Presidential Faculty/Student Collaboration and Publication Grant
Deadline Monday, February 22, 2016

Please use this checklist and budget. Include with your completed application. For more information about Presidential Faculty/Student Collaboration and Publication grants, please see https://gustavus.edu/kendallcenter/grant-opportunities/presidential-grant.php.

FACULTY INFORMATION

Name: Charles Niederriter | Email: chuck@gustavus.edu

Department: Physics | Rank: Professor

STUDENT INFORMATION

Name: Jill Malecha | Email: jmalecha@gac.edu

Major(s): Physics | Graduation Year: **2017**

CHECKLIST

Project Details

X Brief description of the proposed project including its collaborative nature

X Clear statement of anticipated outcomes

X Likely placement for publication or performances

X Anticipated research completion date

Participant Details

X Names and brief biographies of all participants

X Explanation of how this project fits into the career of the faculty member
Note: Applications from faculty at all career stages are encouraged

X Explanation of how this project fits into the educational trajectory of the student
Note: Statement should be written by the student; include year of graduation; student eligibility is limited to full-time returning students

X **Presidential Budget Proposal Form**

X If successful, my proposal can be used as an example to assist future applications. Check to give permission. This decision will not influence the application evaluation.

Submit electronically as a PDF to cblaukat@gustavus.edu at the John S. Kendall Center for Engaged Learning.

Presidential Faculty/Student Collaboration Grant

Budget Information

Faculty Stipend ($300 per week, up to $3,000 for a maximum of 10 weeks)
Student Summer Stipend ($400 per week, up to $4,000 for a maximum of 10 weeks)
Student Summer Campus Housing ($60 per week, for a maximum of 10 weeks)
Budget Maximum ($8,100 for all categories)

Item		**Amount**
Equipment (e.g., transcription machine, camera, cassette recorder – but not to include computer hardware)		**$**
1: Coleman 400W Wind Turbine from Menards	Cost: $500	$500
2:	Cost:	
3:	Cost:	
Materials (e.g., books, printing, software, lab supplies)		**$**
1:	Cost:	
2:	Cost:	
3:	Cost:	
Travel Costs (cannot include conference travel, see http://gustavus.edu/finance/travel.php for allowable travel expenses)		**$**
Airfare:		
Mileage: Number of miles____ @ $0.56/mile		
Lodging:		
Meals:		
Stipends & Housing		**$**
Faculty Stipend	$300 per week, up to $3,000 for a maximum of 10 weeks	$3,000
Student Summer Stipend	$400 per week, up to $4,000 for a maximum of 10 weeks	$4,000
Student Summer Campus Housing	$60 per week, up to 10 weeks	$600
Total Expenses		**$500**
Amount Requested (Total Expenses + Requested Stipends + Housing)		**$8,100**

Have you applied for, or received funding from, another source to help support this project? (If no, skip a, b, and c below.)
X Yes ☐ No

a. Funding Source: Environmental Studies and the Johnson Center
b. Amount: $3,500
c. Please explain how the Presidential grant will be used in addition to the other funding, and (if relevant), how the Presidential grant project would be impacted if external funding is not approved**.**
If the funds from Environmental Studies and the Johnson Center are not allocated to this project, we will use Physics department funds as a partial replacement and reduce the scale of the project. We will purchase and install only one turbine and make use of instruments constructed from parts available in physics labs. It will take a bit longer, but we should still be able to have a working system by the end of the summer.

Characterizing a New Wind Delivery System

A Proposal to the Presidential Faculty/Student Collaboration Fund

Charles F. Niederriter
Professor of Physics
And
Jill Malecha
Junior Physics Major

Description of Project:

Introduction

Although there is good potential for wind energy in the Saint Peter area, Nicollet county regulations limit the installation of utility scales wind turbines to a few, mostly undesirable, locations. As a result, Gustavus has been denied the opportunity to generate approximately one-third of the electricity it consumes in a year and reduce its greenhouse gas emissions. If the College were able to raise the funds necessary to install a utility scale wind turbine, though, it would be possible in LeSueur county, just across the river. But, this would add complications and cost to the project in the form of a land lease and transmission line costs. And the turbine would not be easily accessible to Gustavus students. Clearly there are still advantages to constructing the turbine on College land.

