**Sustainability proposal**

Karls Hall Greenhouse: Energy Waste Reduction

Submitted By:

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1. **Identification of Sponsors**

 **Project Sponsors**

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**II. Description of Proposed Project**

1. **General Description of Proposal**

 The rooftop greenhouse of Karl Hall provides Missouri State University students with a hands-on learning experience, an invaluable teaching tool that caters to all disciplines. The greenhouse, built in 1998, has a variety of uses including showcasing plants, greenhouse management and production, research projects for food security, research into agricultural disease resistance, and floral propagation. The greenhouse has not been properly serviced since its initial construction and has many problems which should be addressed to help with energy consumption and management. This proposal addresses the most basic issues that would immediately help in the energy consumption and maintenance of the greenhouse climate systems.

1. **Proposal Details**

 The proposal immediately addresses the problems with the waste of energy in an inefficient and derelict climate system. The major problems in the greenhouse include the shade cloth system, vent drives, evaporative cooling systems, and air flow circulation fans.

 The shade cloth serves a single purpose of reflecting solar radiation back out of the greenhouse to keep the temperature down and to keep plants in an optimum level of photosynthesis. Currently, the shade cloth system is broken in most of the greenhouse rooms. The proposed renovations will repair the system and install a new shade cloth that doubles as a heat retention blanket to increase the efficiency of our heating systems by 55% according to the NRCS greenhouse efficiency calculator.

 The vent drives provide for air flow into and out of the greenhouse to increase the efficiency of our evaporative cooling systems, release excess heat radiation, and control humidity. Currently, many of the drive shafts on the vent system are broken and in disrepair, causing decreased airflow and increased temperatures. This puts further stress on our evaporative cooling systems which are already in need of replacement. The proposed renovations will replace these drive shafts, service the motors and replace any that are needed, and bring the system back to a good working condition.

 The evaporative cooling system is a cooling unit that uses airflow from fans to pull air across a cardboard medium soaked in water. The evaporation of the water from these cardboard units cools and humidifies the air. Currently, the casings of the evaporative cooling units have numerous leaks due to the corrosion of the aluminum used in their casings. These leaks can be conservatively estimated as reaching 40 gallons a day in times of increased temperatures. The proposed renovations will replace these casings with a non corrosive poly carbonate material that will far outlast the obsolete aluminum casings.

 The air flow mixing fans run at regular intervals to maintain a uniform distribution of air in each controlled greenhouse room. The even distribution of air helps to increase the efficiency of the systems by allowing the sensors to gather a more accurate assessment of the climate in each room.

1. **Proposed location for the object of the proposal**

 Karls Hall Rooftop Greenhouse

1. **Drawbacks**

1. The main drawback is the price inherent in addressing all of the issues, but these systems are critical in maintaining an efficient and sustainable greenhouse.

2. If needed, electrical wiring is not included in these costs and will not be provided by either contractor.

1. **Necessary modifications to existing structures**

 Modifications to existing structures are not required. Modifications to equipment are the main emphasis of this proposal.

1. **Estimated Cost of the Project**

**A. Provisions in Order of Preference**

The acceptance of all of the provisions are preferential to the fracturing of systems into individual components. Climate control is a multifaceted system that works as a complex in tandem with all systems. However, the systems have been broken down into components that the committee may peruse for a decision on the matter of funding. The breakdown in pricing has been removed and the attachment of two separate bids have been added to the proposal. Listed are the prices of labor and materials for each company; The Rough Brothers and Texo Industrial. The Rough Brothers are a commercial greenhouse contractor based in Ohio, and Texo Industrial is based out of Springfield. The costs include labor. Texo Industrial has included the labor hours billed at prevailing wages, Rough Brothers have not. Dr. Anson Elliot has agreed to provide 25% of the cost to help with funding. The order of preference of funding are as follows:

 **a.** Evaporative Cooling Systems and Vent Drives

 Texo Industrial

|  |  |
| --- | --- |
| Sub Total | $46,982.00  |
| Contingency  | $4,698.20 |
| Total | $51,680.20 |
| After 25% Provided by Darr School of Agriculture | $38,760.15 |

 Rough Brothers

|  |  |
| --- | --- |
| Sub Total | $45,700.00  |
| Contingency  | $4,570.00 |
| Total | $50,270.00 |
| After 25% Provided by Darr School of Agriculture | $37,702.50 |

 **b.** Energy Retention System / Shade Systems:

 Rough Brothers

|  |  |
| --- | --- |
| Sub Total | $31,625.00  |
| Contingency  | $3,162.50 |
| Total | $34,787.50 |
| After 25% Provided by Darr School of Agriculture | $26,090.63 |

 Texo Industrial

|  |  |
| --- | --- |
| Sub Total | $29,890.00  |
| Contingency  | $2,989.00 |
| Total | $32,879.00 |
| After 25% Provided by Darr School of Agriculture | $24,659.25 |

 **c.** Airflow Mixing Systems

 Texo Industrial

|  |  |
| --- | --- |
| Sub Total | $4,741.00  |
| Contingency  | $474.00 |
| Total | $5,215.10 |
| After 25% Provided by Darr School of Agriculture | $3,911.33 |

 **d.** Totals

 Texo Industrial\*

|  |  |
| --- | --- |
| Sub Total | $81,613.00  |
| Contingency  | $8,161.30 |
| Total | $89,774.30 |
| After 25% Provided by Darr School of Agriculture | $67,330.73 |

 Rough Brothers

|  |  |
| --- | --- |
| Sub Total |  $77,325.00  |
| Contingency  | $7,732.00 |
| Total | $85,057.00 |
| After 25% Provided by Darr School of Agriculture | $63,792.75 |

 **\*Note:** Texo Industrial has an added system that the Rough Brothers did not bid on. The total reflecting of the same systems equals $84,559.20 for Texo Industrial.

 Additional sources of funding are being sought by the project manager. As more systems are being addressed, applications to grants are being submitted to make additional changes to the technologies of the greenhouse to make it a start of the art and energy efficient structure.

**B. Provisions of any Ongoing Costs**

 The proposal is for replacement and repairs to existing structures. Facilities Management has been maintaining the equipment since the initial construction in 1998. For the year of 2014 the entire materials cost for maintenance was $57.63, paid for by the School of Agriculture. This is excluding labor hours which totaled 47.25 hours. This year is not indicative of the cost associated with maintaining the greenhouse as notable problems have occurred. The rupturing of heating systems resulting in the flooding of the first floor of Karls Hall, and the replacement of a climate control board which cost $1700. These costs are incurred at the expense of the Darr School of Agriculture.

1. **Estimated Completion Time of Project**

 Once Funding has been secured the implementation of these renovations can take place immediately. Texo Industrial has expressed no concern over the funding of a single project and can work on each system independently. The coming summer will provide an excellent time for the undertaking of the workers with little interference from students and faculty alike.

1. **Estimated Life of Project**

 The greenhouse is an integral part of the learning curriculum for many students in the School of Agriculture and will continue to serve the needs of faculty and students alike. Once these initial systems are funded, the project will continue to add energy efficient systems and technologies that will help with emissions and efficiency.

1. **Justification of Project**

 Missouri State University adheres to three pillars of their Public Affairs Mission. Those pillars, as described by Missouri State University, are: Ethical Leadership, Cultural Competence, and Community Engagement. Fulfilling those pillars is the aim of the university, and it encourages students, faculty, and staff to take part in actively engaging in behaviors that promote this mission.

 This proposal is part of a project put together by a student who has been encouraged by faculty and staff to manage the implementation of ideas reached by mentoring and individual research. In accordance with the first pillar, encouragement has been given by university faculty and staff for the student manager to lead the project through the democratic systems that can allocate funding to student projects.

