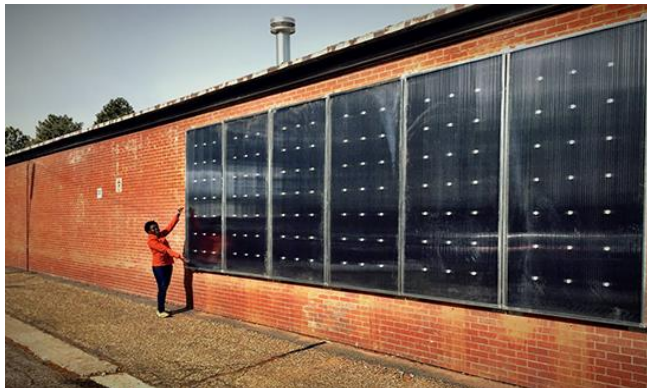
Solar Hot Air Heaters

Approval Budget: \$10,352

Approval Date: November 25, 2015

Project Advisors: Rachelle Berry (760) 521-8542 Rachelle.Berry@nau.edu
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Category: Renewable Energy

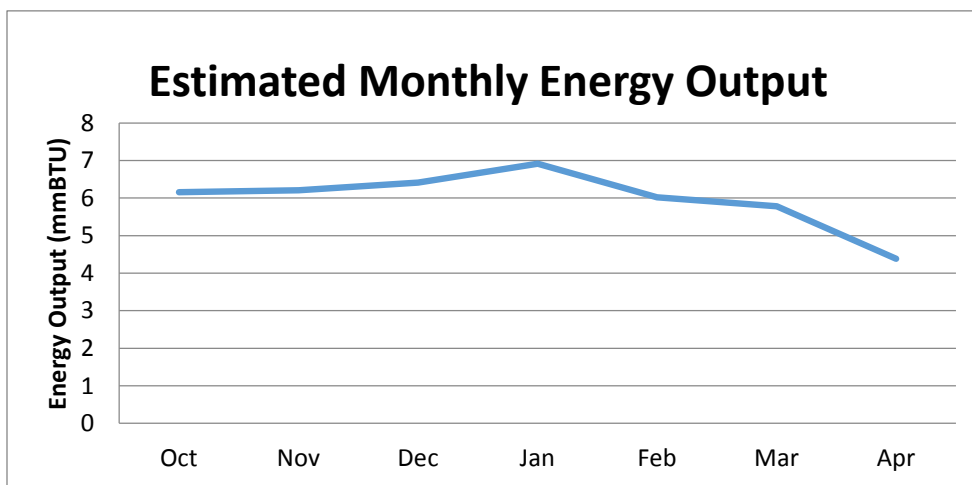


The expenses for this project consisted of purchasing six solar heaters for the Campus Surplus on the NAU campus, and it is the most successful carbon reduction project of the year. The solar heaters are manufactured by an Arizona company called SolarThermiX LLC and are the first test for the feasibility of wide spread use of the solar heaters on campus. These solar heaters will help replace NAU's natural gas usage with a clean renewable energy.

Flagstaff receives a generous amount of 300 days of sunlight per year. When combined with Flagstaff's significant heating energy requirements, these solar heaters were considered an excellent match to provide clean heating. Each panel can heat a 1000 sq. ft. building by itself completely replacing the existing heating system's output during a sunny day. Assuming the heating season lasts from October to April, it was estimated that the panels would produce approximately 42 MMBTUs each heating season. This is

