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## MTSU Clean Energy Initiative Project Funding Request

There are five (5) sections of the request to complete before submitting. See <http://www.mtsu.edu/sga/cleanenergy.shtml> for funding guidelines. Save completed form and email to [cee@mtsu.edu](mailto:cee@mtsu.edu) or mail to MTSU Box 57.

1. General Information	
Name of Person Submitting Request <b>Dr. James Brian Robertson</b>	
Department/Office <b>Biology / SCI 2053</b>	Phone # (Office) <b>898-2066</b>
MTSU Box # <b>60</b>	Phone # (Cell)
E-mail <a href="mailto:james.robertson@mtsu.edu">james.robertson@mtsu.edu</a>	Submittal Date 2/16/18

2. Project Categories (Select One)			
Select the category that best describes the project.			
<input type="checkbox"/>	Energy Conservation/Efficiency	<input type="checkbox"/>	Sustainable Design
X	Alternative Fuels	<input type="checkbox"/>	Other
<input type="checkbox"/>	Renewable Energy		

3. Project Information	
<p>a. Please provide a brief descriptive title for the project.</p> <p>b. The project cost estimate is the expected cost of the project to be considered by the committee for approval, which may differ from the total project cost in the case of matching funding opportunities. <b>Any funding request is a 'not-to-exceed' amount. Any proposed expenditure above the requested amount will require a resubmission.</b></p> <p>c. List the source of project cost estimates.</p> <p>d. Provide a brief explanation in response to question regarding previous funding.</p>	
3a. Project Title <b>Enzymatic Conversion of Recycled Waste Paper into Ethanol Biofuel</b>	
3b. Project Cost Estimate <b>\$5,000</b> Supplies include oligonucleotide primers, reagents to prepare high quality DNA, DNA modification enzymes for cloning, chemicals for treating microbes, plastic consumables, sequencing reagents, media and supplements. (An itemized list of supplies and their costs can be provided if requested).	

**3c. Source of Estimate**

Based on MTSU prices from Fisher Scientific, Invitrogen, New England Biolabs, Promega, Sigma-Aldrich and VWR Scientific.

3d. If previous funding from this source was awarded, explain how this request differs?

Dr. Robertson was funded in 2014 for a proposal titled "Development of a novel microbial consortium approach to produce ethanol biofuel from tree and grass" which made substantial findings regarding the limitations of using the cellulose harvested from natural sources as a feedstock for microbial fermentation. This proposed work differs from the previous work in that this work focuses on optimizing combinations of enzymes (not microbes) to convert a refined cellulose source (recycled paper, not natural woody materials) into ethanol. This work makes use of the findings from the previous project to overcome/bypass limitations in the production stream.

**4. Project Description**

(Completed in as much detail as possible.)

- a. The scope of the work to be accomplished is a detailed description of project activities.
- b. The benefit statement describes the advantages of the project as relates to the selected project category.
- c. The location of the project includes the name of the building, department, and/or specific location of where the project will be conducted on campus.
- d. List any departments you anticipate to be involved. Were any departments consulted in preparation of this request? Who? A listing may be attached to this form when submitted.
- e. Provide specific information on anticipated student involvement or benefit.
- f. Provide information for anticipated future operating and/or maintenance requirements occurring as a result of the proposed project.
- g. Provide any additional comments or information that may be pertinent to approval of the project funding request.

#### 4a. Scope: Work to be accomplished

Ethanol (as a biofuel) is a renewable alternative to gasoline that industry currently produces by fermenting corn grain sugars. Growing corn as a feedstock for ethanol production requires land, irrigation, fertilizers, and labor that could otherwise be used for food production. Cellulosic ethanol is an emerging alternative to corn grain ethanol that derives fermentable sugars from cellulosic feedstocks like wood chips, sawdust, leaves, grass, and agricultural byproducts. The benefit of cellulosic ethanol is that it uses byproducts and waste streams of other materials and does not require dedicated land or efforts to produce. However, the drawback for using traditional cellulose sources (wood fiber) is that wood fiber includes lignin, a strengthening chemical that makes digesting cellulose into sugars more difficult (and to this point, largely cost-prohibitive). However there is a readily available source of cellulose on campus for which the inhibitory woody lignin chemicals have already been removed... waste paper. Paper (such as that which MTSU shreds and recycles) is virtually pure cellulose, and potentially a valuable feedstock for ethanol production.

