Project Title:

ENRTF ID: 159-CH

'Solarize your House' Modeling Activities for K12

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

Sub-Category: C. Environmental Education

Total Project Budget: $ 29,960

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

Summary:

Project will implement 3D solar energy modeling curriculum in K12. Engagement will be increased because students will model their home and the return-on-investment of each solar-panel installation will be determined.

Name: Jacob Swanson

Sponsoring Organization: Minnesota State University - Mankato

Title: Assistant Professor

Department: College of Science, Engineering, and Technology

Address: 9700 France Ave S
Bloomington MN 55431

Telephone Number: (952) 358-9194

Email jacob.swanson@mnsu.edu

Web Address http://cset.mnsu.edu/ie/

Location

Region: Metro

County Name: Hennepin

City / Township: metro area

Alternate Text for Visual:

Image that shows classroom of K12 students conducting solar panel modelling activities. Each student leaves activity with modeled energy costs and savings and ROI of solar panel installation

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_______ TOTAL	______%
	____ If under $200,000, waive presentation?		

PROJECT TITLE: 'Solarize your house' 3D solar panel modeling activities for K12

I. PROJECT STATEMENT

This project is a focused effort to deliver and implement existing **solar panel energy modeling** curriculum. A "pilot" program is proposed in which a single class of K12 students in the TC Metro Area is identified based on synergy with their existing curriculum and level of interest. The principle investigator and a research assistant will work with every student to create a realistic 3D model of their custodian's home or apartment (or provide alternative models – such as one of their school buildings). See examples in Figure 1. In conjunction with the K12 STEM teacher, approximately five class periods will be used to describe how to use "Energy 3D" solar energy modeling software, how to optimize the placement of solar panels on the roof, how to calculate costs and savings, etc. Under supervision during the class, the students will then optimize the placement of solar panels on their model house and run accurate simulations of cost, energy savings, effectiveness based on location, time of year, house geometry, etc. Students will be working with models of their dwelling so engagement will be significantly increased and will be at a higher level. Results will be explicitly relevant to each student and their family.

Benefits to students and the state

After the training and modeling session, all students leave with:

- A 3D model of **their home** or dwelling with **optimized placement of solar panels**. The house will be superimposed on Google Maps so the neighborhood and other context can be seen. Figure 1 is an example that shows a house drawn with the intensity of solar radiation. ***It very important that each student models their dwelling or house to ensure a high level of engagement.***
- Calculated and modeled costs and energy savings, and return on investment (ROI) of a solar panel installation
- Increased engagement and understanding of solar technology, limitations, and opportunities to reduce energy consumption

The expected benefits to the state are as follows. First, it is expected that a subset of the results will show a very good ROI on solar panels that was not otherwise known. This may lead to increased public adoption of solar technologies that increase renewable energy use. As described in the long-term implementation, it is expected that this work be turned into a "package" that can be deployed at other schools for almost no cost – this will have an amplifying effect of all the benefits already discussed.

Software

"Energy 3D" is a solar energy modeling program that can be integrated into environmental education-based school curriculum. The National Science Foundation has supported the development of software called Energy3D (http://energy.concord.org/energy3d/). This is developed and freely disseminated by the Concord Consortium. The software enables models of houses to be built and optimized placement of solar panels. The models are realistic in that they take into account geographical location, time, season, angle and type of solar panel. This enables calculations and modeled costs and energy savings.

Figure 1. Example house with solar panels and intensity of solar radiation shown in color, house superimposed on google maps, and model results showing energy generated by solar panels. Source: http://energy.concord.org/energy3d/projects.html

Previous work and likelihood of success
I first evaluated this idea in my classroom (Jr and Sr undergraduate engineering students) and it was successful as evidenced by the level of student engagement and the quality of results. My students received much less instruction than would be anticipated for a k12 program. The software manufacturer (Concord Consortium) verbally indicated they have conducted similar projects with high degrees of success, but these results are not yet publically available. I have received very positive verbal feedback from K12 teachers who reviewed this proposal.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Software preparation and model development*
Develop expertise in Energy 3D software, draw 3D models of every students' dwelling for one K12 class students. Run trials to determine time requirements for each different modeling activity in the classroom.

ENRTF BUDGET: $21,000

Outcome	Completion Date
1. 3D model of every students' dwelling to enable the next activity	*Jan 1, 2020*

Activity 2: Classroom learning activity.
Engage with STEM teacher and devise and provide suggested basic student preparation activities. Conduct one week of classroom learning activities, which includes a day of explanation of model, three days of guided and supervised modeling and one day of summary and wrap up. Survey staff and students on the effectiveness and engagement of the program. Document all activities and results so that pilot can be further disseminated.

ENRTF BUDGET: $8,960

Outcome	Completion Date
1. Every student has a personal 3D model, optimized placement of solar panels, and ROI	*Jan 1, 2020*
2. Analyzed survey results from students and K12 on activity effectiveness	*May 1, 2020*
3. Documentation of activities and results for that program can be replicated	*May 1, 2020*

III. PROJECT PARTNERS:

A. Partners receiving ENRTF funding

Name	Title	Affiliation	Role
STEM K12 teacher		TBD	Preparation / support classroom activites during modeling sessions

B. Partners NOT receiving ENRTF funding

Name	Title	Affiliation	Role
The Concord Consortium			Provide documentation / instructor training materials at no cost

IV. LONG-TERM- IMPLEMENTATION AND FUNDING: This is intentionally and explicitly a "pilot" in the sense that the activity is intended to be scalable. A successful pilot will be followed by recruitment of K12 teachers to help further disseminate the model and approach. The overall cost is on a per unit basis is expected to decrease significantly – to nearly 0, giving the following justification. A major cost is the labor of constructing the 3D models of each house. Expertise will be developed during this time that can be easily disseminated to interested K12 teachers in future projects. The actual cost of K12 teachers deploying this approach in their classrooms is 0.