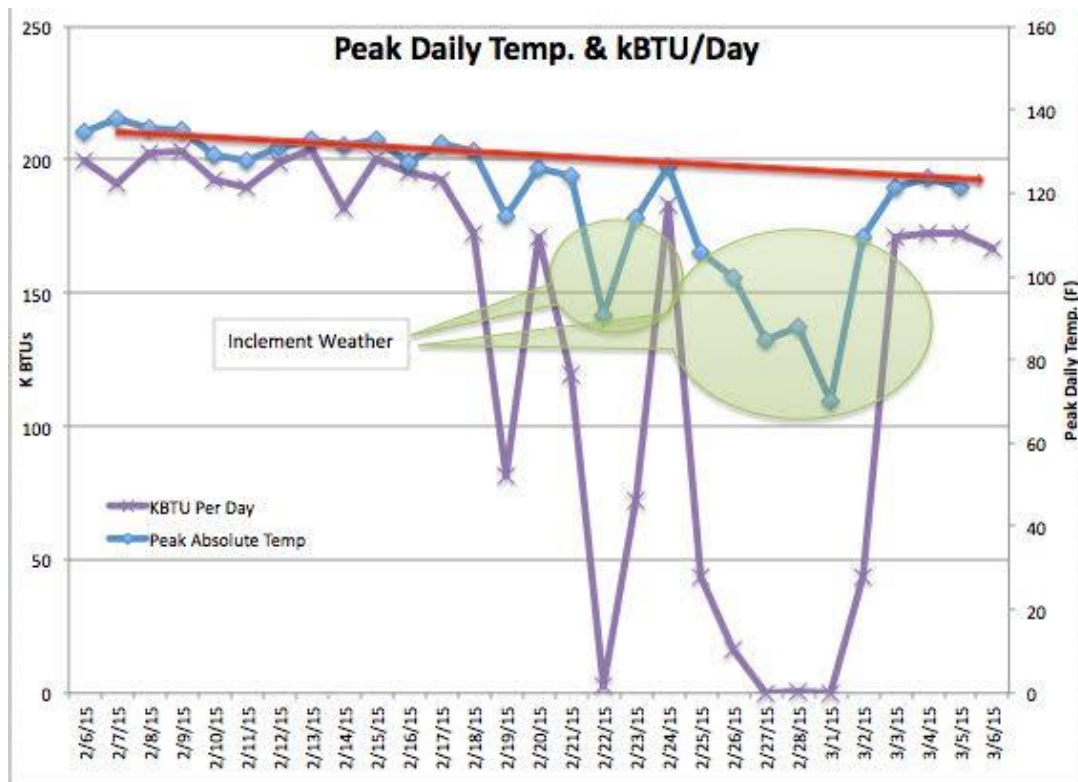
based off the average solar irradiance¹ Flagstaff receives monthly. The table and graph below shows the estimated monthly energy output based off of these assumptions. The increasing output in MMBTUs from October to January and the decline from January to April is the result of the solar angle of incidence, i.e., the sun moving higher in the sky during summer and lower in the winter. Since the panels are mounted at a 90-degree angle, as the sun rises higher in the spring and summer months less sunlight hits the panels reducing BTU output. The decrease in BTUs produced as spring approaches is offset by the reduced heat requirements due to warming outdoor temperatures. The decreased sunlight on the panels in the warmer months also helps prolong their lifespan.

	Oct	Nov	Dec	Jan	Feb	Mar	April	Total
Estimated Monthly Energy Output in mmBTUs	6.16	6.20	6.41	6.91	6.02	5.78	4.38	41.87



Actual energy output data, from the installed six panels, was measured February 6th to March 6th in 2015. This data is plotted below along with the panel's daily peak temperature.

¹ The average solar irradiance data was obtained from the National Renewable Energy Laboratory (NREL) and was based off of Flagstaff's location, the 90 degree mounting angle of the panels, the Solarthermix panel size (2.78 sq. meters), and the panel's measured efficiency (71%).



If the temperature of the panel does not reach 100°F, the fan will not turn on and consequently no heat is produced. The days with reduced output on the graph are due to clouds/fog on the corresponding days limiting heating, and those conditions are shown in the table below. The red declining line also re-enforces the fact that the sun is moving higher in the sky from the beginning of February to the beginning of March.

2015	Temp. (°F)			Precip. (in)	Events
Feb	high	avg	low	sum	
22	49	39	29	0.14	Rain , Snow
23	36	33	30	1.3	Fog , Rain , Snow
24	38	28	18	0.07	Fog , Snow
25	49	31	13	0	
26	44	34	23	T	Snow
27	40	30	20	T	Rain , Snow
28	37	35	33	0.48	Rain , Snow
March					
1	40	36	32	1.98	Fog , Rain , Snow
2	39	34	29	1.71	Fog , Rain , Snow

These six panels offset the use of natural gas, which lowers NAU's CO₂ output by an estimated 3 tons per year. The installation of more solar hot air heaters on campus could greatly offset NAU's greenhouse gas emissions.