Approximately fifteen years ago, Daryoush Allaei, working for the federal government, was searching for solutions to some of the problems associated with wind turbines. These included installation and maintenance of large mechanical devices high above the ground, possible collisions of birds and bats, and most importantly the necessity of having huge blades in order to generate electricity in moderate wind climates. He invented a new "wind delivery system" that brings wind down to ground level and speeds it up in a venturi where the energy is extracted by relatively small wind turbines, as shown in figure 1.

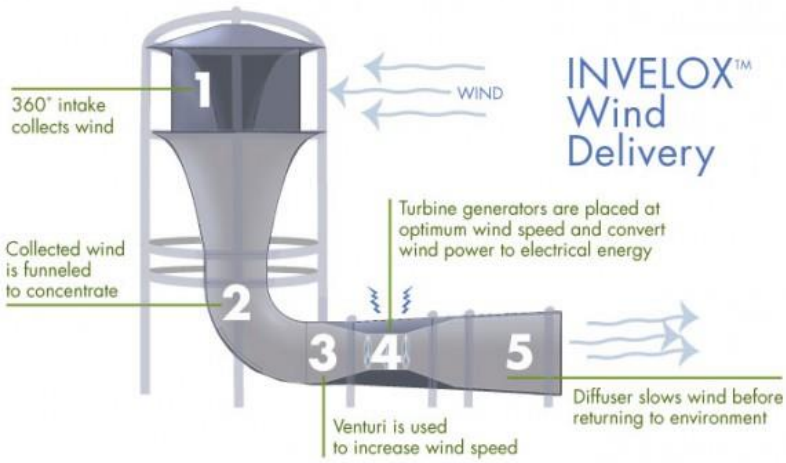

Figure 1: The INVELOX wind delivery system.

Because the INVELOX wind delivery system would allow the wind turbine to be located near the ground and fully contained in a structure, it may allow Gustavus to have an installation on campus with only minor permitting concerns. However, these systems are still more theory than reality. Dr. Allaei and colleagues at City College of New York have published a number of theoretical papers on the systems in per-reviewed journals which include the results of simulations of energy production in a variety of wind climates. His company, Sheerwind (Chaska, MN), has only constructed small test systems and has limited data to support their claims. Seeing this as an opportunity to contribute to the database of information about the wind delivery system and increase our chances of getting a wind energy installation on campus, we are proposing to build a demonstration system which could be used by other students to continue research in this area.

Proposed Research

We are proposing to design and construct an INVELOX system adjacent to the compost building, using 400 watt wind turbines from Menards to extract the energy. Since these use 44" diameter blades, the system can be kept relatively small, inexpensive, and less than 50' tall, facilitating easy and cheap permitting. We plan to construct a wood support structure to hold an intake and tubes constructed from polycarbonate with the narrowest region being just slightly larger than 44" in diameter to house the turbines. To fully test the system, we would install three identical turbines separated by variable distances so that we can explore the relationship of separation to efficiency. The systems will be instrumented with anemometers at the intake and in key locations inside the tube and near the exhaust.

Once constructed, research can begin in earnest with the collection of data on energy produced as a function of wind speed and direction. Our first system will be based on the design Sheerwind is preparing for construction in Royalton, but scaled down to better accommodate the 400 Watt turbines. Analysis of the results of data collection will inform necessary adjustments to the design which will improve efficiency. We will implement changes throughout the summer with the expectation that the system will be optimized by the end of 10 weeks, leaving it ready for other students to use for projects during the academic year.

Future Research

Research on the effects of wind speed and direction on power production will be conducted throughout the 2016-17 academic year and the following summer. These data will be compared to predictions based on theory and simulations performed by Allaei and coworkers[1]. In addition, we will study energy production with multiple turbines to test

the predictions in their most recent publication[2]. If the system proves to be as efficient as predicted, of course, we hope to be able to construct a much larger system with 500 kW turbines which could produce as much as one-third the electricity needs of the campus.