 Rooted in Latin, culture has come from the direct tie of civilizations and peoples to the land and the cultivation of their agriculture. Cultural competence of our plant systems have been exchanged with many foreign students and their cultural practices. Examples of Brazilian and Chinese students learning our plant systems and sharing their culture of production with our students are numerous. These students can learn how to be more energy conscious in their agricultural systems and take them back to their communities, communities that are rapidly growing and industrializing. Providing examples of sustainable technologies will greatly help spread awareness across many cultures.

 Community is a multi leveled system that is interconnected in subtle ways. Many graduates from Karls Hall have actively engaged our Springfield community. The owner of Wickman Gardens is a Missouri State graduate and applies sustainable practices and solutions to gardening in the Springfield and surrounding communities, sharing and disseminating his passion to the community. Many graduates learn here and move on to other areas, many participating in our state government implementing policies that will help shape the community of our state. Graduates have moved on to work in many other states and the knowledge they share reaches larger and larger communities. Many of these students have learned in the greenhouse, directly using ideas they have learned to shape the communities around them.

 Making our greenhouse more efficient and implementing new sustainable technologies will help spread the consciousness of sustainable practices to the world community. As all things are related, it is up to all of us to make our university a more environmentally conscious place. We are not many divided groups, but are part of a whole community. Each individual is a branch connecting all of the parts to a whole, and each part has a role to play. With projects, such as this proposal, put forth by students benefiting students, we are fulfilling the three pillars of our Public Affairs Mission.

 This proposal addresses repairs and renovations to an academic building. Concerns may arise due to the question of whose responsibility this building falls under. Arguments may be made that in accordance with the values of community engagement, it is everyone's responsibility to do the part they can do to make sure our global community and ecosystem is the most efficient and carbon friendly that it can be. We are after all, all in this together.

 The project will improve the efficiency of the climate systems in the greenhouse by improving machinery that helps with bulk airflow to uniformly cool and heat the greenhouse rooms, provide a new shade cloth that doubles for heat retention in the cool parts of the year, and help improve the passive cooling systems in each of the four greenhouses. This will help save on energy costs, cut carbon emissions, and provide an environment conducive to plant growth.

 All calculations have been made using estimated energy consumption based on temperature set points of each piece of equipment in the system, average days in a year that systems will be on because the temperatures are above or below these set points, and known energy efficiency based on various journals and equipment details. Overall consumption of energy needs in the greenhouse cannot be determined as there is no separate meter detaching this structure from Karls Hall. The estimates are very conservative and based on existing research.

 In regards to the cooling system and vent drives, the proposed changes will increase efficiency by over 71% (Katsoulas). This increased efficiency will help with the reduction of carbon emissions by 6.5 metric tons a year, according to estimates of our usage using the EPA's emission calculator. Energy savings have been calculated at approximately $1,200 annually.

 The heat retention cloth increases the efficiency of our heating systems by 55%, according to an NRCS greenhouse energy calculator. This efficiency increase will save over 2.64 metric tons of carbon emissions a year. This calculation does not include solar radiation reflected in times of intense light. Energy savings have been calculated at approximately $1,500 annually.

 Further energy efficient systems will be implemented that will further increase the efficiency of the systems and provide exponential savings of energy and greater reductions in cutting carbon emissions. The goal of this proposal is to establish a base framework to address more expensive and cost prohibitive technologies in energy efficiency.

1. **University Support**

Attached are various letters of support for my proposal. All have been a great help in my project to secure funding and renovate the Karls greenhouse into a more sustainable building.

* Dr. Elliot is the dean of the Darr School of Agriculture
* Mike Klem is the Coordinator of Business and Support Services of the School of Agriculture
* Dr. Alsup is the greenhouse manager and a horticultural professor
* Pilar Karlen is the Energy Manager of Missouri State University
* Jerry Brooks is Facilities Manager of Missouri State University
1. **References**

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