Centralized Irrigation System

Approval Budget: \$53,626

Approval Date: December 12, 2014

Project Advisor: Nick Koressel (928) 523-0442 nick.koressel@nau.edu

Category: Water Efficiency



The purpose of this project is to reduce water consumption through irrigation of the NAU landscaping by installing a Calsense centralized irrigation control system on the North Quad, Native American Cultural Center, Skydome fields, and the Observatory fields. The North Quad, Skydome fields, and Observatory fields are all watered with reclaimed water, while the Native American Cultural Center is watered with potable water. The selection of these locations was decided based on the necessary size of the system, and whether they were easily modifiable. The previous irrigation system was controlled by individual clocks that turn the sprinklers on and off. The cost of the project included the Calsense equipment, four master vales that needed to be installed, and signage for the new system. The new Calsense centralized irrigation control system is an improvement to the previous system by:

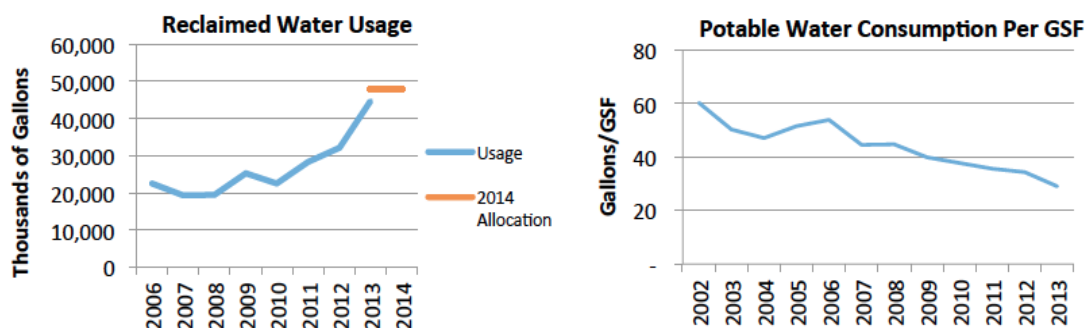
- Adjusting watering levels based on precipitation rates
- Adjusting watering levels based on local weather data
- Ability to sense line breaks and leaks and turn off the system automatically
- Remotely adjust settings from a central location rather than visiting every station in person

- Using different watering cycles such as “cycle and soak” for hard to water areas like slopes
- Ability to turn on the system with a handheld remote rather than moving back and forth between the controller and the location
- The ability to meter the water usage by location

The benefits of these features include having higher water efficiency for landscape irrigation. Accounting for precipitation rates and local weather data will ensure that watering during the rain is not an issue. Any leaks and breaks will automatically be sensed and water will be shut down in the affected areas. The new system will also require fewer maintenance costs and less time. The NAU Grounds workers will have a higher degree of control as far as turning the system on and off, which will minimize the time the system is active while maintenance is being performed. Breaks and leaks will be automatically reported to staff and they will be alerted to the broken location. Actual water consumption numbers will now be available from each location, and we will be able to get real usage numbers from irrigation. Currently, there is no way to monitor actual irrigation usage data, but thanks to the water consumption data from the new Calsense system, better planning of water usage and the ability to fine tune can be achieved.

The new Calsense system is currently being installed in July 2015. Since there is no way to monitor how much water is currently being used for irrigation, it will take at least a year of information to determine water savings. However, Calsense notes that they typically see a 37% savings based on average comparisons before and after when implementing a Calsense system.

Integrating sustainable practices into university life, such as taking advantage of the usage of reclaimed water rather than potable water, is very important to NAU and its students. However, the City of Flagstaff limits the amount of reclaimed water that NAU can use each year. NAU uses reclaimed water for flushing toilets in new and renovated buildings. As more buildings are built and renovated, the need for reclaimed water increases. For NAU to continue saving potable water it is important that the irrigation systems become more efficient. The charts below show NAU’s “Reclaimed Water Usage” and “Potable Water Consumption per GSF (Gross Square Foot)”.



Usage of reclaimed water for irrigation does not only help save water, but also reduces carbon emissions. The type, quality, and location of a water supply are the main factors that determine the energy usage in a water supply system. According to a report titled, The Carbon Footprint of Water¹, funded by The Energy Foundation, states electricity is the predominate energy source used for city's water supply and wastewater treatment systems. The City of Flagstaff's water supply comes from a variety of sources including ground and surface water². Since ground water needs to be pumped from a well, it requires more energy compared to surface and reclaimed water. The report estimates an energy intensity factor of 2,000 (kWh/MG) for ground water.