Anticipated Outcomes:

If this proposal is funded, we plan to give a talk on this work at the American Association of Physics Teachers meeting in late July on the progress of the system and preliminary results. We will follow up with a second talk at a future AAPT meeting (either January or July 2017) discussing how such as system can be used to provide research opportunities for students interested in engineering, energy, and the environment. We will also prepare a paper describing the results of our measurements to be submitted to *Energy, The International Journal,* and/or presented at a conference such as *The International Conference on Energy Sustainability.*

Participants:

Dr. Charles Fredrick Niederriter

Educational Background:

B.S.	Gannon College, Erie, PA	Physics	1978
M.S.	Ohio University, Athens, OH	Physics (Condensed Matter Physics)	1985

Thesis Title: *Properties of Ion-Beam Produced Thin Polymer Films*

Ph.D.	Ohio University, Athens, OH	Physics (Condensed Matter Physics)	1985

Thesis Title: *The Electrical Resistivity of Germanium Tin Diselinide Glasses*

Experience:

1985 - present	Chair (1993 and 1997 - 1999), Professor (2000 - present), (Associate Professor (1991 - present); Assistant Professor (1985-91), Physics Department, Gustavus Adolphus College
June 2008 2014	Director of the Nobel Conference, Gustavus Adolphus College,St. Peter, MN
Sept. 1987 - Jan. 1988	Acting Co-Director of Academic Computing, Gustavus Adolphus College
Jan. 1979 - August 1985	Graduate Assistant, Physics Department, Ohio University, Athens, Ohio

June 1979 - August 1979 June 1980 - August 1980 & June 1981 - August 1981	Scientist, Corporate Research and Development, Lord Corporation, Erie, Pennsylvania
August 1978 – Dec. 1978	Graduate Assistant, Physics Department, Iowa State University, Ames, Iowa
June 1978 - August 1978	Technician, Corporate Research and Development, Lord Corporation, Erie, Pennsylvania

Teaching Awards:

- The Faculty Service Award (Awarded 2012)
- The Swenson and Bunn Memorial Award For Teaching Excellence (Awarded 1995)

Teaching Grants:

- National Science Foundation – Course Curriculum and Laboratory Improvement Grant: Integrating Sustainability Across and Within the Science Curriculum of Gustavus Adolphus Collegey ($154,045), Gustavus Adolphus College (2010 2014)
- National Science Foundation – Course, Curriculum, and Laboratory Improvement Grant: *Enhanced Observing Exercises for Introductory Astronomy* ($41,000), Gustavus Adolphus College (2000-2003)
- National Science Foundation - Instrumentation for Laboratory Improvement Grant: *A Surface Science Laboratory* ($42,000), Gustavus Adolphus College (1994-1996)
- National Science Foundation - Instrumentation for Laboratory Improvement Grant: *Electronics and Instrumentation Laboratory Development Project* ($43,656), Gustavus Adolphus College (1992-1994)
- National Science Foundation - Instrumentation for Laboratory Improvement Grant: *Microcomputer Interfaced Experiments in Introductory Physics Laboratories* ($87,970), Gustavus Adolphus College (1990-1992)
- National Science Foundation College Science Instrumentation Grant: *Experimental Modern Physics Laboratory Development Project* ($55,340), Gustavus Adolphus College (1987-1989) Co-author but not principle investigator
- National Science Foundation – Major Research Instrumentation Grant: *Acquisition of Equipment for Acoustical, Optical, and Computational Scattering Studies* ($102,000), Gustavus Adolphus College (1997-2000)
- Presidential Faculty/Student Collaboration: *Growth Rate of Plasma-Produced Thin Polymer Films* ($7,190), Gustavus Adolphus College (1997)

- Cray Research: *Visualization and Simulation in the Sciences at Gustavus Adolphus College* ($8,000 & 10 hours of Supercomputer Time), Gustavus Adolphus College (1994-1996)

- Hewlett-Mellon Foundation Faculty Development Grant: *Semiconductor and Superconductor Research* ($2,508), Gustavus Adolphus College (1988-1989)

- Northwest Area Foundation of Research Corporation, Grant for Faculty/Student Research: *Electrical Conductivity Measurements of Amorphous Material; Relation to Microscopic Structure* ($20,000), Gustavus Adolphus College (1988-1990)

- Johnson Wax Foundation, Grant for Faculty/Student Research: *Computer Hardware and Software* ($9,000), Gustavus Adolphus College (1988-1989)

Selected Papers and Publications:

- *The Construction of a Low Cost Carbon-Dioxide Laser for Undergraduate Research*, S.E. Haywood, D.C. Jordan, C.F. Niederriter, W. Christian, and P.B. Griesaker, Paper presented at the Spring 1977 meeting of the Pennsylvania Academy of Science.

