

**Environment and Natural Resources Trust Fund
2019 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 150-CH

Converting UMN's Sustainable-Electricity Course for Two-Year Community Colleges

Category: H. Proposals seeking \$200,000 or less in funding

Sub-Category: C. Environmental Education

Total Project Budget: \$ 96,956

Proposed Project Time Period for the Funding Requested: June 30, 2021 (2 yrs)

Summary:

Develop free-to-use resources so that an established course (Sustainable-Electricity Supply) at UMN can be taught in two-year community colleges statewide to build a robust pipeline of students to 4-year colleges/universities.

Name: Ned Mohan

Sponsoring Organization: U of MN

Title: Professor - UMN

Department: Electrical and Computer Engineering / CSE

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Minneapolis MN 55455

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Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Developing a Free and Open Audio-Visual Book for teaching Sustainable-Electricity Supply in 2-year community colleges, with low-cost lab experiments on solar and wind using an extremely low-cost controller.

<input type="checkbox"/>	Funding Priorities	<input type="checkbox"/>	Multiple Benefits	<input type="checkbox"/>	Outcomes	<input type="checkbox"/>	Knowledge Base
<input type="checkbox"/>	Extent of Impact	<input type="checkbox"/>	Innovation	<input type="checkbox"/>	Scientific/Tech Basis	<input type="checkbox"/>	Urgency
<input type="checkbox"/>	Capacity Readiness	<input type="checkbox"/>	Leverage	<input type="checkbox"/>		TOTAL	<input type="checkbox"/> %
<input type="checkbox"/> If under \$200,000, waive presentation?							



PROJECT TITLE: Converting UMN's Sustainable-Electricity Course for Two-Year Community Colleges

I. PROJECT STATEMENT

The goal of this project is support environmental education in the state. We propose to develop completely *free-to-use* resources so that an *established* course on “Sustainable-Electricity Supply: Renewables and Conservation” at the University of Minnesota can be taught in two-year community colleges statewide. By transfer of credits seamlessly, this will build a robust pipeline of much-needed students to 4-year colleges/universities who upon graduation can implement solutions, that we already have, to combat climate change. It is expected that some of these students upon graduation will go on to pursue graduate studies and conduct PhD research.

Climate change is the greatest threat facing humanity due to the emission of greenhouse gases by the electric power sector and the transportation sector. As a means of combating it, a course EE2701 on the topic of “Sustainable Electricity Supply: Renewables and Conservation” was developed at the University of Minnesota in the Department of Electrical and Computer Engineering with the help of a Navy grant. This 3-credit course was taught in Spring of 2016 with an enrollment of **37** students and is again scheduled to be taught in Spring 2019 along with an associated 1-credit laboratory course EE2703.

The purpose of this proposal is to seek a grant to develop **completely free-to-use resources** for all community-college instructors so that this established course at UMN and its associated laboratory course can be taught in our state’s over **30** two-year community colleges. No such funding is available at the University of Minnesota to make these resources available.

Importance of teaching this course in community colleges: Across the United States, there are nearly **1,500** Community Colleges. Minnesota itself has over **30** two-year community colleges. There are several reasons why students prefer to attend two-year community colleges and then transfer to 4-year colleges and universities such as to the University of Minnesota. One of them is the low cost of tuition as shown on the left side of the table below. The other is diversity as shown in the right side of the table below. Both of these are important as exemplified at UMN where in the upper division in the College of Science and Engineering, nearly 30 percent of the students are transfer students from community colleges and bring diversity that otherwise wouldn’t exist.

Public Two-Year	\$2,713	Gender:	
Public Four-Year In-State	\$7,605	• Women	57%
Public Four-Year Out-of-State	\$19,595	• Men	43%
Private Nonprofit Four-Year	\$27,293	Ethnicity:	
Private For-Profit	\$13,935	• White	54%
		• Hispanic	16%
		• Black	14%
		• Asian/Pacific-Islander	6%
		• Native American	1%
		• Other	10%

Catalog Description of EE2701 (“Sustainable-Electricity Supply: Renewables and Conservation”): Overview of energy usage, role of electricity and its contribution to global warming/climate change. Electric power systems with conventional generation and transmission, and renewable resources such as solar and wind. Electric and hybrid vehicles, conservation using LEDs and green house applications. Power electronics and electric machines/drives.