*Trichoderma reesei* is filamentous fungus that readily digests cellulose as a food source. The fungus secretes a cocktail of enzymes (cellulases) that work in concert to efficiently break down the cellulose into sugars that the fungus then eats. This project proposes to do the following:

- 1) Transfer the individual genes that code for each of the cellulases in *Trichoderma reesei* (about 7 or 8 genes) into yeast strains that can then be used to individually produce purified cellulases in the laboratory.
- 2) Experimentally determine the appropriate ratios of purified cellulases to mix so as to maximize the conversion of paper into fermentable sugars.
- 3) Ferment the paper-derived sugars into ethanol as a pilot project for "scale-up" calculations.

#### 4b. Scope: Benefit Statement

This project could provide MTSU with an alternative energy stream and an alternative use for recycled paper. Insights gleaned from this research will also have broader impacts on lignocellulosic research in general. The determined ratios of cellulases for optimizing the breakdown of cellulose (regardless of source) will benefit the industry as a whole and will result in publishable results in biofuels journals.

**4. Project Description (continued)**

## 4c. Location of Project (Building, etc.)

This research will be conducted in Dr. Robertson's lab in SCI 2050.

## 4d. Participants and Roles

**Dr. Robertson** will supervise the construction of the strains necessary to produce the various cellulases. As a genetic engineer, Dr. Robertson is well versed in the requirements and processes of this work. The work will be performed by one M.S. student in the Biology department, as well as possible undergrads.

## 4e. Student participation and/or student benefit

This research project will be completely student-driven. Dr. Robertson will lend his expertise and advice to guide the project but the hands-on construction and development will be done by the students. Completions of this work is also expected to benefit the new Fermentation Sciences program and developing a tie-in for scale-up will be a priority post completion.

## 4f. Future Operating and/or Maintenance Requirements

This is a one-time investment in research material needed to construct the strains for enzyme production and to carry out a pilot project for feasibility.

## 4g. Additional Comments or Information Pertinent to the Proposed Project.

This proposal is for technology development with a proposed timeframe of two semesters to construct the strains. Large scale production of ethanol is beyond the scope of this proposal. However, should this research be successful, the goal of scaling up production may be worthy of another proposal in the future.

## 5. Project Performance Information

Provide information if applicable.

- a. Provide information on estimated annual energy savings stated in units such as kW, kWh, Btu, gallons, etc.
- b. Provide information on estimated annual energy cost savings in monetary terms.
- c. Provide information on any annual operating or other cost savings in monetary terms. Be specific.
- d. Provide information about any matching or supplementary funding opportunities that are available. Identify all sources and explain.

5a. Estimated Annual Energy Savings (Estimated in kW, kWh, Btu, etc.)

See below

5b. Annual Energy COST Savings (\$)

This project by itself does not produce energy cost savings, however it is the beginning of a series of steps that can ultimately lead to reducing our nation's dependence on fossil fuels and the need to import them from foreign countries. Successful completion of this work can provide the impetus for Tennessee to develop regional ethanol biorefineries so that our locally produced sources of cellulose can provide an avenue for fuel cost savings. Research that benefits development of locally produced renewable fuels reduces transportation costs and provides flexibility to offset the volatility of the fuel market.

5c. Annual Operating or Other Cost Savings. Specify. (\$)

5d. Matching or Supplementary Funding (Identify and Explain)

All of the equipment needed for this research has been purchased using other funds. Additionally, student labor for this project will be funded through teaching assistantships.