- *Optical Image Enhancement by Spatial Frequency Filtering*, S.E. Haywood, D.C. Jordan, C.F. Niederriter, W. Christian, and P.B. Griesaker, Paper presented at the Spring 1977 meeting of the Pennsylvania Academy of Science.

- *Infrared Absorption Measurements with an Opto-acoustic Cell*, W. Christian, C.F. Niederriter, J.B. Jaquel, D.C. Jordan, D.S. Shenk, and P.B. Griesaker, Paper presented at the Spring 1978 meeting of the Pennsylvania Academy of Science.

- *Infrared Absorption Measurements with an Opto-acoustic Cell*, W. Christian, C.F. Niederriter, J.B. Jaquel, D.C. Jordan, D.S. Shenk, and P.B. Griesaker, Pennsylvania Academy of Science, 52:1 (1978).

- *Production of Corrosion-Resistant Organic Thin Films on Metallic Substrates*, C.F. Niederriter and R.L. Cappelletti, Paper presented at the Fall meeting of the Ohio Section of the American Physical Society, October 1981.

- *Properties of Corrosion-Resistant Thin Polymer Films*, C.F. Niederriter and R.L. Cappelletti, Paper presented at the March meeting of the American Physical Society, March, 1983.

- *The Electrical Resistivity of Germanium Tin Diselenide Glasses*, C.F. Niederriter and R.L. Cappelletti, Paper presented at the March meeting of the American Physical Society, March, 1985.

- *Correlation of electrical conductivity with Mossbauer and Raman results in the alloy glass Germanium Tin Diselinide*, C.F. Niederriter, R.L. Cappelletti, and P. Boolchand, Solid State Communications, 61:9 (1987).

- *The Electrical Resistivity of Silicon Telluride Glasses; An Undergraduate Research Project*, S. Sehlin and C.F. Niederriter, Paper presented at the Fall meeting of the Minnesota Area Association of Physics Teachers, October, 1987.

- *The Electrical Resistivity of Silicon Telluride Glasses*, C.F. Niederriter and S. Sehlin, Paper presented at the March meeting of the American Physical Society, March, 1988.

- *Measurements of Critical Temperature in High-Temperature Superconductors*, E. Montei, T. Peterson, and C.F. Niederriter, Paper presented at the Minnesota Area Association of Physics Teachers, May 1989.

- *The Electrical Resistivity of Silicon Telluride Glasses at Low Temperatures*, C.F. Niederriter, J. Keay and R.S. Vallery, Paper presented at the March Meeting of the American Physical Society, March, 1990.

- *An Experimental Modern Physics Course For Undergraduates*, C.F. Niederriter and S. Mellema, Paper presented at the Summer Meeting of the American Association of Physics Teachers, June, 1990.

- *Microcomputer Interfaced Experiments in Introductory Physics Laboratories*, C.F. Niederriter and S. Mellema, Paper presented at the Summer Meeting of the American Association of Physics Teachers, August, 1992.

- *Using a Hall Effect Force Probe To Measure Electric Fields*, C.F. Niederriter and S. Mellema, Paper presented at the Summer Meeting of the American Association of Physics Teachers, August, 1992.

- *The Optical Energy Gap in Silicon Telluride Glasses at Room Temperature*, C.F. Niederriter, D. Lightly, and B. Obradovic, Paper presented at the March Meeting of the American Physical Society, March 1993.

- *A Computer-Based Homework System with Individual Problem Solving and Instructor Diagnostics*, S. Mellema, C.F. Niederriter, and B. Thompson, Paper presented at the Joint Meeting of the American Physical Society and the American Association of Physics Teachers, April 1993.