This course is on a very timely topic of combating climate change by looking closely at electricity generation, delivery, and its use for a sustainable future. Generating electricity from renewables and conservation in all forms, including improving energy efficiency, are the most important tools we have for combating climate change. This course helps students realize the potential societal benefits such as reduced energy bills, cleaner air and water, increased economic opportunities, and prepares them for an exciting and meaningful careers in renewable energy and sustainability where most of the job opportunities exist.



**Environment and Natural Resources Trust Fund (ENRTF)
2019 Main Proposal Template**

At present, according to the Minnesota Pollution Control Agency, the state’s projected greenhouse gas emissions will exceed the state’s goal for 2025. Several coal, gas and nuclear plants are targeted to be retired. This will require meeting the electricity need from renewables such as wind and solar and using it wisely like in electric vehicles for transportation. With this goal in mind, this course EE2701, and now its lab-course EE2703, teaches students the necessary knowledge to use as a foundation to pursue senior-level courses in this field as well as other related courses in STEM for sustainable future.

This course covers the following topics: Wind Plants: on-land and offshore; Solar Photovoltaic Plants; Conservation through LEDs; Efficiency improvements using heat pumps; Electrifying transportation; Fuel Cells; Energy Storage; Using LEDs to grow vegetables at home; Net-zero energy buildings and homes; etc. All through the course, critical thinking and decision making on socio/economic impact of energy and electricity is promoted.

We have a synergistic grant from the Navy to develop an extremely low-cost simulation and a real-time control platform for multipurpose applications. This very easy to use simulation platform will be utilized in the laboratory course to demonstrate the working of high power systems such as utility-scale wind turbines, solar plants, fuel cells, etc. described in the lecture course. Students will get hands-on experience in the lab. *The primary goal of these experiments is to demystify these systems so as to entice more new engineers towards renewable energy.*

Project Deliverables: This project will deliver the following:

- 1) An interactive and open digital audio-visual textbook that is *free-of-charge*. This book will be web-based and the instructors will edit it as they see fit for their use in the classroom. At present, there is no resource that instructors can rely upon to teach these topics in a comprehensive way.
- 2) Low-cost hands-on experiments that community college instructors can easily adapt. These experiments can be easily replicated using readily available off-the-shelf components, including the controller platform already developed through the Navy funding at UMN. Here too, instructors can pick-and-choose and/or modify the experiments based on their needs.

II. PROJECT ACTIVITIES AND OUTCOMES

ENRTF BUDGET: \$96,956

Outcome	Completion Date
1) <i>Develop a free interactive and open audio-visual digital book</i>	<i>December 2019</i>
2) <i>Develop hands-on experiments that 2-year community colleges can implement</i>	<i>June 2020</i>

III. PROJECT PARTNERS:

A. Partners receiving ENRTF funding: Timothy C. Grebner (Consultant; teaching at Century College – a community college in Minnesota)

B. Partners NOT receiving ENRTF funding: None

IV. LONG-TERM- IMPLEMENTATION AND FUNDING:

This technology-oriented course has very significant societal impacts such as combating climate change which is a moral imperative, preparing students for meaningful and growing Jobs in renewable Industry, recapturing American leadership in clean energy, preparing students to help with making informed policy decisions, saving consumers from paying high electricity bills, etc.

This effort and the requested funding is to develop the resources for the two-year community colleges statewide (and nationwide) as a pipeline of students to 4-year colleges and universities. This project is sure to succeed in its mission and subsequent to its completion, it will be self-sustaining and there will be no need for further funding.

V. TIME LINE REQUIREMENTS:

The Plan for this proposal implementation is for the following to be completed within one year:

1. Develop a free, interactive and open audio-visual digital book for the community-college instructors.
2. Develop low-cost hands-on experiments that can be implemented in community colleges.

