

Quarterly Progress Report:

Project Number and Title: 1.11 Energy Harvesting and Advanced Technologies for Road Assessment Tools

Research Area: *Devotement of Improved Road and Bridge Monitoring and Assessment Tools*

PI: *K. Wayne Lee, University of Rhode Island (URI), Civil and Environmental Engineering*

Co-PI(s): *Michael L. Greenfield, URI, Chemical Engineering and Sze Yang, URI, Chemistry*

Reporting Period: 10/1/19 – 12/31/19

Submission Date: 12/31/2019

Overview:

Provide **BRIEF** overview and summary of activities performed during the reporting period. This summary should be written in lay terms for a general audience to understand. This should not be an extensive write up of findings (those are to be included in the final report), but a high-level overview of the activities conducted during the last three months....

Literature review utilizing the Seebeck Effect (thermoelectric effect) was further researched and reviewed. The solar harvester apparatus is being further designed and built based on European and Texas experiences. Materials were bought to begin initial testing of the apparatus. The initial testing concluded that the solar harvester can produce energy.

Provide context as to how these activities are helping achieve the overarching goal(s) of the project...

The project goal is to extract energy from a pavement that experiences heating due to incoming solar radiation. One application of harvested solar energy could be a self-powered structural health monitoring system for roadways. The first two activities relate to testing energy extraction experimentally. A temperature difference between warm water and a support material generated small thermoelectric voltages as one experimental test of this approach. Heated copper provides another example. These demonstrate that a thermal heat source can be sufficient to enable a small voltage. The third activity relates to evaluating the feasibility and success of these steps by using parameterized physics- and chemistry-based models. The solar harvester was analyzed and reviewed prior to ordering the materials.

Describe any accomplishments achieved under the project goals...

Producing voltage from the copper plate solar apparatus was an accomplishment for the project (Figure 1).



Figure 1: initial testing of solar harvester unit

Complete the following tables to document the work toward each task and budget (add rows/remove rows as needed)...

Table 1: Task Progress			
Task Number	Start Date	End Date	Percent Complete
Task 1: Literature	7/1/18	12/31/18	90%
Task 2: Candidates	11/1/18	4/30/19	80%
Task 3: Perpetual Pavt	1/1/19	6/30/19	70%
Task 4: Solar Harvesting	4/1/19	12/31/19	60%
Task 5: Cycle Model	10/1/19	3/31/20	50%
Task 6: Losses	1/1/20	6/30/20	0%
Task 7: Outcomes	4/1/20	9/30/20	0%

Table 2: Budget Progress		
Entire Project Budget	Spend Amount	Spend Percentage to Date
\$ 257,510	\$129,000	50%

Describe any opportunities for training/professional development that have been provided...

The graduate student is working on the project is in the non-thesis Civil Engineering master's program. He is receiving training that is not usually available to non-thesis students regarding conducting research and actively participating in the research process.

Describe any activities involving the dissemination of research results (be sure to include outputs, outcomes, and the ways in which the outcomes/outputs have had an impact during the reporting period. Please use the tables below for any Publications and Presentations in addition to the description of any other technology transfer efforts that took place during the reporting period.)... Use the tables below to complete information about conferences, workshops, publications, etc. **List all other outputs, outcomes, and impacts after the tables** (i.e. patent applications, technologies, techniques, licenses issued, and/or website addresses used to disseminate research findings).

Table 3: Presentations at Conferences, Workshops, Seminars, and Other Events				
Title	Event	Type	Location	Date(s)
Infrastructure Assessments Through Solar Energy Harvesting.	4 th Renewable Energy Sources – Research and Business RESRB 2019 Conference	Conference	Wroclaw	July 8, 2019
Energy Harvesting and Advanced Technologies for Road Assessment Tools	32 nd Rhode Island Transportation Forum	Conference	URI	October 25 th , 2019
Modeling Heat Flow from Asphalt Pavement into an Embedded Water Pipe	32 nd Rhode Island Transportation Forum	Conference	URI	October 25 th , 2019

Table 4: Publications and Submitted Papers and Reports

Type	Title	Citation	Date	Status
Conference paper	<i>Infrastructure Assessments Through Solar Energy Harvesting.</i>	Book of Abstracts: 4 th Renewable Energy Sources – Research and Business RESRB 2019 Conference	7/8/19	Published

Participants and Collaborators:

Use the table below to list all individuals who have worked on the project.

Table 5: Active Principal Investigators, faculty, administrators, and Management Team Members			
Individual Name	Email Address	Department	Role in Research
K Wayne Lee	leekw@uri.edu	URI CVE	PI
Michael Greenfield	greenfield@uri.edu	URI Chem E	Co-PI

Use the table below to list all students who have participated in the project.

Table 6: Student Participants during the reporting period				
Student Name	Email Address	Class	Major	Role in research
Austin DeCotis	austindecotis@my.uri.edu	Masters	CVE	GRA I
Mason Hyde	Mason_hyde@my.uri.edu	Bachelors	CHE	calculations

Use the table below to list all students who worked on this project and graduated during this reporting period.

Table 7: Student Graduates			
Student Name	Role in Research	Degree	Graduation Date
David Schumacher	Research on solar energy harvesting for warm water through embedding conductive pipe	M.S.	8/31/19

Use the table below to list organizations have been involved as partners on this project and their contribution to the project.

Table 8: Research Project Collaborators during the reporting period						
Organization	Location	Contribution to the Project				
		Financial Support	In-Kind Support	Facilities	Collaborative Research	Personnel Exchanges
Dept of Civil Engineering, URI	Kingston, RI		X			
Dept. of Chemical Engineering, URI	Kingston, RI		X			
Department of Chemistry, URI	Kingston, RI		X			
Research Office, URI	Kingston, RI	X				

List all other outputs, outcomes, and impacts here (i.e. patent applications, technologies, techniques, licenses issued, and/or website addresses used to disseminate research findings). Please be sure to provide detailed information about each item as with the tables above.

N/A

Have other collaborators or contacts been involved? If so, who and how? (This would include collaborations with others within the lead or partner universities; especially interdepartmental or interdisciplinary collaborations).

Name of Technical Champion: Steven Cascione

Title: Programming Services Officer

Organization: RIDOT

Phone number: 401-734-4803

Email: Steven.Cascione@dot.ri.gov

Changes:

Discuss any actual or anticipated problems or delays and actions or plans to resolve them...

None

Discuss any changes in approach and the reasons for the change...

N/A

Planned Activities:

Description of future activities over the coming months.

Experiments on Seebeck effect between a hot pavement and a cold sink in the ground will be conducted in the Kirk Lab/URI transportation room. The solar harvester will be fully built, optimized and tested for electricity generation.

Calculations to improve the geometry of the cold sink and the thermocouple layout will be conducted to pursue improved temperature gradients with minimal heat flow.