- Computer Interfacing to Ultrasonic Rangers and Electronic Probes, B. Obradovic and C.F. Niederriter, Paper presented at the Minnesota Area Association of Physics Teachers, May 1993. Winner of Pasco Award for Outstanding Student Paper.

- *Does Hot Water Freeze Faster Than Cold Water? A Physics Practicum*, C.F. Niederriter, T.M. Huber, and K. Vigen, Paper presented at the American Association of Physics Teachers Meeting, August 1993.

- Using Supercomputing and Modern Visualization Techniques to Introduce Modeling in Introductory Astronomy, C.F. Niederriter, M. Ibrahim, and M. Mullerlielle, Paper presented at the American Association of Physics Teachers, August 1995.

- Surface Science Experiments in Materials Science Laboratory, C.F. Niederriter and L.W. Potts, Paper presented at the American Association of Physics Teachers, August 1997.

- A Pinewood Derby Race as an Introductory Physics Lab Practicum, C.F. Niederriter, Paper presented at the American Association of Physics Teachers, January 2000.
- *Formation of Thin Polymeric Films in Direct-Current Plasma*, C.F. Niederriter, J. Smerdon, D. Asleson, and M. Cunningham, Paper presented at the March Meeting of the American Physical Society, March, 2000

- *Spectroscopy in Introductory Astronomy Courses*, C. F. Niederriter and P. R. Scherbring, Paper presented at the American Association of Physics Teachers, August 2000.

- *Physlets in Introductory Astronomy Courses*, C.F. Niederriter, Paper presented at the American Association of Physics Teachers, August 2001.

- *Observational Exercises for Introductory and Advanced Astronomy Courses*, C.F. Niederriter, Paper presented at the American Association of Physics Teachers, August 2003.

- *Worthwhile Wind? The Feasibility of Wind Power at Gustavus Adolphus College*, C.F. Niederriter, C. D. Ferkinhoff, J. A. Lee, and S. G. Hayek, Paper presented at the American Association of Physics Teachers, August 2005.

- *Energy Storage Systems for Peak Shaving as a Complement to Wind Power at Gustavus Adolphus College*, J.D. Sieling, D.A. Berg, and C.F. Niederriter, Paper presented at the American Association of Physics Teachers, January 2007.

- *Energy Storage Systems for Peak Shaving as a Complement to Wind Power at Gustavus Adolphus College*, J.D. Sieling, D.A. Berg, and C.F. Niederriter, Paper presented at the American Association of Physics Teachers, January 2007.

- *Renewable Energy Projects for Students at a Liberal Arts College*, C.F. Niederriter, C. Ferkinhoff, J. Lee, J.D. Sieling, and D.A. Berg, Paper presented at the American Association of Physics Teachers, January 2009.

- *Integrating Sustainability Across the Science Curriculum of Gustavus Adolphus College*, C.F. Niederriter, Amanda Hochstatter, and Hasanga Samaraweera, Paper presented at the American Association of Physics Teachers, July 2011.

- *Integrating Sustainability Across the Science Curriculum of Gustavus Adolphus College*, C.F. Niederriter, Amy Audette, Kevin Clark, Jeff Jeremiason, Colleen Jacks, Paper presented at the American Association of Physics Teachers, July 2012.

- *Integrating Sustainability Across the Science Curriculum of Gustavus Adolphus College*, C.F. Niederriter, J. Jeremiason, C. Jacks, and J. Dontje, Paper presented at the American Association for the Advancement of Science/National Science Foundation Conference, January 2012.

- *Wind Turbine and Geothermal Lab Development*, Amy Audette, Kevin Clark, Jeff Jeremiason, Colleen Jacks and C. F. Niederriter, Poster presented at the American Association of Physics Teachers, July 2012.

- *Biofuels: Production and Quantification Methods for Undergraduate Laboratories*, Kevin Clark, Amy Audette, Jeff Jeremiason, Colleen Jacks and C. F. Niederriter, Poster presented at the American Association of Physics Teachers, July 2012.