2019 Proposal Budget Spreadsheet

Project Title: Converting UMN's Sustainable-Electricity Course for Two-Year Community Colleges

IV. TOTAL ENRTF REQUEST BUDGET [1] years

BUDGET ITEM (See "Guidance on Allowable Expenses")	AMOUNT
Personnel: Principal Investigator Name: Dr. Ned Mohan Time: One month of summer /year Salary: \$22,599 Fringe Benefits: \$7,571 Responsibility: Overall scientific leadership and project management and will supervise and mentor student researchers supported on this project.	\$ 30,170
Personnel: PostDoc (1) Name: TBD Time: 100% appointment Salary: \$47,600 Fringe Benefits: \$10,186 Responsibility: Creating lab experiments, creating simulation models, examples, and demos, deploying multimedia content to web	\$ 57,786
Professional/Technical/Service Contracts: Consultant Name: Tim Grebner (Century College, Minnesota) Salary: \$5,000 Benefits: None Responsibility/Description of Services: Guide the project using experience as a community college instructor teaching electrical engineering topics.	\$ 5,000
Equipment/Tools/Supplies: Power supplies and electronic components for creating lab experiments / demos; including PCB fabrication.	\$ 4,000
Acquisition (Fee Title or Permanent Easements):	\$ -
Travel:	\$ -
Additional Budget Items:	\$ -
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =	\$ 96,956

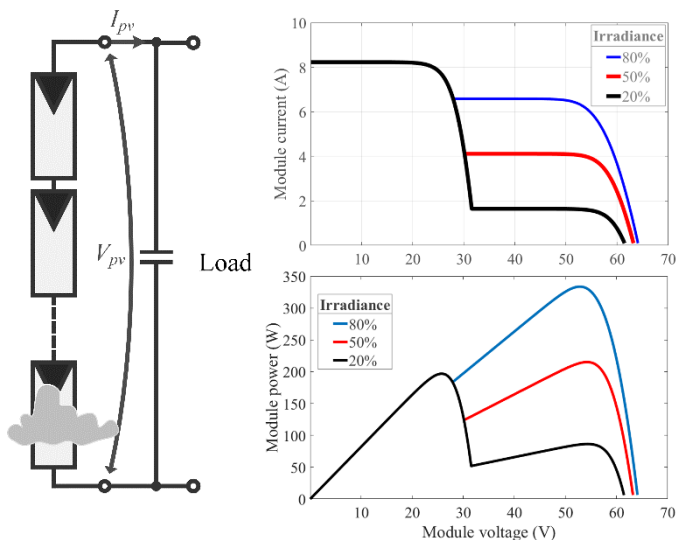
V. OTHER FUNDS (This entire section must be filled out. Do not delete rows. Indicate "N/A" if row is not applicable.)

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State \$ To Be Applied To Project During Project Period:	\$ -	
Other State \$ To Be Applied To Project During Project Period:	\$ -	
In-kind Services To Be Applied To Project During Project Period:	\$ -	
Past and Current ENRTF Appropriation:	\$ -	
Other Funding History:	\$ -	

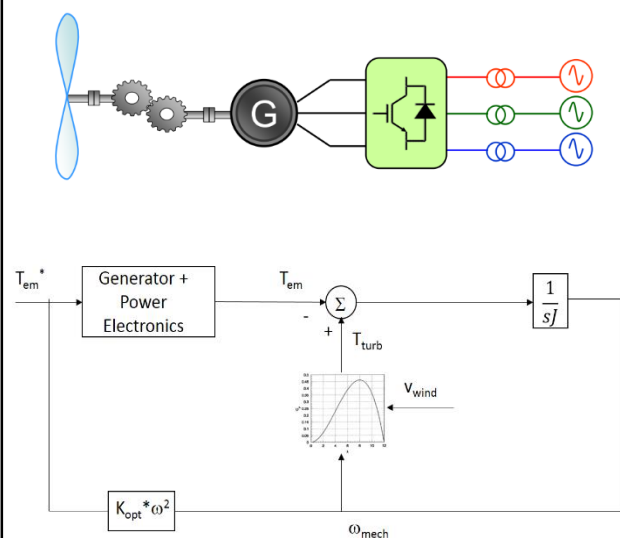
Converting UMN's Sustainable-Electricity Course for Two-Year Community Colleges