In the year 2014, NAU consumed 182,045,145 gallons of potable water and 46,059,150 gallons of reclaimed water. For the purpose of the following carbon savings calculation, it is assumed the reclaimed water replaced electricity pumped well water from the City of Flagstaff's drinking water supply. The reclaimed water is assumed to require zero additional energy as the City is required to process their wastewater to this level regardless of reclamation and the source is near the campus. With these assumptions, NAU reduces emissions of CO₂e by 49 metric tons annually through using reclaimed water.

¹ The Carbon Footprint of Water can be accessed at <https://www.csu.edu/cerc/researchreports/documents/CarbonFootprintofWater-RiverNetwork-2009.pdf>

² Flagstaff's water sources can be accessed at <http://www.flagstaff.az.gov/FAQ.aspx?QID=77>

International Pavilion

Approval Budget: \$157,705

Approval Date: December 17, 2014

Project Advisors: Dylan Rust (928) 523-3751 Dylan.Rust@nau.edu
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Category: Sustainable Lifestyle



The International Pavilion is a new LEED-Platinum facility on NAU's campus on the south side of the Campus Heights International House Community that will contain an auditorium, meeting space, and offices all established for support of international students. This project is funding for a Global Peace and Tolerance Garden that is located at a central and functional thoroughfare between Campus Heights and the International Pavilion. The garden will follow the Green Fund and students' sustainability priorities by the following:

- Retaining and promoting existing green space
- Contributing to water efficiency on campus by tapping into existing reclaimed water lines
- Contributing to water quality by providing a sustainable pre-filtration system for water that falls on the site
- Acting as an educational forum for sustainable practices by promoting native and xeriscape landscape

The garden will primarily serve as a communal space for sharing dialog and contemplation across cultural barriers. The garden will also include seating and mediation areas surrounded by signs that include quotes on peace and tolerance from prominent social justice figures in world history, as well as signage communicating the importance of sustainability on a global scale.

Solar Optimization

Approval Budget: \$3,336

Approval Date: January 18, 2015

Project Advisors: David Richter (928) 523-7303 David.Richter@nau.edu
Ellen Vaughan (928) 523-1791 Ellen.Vaughan@nau.edu

Category: Renewable Energy and Energy Efficiency



In 2007, APS donated a solar field comprised of 798 panels. The field consists of 19 rows containing 42 panels each and it is located on south campus. Each panel has the capacity of generating 208 peak Watts with an ideal peak output of 163 kW. The solar panels originally were designed to have a sun-tracking system; however, this tracking system stopped working in 2011. As a result, the individual rows of panels have been locked at a non-optimal angle, only producing about 70-75% of its maximum potential electric power.

This project was to provide a solution to this problem through permanently repositioning the panels to an optimal fixed alignment of 5° east facing. The money provided was for a repositioning of the panels so that the panels required no ongoing maintenance. Fixing the panels was not only important to the efficiency and performance of the panels, but also to providing the ARD Building 20% of its total power.

The ARD building is a LEED Platinum certified building and was the third most efficient building in the world at the time of certification. This certification was partly because the solar field was supplying 20% of its power. When the panels were not properly working, it was estimated that the building was not meeting this requirement. The table below shows the estimated annual kWh produced and the cost savings associated with

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the energy produced for the panels when the system tracked as initial designed, when the system ceased to track properly, and the new position at the 5° tilt.

	Annual kWh	Annual Energy Value
Properly Tracking Panels	313,638	\$12,545
Panels as Currently Positioned	204,110	\$8,164
Fixed 5° Tilted Panels	272,181	\$10,887

The annual kWh produced is an estimation that was calculated on pvwatts.nrel.gov.

* The annual kWh uses the output for new panels reduced by the average solar panel output degradation of 0.5% per year. NAU's solar panels were installed in 2007; therefore, an age of seven years was applied.

The permanent repositioning of the panels at a 5° tilt is estimated to increase the annual kWh by 68,071, or 25%, which is estimated to save \$2,723 annually. This project is estimated to have a short payback period of approximately 1.22 years.