V. TIME LINE REQUIREMENTS: After the classroom is identified, it will take 3 months to draw and develop all the individual house/apartment/school models – this is where the bulk of the time will be spent. Approximately three months will be required to create basic preparation activities to ensure adequate levels of student preparation and to engage and on-board STEM teacher. The actual classroom instruction is 1 week. The documentation of the pilot so that it is further deployable will take a few more months.

2019 Detailed Project Budget

Project Title: 'Solarize your house' 3D solar panel modeling activities for K12

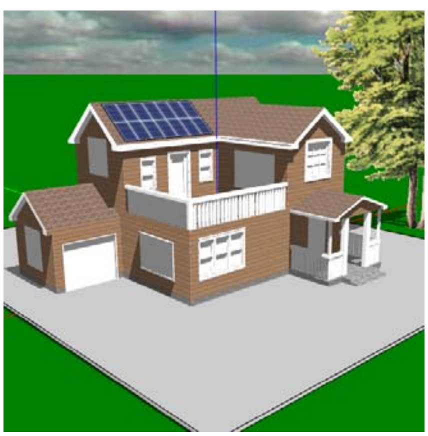
IV. TOTAL ENRTF REQUEST BUDGET 3 years

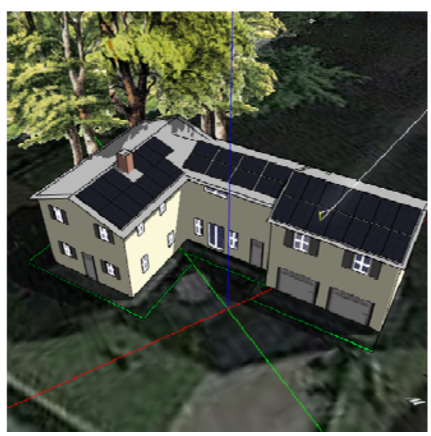
BUDGET ITEM		AMOUNT
Prof. Jacob Swanson, Project Manager, (82% salary, 18% benefits); 15% FTE for 1 year	$	21,240
1 Undergraduate Research Assistant (92% salary, 8% benefits, $12.50/hr); 0.25 FTE for 1 year	$	7,020
Professional/Technical/Service Contracts:		
Contract for K12 teacher	$	1,000
Equipment/Tools/Supplies:		
Printer and color printing supplies to print model results in color for students to bring home	$	500
Acquisition (Fee Title or Permanent Easements): n/a		
Travel:		
Travel to K12 location multiple times at current MinnState mileage rates (~ 0.545/mile)	$	200
Additional Budget Items: n/a	$	-
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST	$	29,960

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	n/a	
Other State $ To Be Applied To Project During Project Period:	n/a	
In-kind Services To Be Applied To Project During Project Period:		
Software - http://energy.concord.org/energy3d/ is free, In-kind support from the Concord	~$2,000	Secured
Consortium (training and/or documentation of previous similar acitivites)		
Travel to the Concord Consortium to receive training supported by Prof. Development funding	~$1,000	Secured
Funding History:		
Remaining $ From Current ENRTF Appropriation: *n/a*	n/a	

Increased engagement – each student gets a complete model of their home or apartment





Benefits for the public and state

- Increased student engagement and knowledge in solar energy technologies
- Calculated and modeled costs and energy savings that lead to identified opportunities and increased public adoption of solar technologies

Image credits: http://clipground.com/clipart-school-desk-with-rose.html, http://energy.concord.org/energy3d/models.html

I. PROJECT MANAGER QUALIFICATIONS

Dr. Jacob Swanson is an Assistant Professor of Engineering in the **Twin Cities Engineering Program** in the Department of Integrated Engineering at Minnesota State University Mankato. He is also an Adjunct Assistant Professor in the Department of Mechanical Engineering (ME) at the University of Minnesota. He was previously a Research Associate in the Department of Engineering at the University of Cambridge, UK and before that, a graduate of UMN's ME Department. Prof. Swanson is internationally recognized for his work on emissions from engine combustion engines, including those from gas turbines. He has published 34 papers and given more than 80 conference presentations on these topics. He is currently advising about 25 students as part of his ENGR Design course. He has 3-4 other external projects supporting about eight undergraduate students. He annually supports, by co-advising, on average 1-2 graduate students in the Particle Technology Laboratory and Engine Research Labs at the University of Minnesota.

II. ORGANIZATIONAL DESCRIPTION

Twin Cities Engineering (TCE) is a program of the Department of Integrated Engineering of Minnesota State University, Mankato. TCE has the purpose of expanding the pool of qualified engineers in the Twin Cities Metro area by establishing an affordable, accessible, and unique option for the region's engineering students. TCE offers an inclusive and innovative learning experience that has attracted non-traditional students and veterans at a higher rate than traditional students. The BSE degree program includes several features that differentiates it from traditional engineering degree programs. TCE addresses the entire learning experience and not simply one component of the curriculum. Five features, designed to produce desired attributes in BSE graduates, are as follows.

- Trans-disciplinary thinking
- Industry-sponsored, project-based-learning
- Experiential learning in context
- Competency-based assessments
- Significant exposure to professionalism, design, creativity, and innovation