Developing a Free and Open Audio-Visual Book for teaching “Sustainable-Electricity Supply” in 2-year community colleges, with low-cost lab experiments

1. Solar Panel characteristics



2. Wind Turbine Characteristics



Enabled by an Ultra-low-cost, intuitive and easy to use controller platform

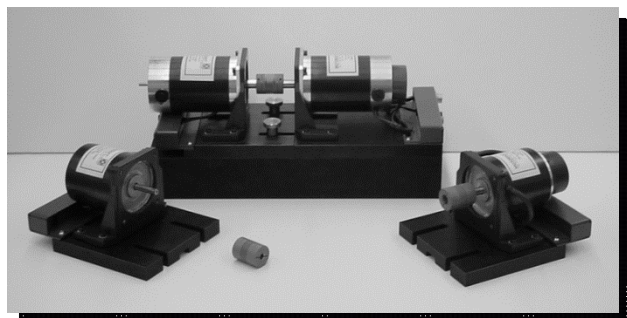


Controller

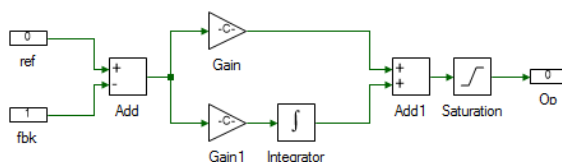


Expansion Boards

ToolBox	
Hardware Integration	
	Read Status
	Analog Input
	PWM Output
	GPI Digital Input
	Digital Output
	AOB Speed
	AOB Position
	SPI Write
	SPI Read



Low cost motors
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Intuitive, drag-drop software interface
ENRTF ID: 150-CH

Prof. Ned Mohan (Project Lead PI) has been teaching and doing research at the University of Minnesota for the past **42** years where he is Oscar A. Schott Professor of Power Electronic Systems and Morse-Alumni Distinguished Teaching Professor. He did his PhD in Electrical Engineering and Master's in Nuclear Engineering, both from the University of Wisconsin – Madison. He has written **5** textbooks and cumulatively they have been translated into **8** languages including Chinese and Spanish. He has graduated **46** PhD students who have gone on to work in iconic companies such as GE, GM, Ford, Tesla, Apple, etc; many of his students are professors at universities such as the University of Wisconsin – Madison, the Arizona State University, Oregon State University, Marquette, etc.

Prof. Mohan's research is focused on increasing the penetration of renewables into the utility grid. He is the Director of the University of Minnesota Center for Electric Energy (UMCEE) which he helped establish in 1981 and that is supported by 6 major utilities in the region including Xcel, GRE and Minnesota Power.

He is passionate about combating climate change and has developed courses that are some of the most popular courses in the Department of Electrical and Computer Engineering. One of these courses is being taught in high schools as well through the College in the Schools (CIS) program at the University of Minnesota.

For his teaching and research, he has received many research and educational awards. Prof. Mohan is a Fellow of the IEEE and in 2014, for his achievements in research and teaching, he was elected to the National Academy of Engineering.

Timothy C Grebner (Consultant) is a faculty member and Program Director at Century College, Minnesota since 1983. He designed and developed the Engineering A.S. Degree Program at Century, and Served on MnSCU committee to develop a Broad Field Engineering AS degree. He has developed articulation agreements with the University of Minnesota, Minnesota State Mankato, and St Cloud State University. He partnered with the University of Minnesota to develop 2+2 engineering program with the University of Minnesota, which enhances collaboration between Century College and the University of Minnesota in making transfer easier for students. In 2004 he received a grant to infuse Service Learning experiences in the engineering curriculum. He also received the MnSCU "Learning by Doing" Grant and successfully implemented a collaborative design and fabrication project to provide engineering students a practical hands on experience.

He has developed new courses in Linear Circuits, Digital Design, Robotics, Introduction to Engineering, Java, Pascal, and Microcomputers, and currently teaches Introduction to Engineering, Circuit Analysis, Statics, and Digital Design. Tim is a member of the American Society of Engineering Education.