- *Using Astronomy to Teach Physics at Gustavus Adolphus College*, C. F. Niederriter, S.H. Mellema, and J. Miller, Paper presented at the American Association of Physics Teachers, January 2013.

- *Renewable Energy and Sustainability at Gustavus Adolphus College*, C.F. Niederriter, J. Jeremiason, C. Jacks, and J. Dontje, Paper presented at the American Association of Physics Teachers, July 2013.

I have been involved in renewable energy projects at Gustavus for at least 15 years and still very much believe that we could produce a significant fraction of our electricity with a wind energy conversion system. Given that traditional systems were deemed inappropriate for our county, I believe that is appropriate to explore other options. In addition to moving us closer to our goal of using wind to produce some of our electricity, this project will provide many opportunities for student faculty research collaborations for the next few years. It will give Jill a chance to develop her engineering and design skills. She will also learn a great deal about data collection and analysis. But, it will also make similar opportunities available to other physics and environmental studies students in the coming years.

Jill A. Malecha

800 W College Ave, St. Peter, MN 56082 jmalecha@gustavus.edu 952-686-1126

Education

Gustavus Adolphus College, St. Peter, Minnesota
Bachelor of Science: Physics and Pre-Engineering, May 2017

Accomplishments

Programming

- Produced code in various languages to accomplish task: C++, Java, Python, Matlab, LabVIEW

Research

- Continually researching energy consumption in buildings around Gustavus Adolphus College to reduce energy costs.

Testing, Evaluation and Analysis

- Tested equipment to ensure compliance.
- Analyzed data and provided recommendations in developing new research solutions
- Wrote highly detailed lab notebook to document research
- Preformed data collection and statistical analysis that generated results towards accomplishing the task at hand.

Engineering

- Designed a clapper circuit to turn on lights.
- Created a LabVIEW VI to communicate with equipment and collect data, as the stepper-motor moved. Data was written to a file.

Teacher's Assistant

- Assist professor in lab set-up.
- Help students become familiar with good lab technique.

Drafting

- Prepared mechanical drawing designs for systems within a building

Related Experience

Receptionist, Information Desk Lund Center, Gustavus St. Peter, MN September 2013-Present

- Coordinate events ranging from 50 to 200 people
- Ability to listen to people's needs and fulfill their needs quickly and communicate effectively
- Efficient time management skills in satisfying customer needs
- Recognize the importance in working as a team and independently

Skills

- Experience with sophisticated equipment
- Analog and digital electronics design
- Advanced analytical and applied mathematical skills
- Inventiveness and ability to design unforeseen problems

- Capacity to learn new technologies quickly
- Mechanical aptitude in design and implementation

Leadership and Student Involvement

Gustavus Adolphus College

- Habitat for Humanity- Board Member
- GOLD Leadership Certified
- Club Tennis- Member
- Physics Demos for Youth

After college, I plan on attending graduate school for either a master's degree or a PhD. I want to study environmental engineering, and this research experience would help me prepare for graduate school. Research will benefit my education goals because I want to explore my interests in wind energy, to create affordable and sustainable energy options. This will allow me to get a better understanding of what sustained research in physics looks like; therefore, it will allow me to observe the ups and downs of research. I am interested to learn new lab techniques and work with new lab equipment, and I want to incorporate the skills I have learned in the classroom and lab setting to a practical research setting. Wind power interests me because renewable, sustainable energy is the future for finding safer and cheaper ways to provide electrical energy for communities. In conclusion, this research experience could help me gain the confidence needed to become a graduate student at a competitive university and pursue my interests in renewable energy.

References:

[1] D. Allaei and Y. Andreopoulos, 7th International Conference on Energy Sustainability & 11th ASME Fuel Cell Science, Engineering and Technology Conference ES-FuelCell (2013).

[2] D. Allaei, Y. Andreopoulos, and D. Tarnowskia, Energy, The International Journal, 93 (1), 1030–1040.

Budget:

In addition to the funds requested here, we will make use of moneys from Environmental Studies and Physics to purchase materials and supplies. We will also make use of a significant amount of equipment and tools currently available in the physics department enabling us to complete this project with a small request for equipment and materials.