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: *1/1/20 –3/31/20*
Submission Date: *3/31/2020*

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 solar power supply for energy consumption was further researched and reviewed. The solar harvester apparatus is being further designed and built based on European and Texas experiences. More materials were bought to finalize the initial prototype. The initial testing concluded that the solar harvester can produce energy, which can be used to power road monitoring sensors.
The circuit board connected to the sensor was developed to control the roadway sensor. The solar harvester apparatus will act as the power supply of this circuit board, resulting in sustainable energy. Code was developed written in the language of Java to send information to the roadway sensor.

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 hot (or warm) surface and a cold 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.
Another accomplishment was attaching a sensor to a circuit board to be able to collect data from that sensor. The sensor can be read from a computer sustainability (Figure 1)

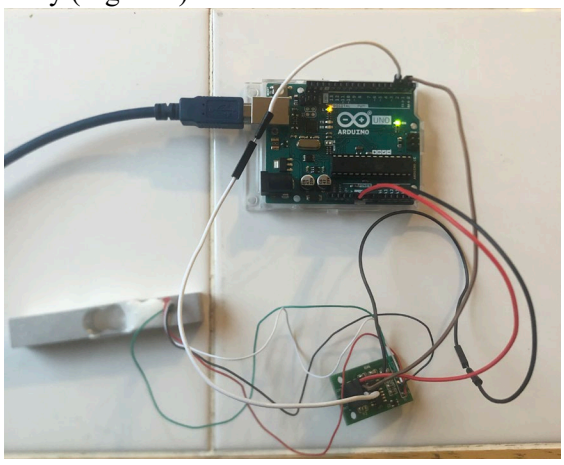

Figure 1: Initial connection for roadway sensor (Arduino board, Weight sensor, and Analog Digital Converter shown.) this connection is necessary for the sensor to work

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	95%
Task 2: Candidates	11/1/18	4/30/19	85%
Task 3: Perpetual Pavt	1/1/19	6/30/19	75%
Task 4: Solar Harvesting	4/1/19	12/31/19	65%
Task 5: Cycle Model	10/1/19	3/31/20	55%
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**
$ 141,664	$85,000 (estimated)	60% (estimated)

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)**
Solar Energy Harvesting from Asphalt Pavement	Research Group Meeting of Prof. Huming Yin of Columbia University	Research Meeting	New York, NY	March 20, 2020

Table 4: Publications and Submitted Papers and Reports				
Type	**Title**	**Citation**	**Date**	**Status**
N/A				

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		Masters	CVE	GRA I
Mason Hyde		Bachelors	CHE	Calculations

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

Table 7: Student Graduates			
Student Name	**Role in Research**	**Degree**	**Graduation Date**
N/A			

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			
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…

Due to the Corona Virus the lab set up is "on the go"

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/FCAE RITRC. However, GRA will work at home during the coronavirus pandemic crisis, and will communicate with PI & Co-PI through WebEx. The solar harvester and the connection for the sensor 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.

The code for the roadway sensor will be further developed for optimal conditions.

The design of the solar apparatus and the roadway sensor will be finalized.

Testing of the sensor underneath the roadway shoulder will also be implemented.