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

Research Area: *Development 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*
Reporting Period: *April – June 2020*
Submission Date: *6/28/2020*

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….*

The solar harvester apparatus was fully built based on European and Texas studies. Materials were bought to for further testing of the apparatus. The initial benchtop testing concluded that the solar harvester can produce energy. The solar apparatus and strain gauge sensor will be installed into Plains Road at URI. Small deformations of the roadway ("micro-strain") are to be measured in real time with the embedded sensor. A prototype is under development in the project and will be installed on a feeder road to the University of Rhode Island (URI). There it will monitor the impact of vehicles come to the campus for deliveries of equipment and construction materials etc. The device extracts energy from the pavement while fully powering the sensor. The project includes modeling work to quantify the viability and performance of this energy harvesting approach.

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

The initial project goal was to extract energy from a pavement that experiences heating due to incoming solar radiation, which could cool the pavement for longer life. Warm water and small thermoelectric voltages are two possible ways to extract this experimentally. The first two activities relate to testing this extraction experimentally. The energy (or power) will be used to support improved road monitoring and assessment tools. 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 heavily analyzed and reviewed prior to the ordering of the materials. Installation of the harvester will allow for real world data of asphalt pavements and sustainable ways of power generation.

Describe any accomplishments achieved under the project goals…

Producing voltage from the copper plate solar apparatus, indoors as a test, was an accomplishment for the project in this quarter.

Another accomplishment was getting access to install the sensor into the roadway. The blueprints were drawn for the contractors.

Figure 1 shows solar energy harvester embedded in roadside and strain sensor in pavement.

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: Review previous research and form baseline understanding installation process	7/1/19	12/31/19	100%
Task 2: Installation of solar harvester and sensor	1/1/20	7/31/20	70%
Task 3: Testing of solar harvester /sensor	1/1/20	8/31/20	60%
Task 4: Cycle Model	1/1/20	8/31/20	50%
Task 5: Prepare the Phase I report and submit it to TIDC	8/1/20	9/30/20	0%
Task 6: Data retrieval of harvester and sensor	10/1/20	7/31/21	N/A
Task 7: Improving efficiency of solar apparatus	5/1/21	8/31/21	N/A
Task 8: New materials/ testing conditions of apparatus	6/1/21	8/31/21	N/A
Task 9: Prepare the Phase II report and submit it to TIDC	7/1/21	9/30/21	N/A

Table 2: Budget Progress		
Entire Project Budget	**Spend Amount**	**Spend Percentage to Date**
$ 141,664	$106,000 (estimated)	75% (estimated)

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

A 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)**
Energy Harvesting and Advanced Technologies fro Enhanced Life	RITRC Weekly Mtg	Research Meeting	URI	Every Monday of 4/6/20 to 6/29/20

Table 4: Publications and Submitted Papers and Reports				
Type	**Title**	**Citation**	**Date**	**Status**
Conference paper	*Infrastructure Assessments Through Solar Energy Harvesting.*	TRB Conference present5ation and publication	Due 8/1/20	Under preparation

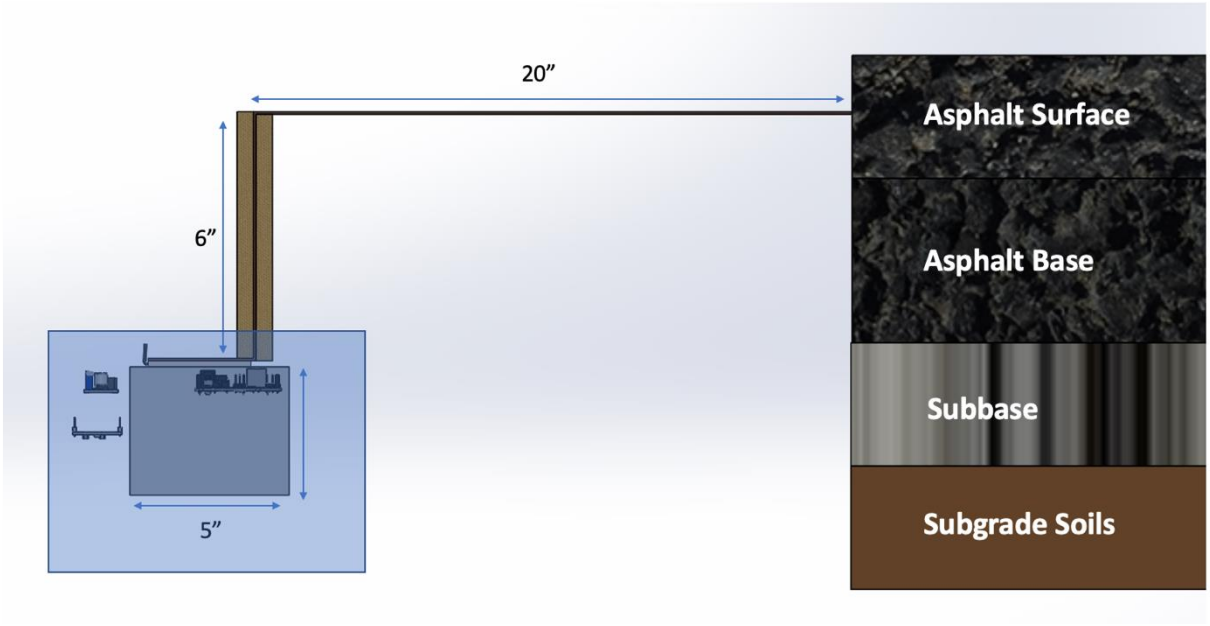

Figure 1: Solar Energy Harvester, embedded in roadside and strain sensor in pavement

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	Email is not included in the external report and is only used for internal purposes.	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		2020	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**
Mason Hyde		BS	2020
Austin DeCotis	Thrust 1	Masters	2020

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**
CVE, URI	Kingston, RI	Mark the appropriate contribution with an "x"	X			
CHE, URI	Kingston, RI		X			
Research Office, URI	Kingston, RI	X				
Capital and Facility, URI	Kingston, RI		X			
RIDOT	Warwick, 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.

None

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 COVID-19, lab has been closed most times of this quarter.

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

GRA worked at home during the coronavirus pandemic crisis, and communicated with PI & Co-PI through WebEx

Planned Activities:

Description of future activities over the coming months.

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 solar harvester will be fully built and embedded into the road for-electricity generation at Plains Road which is one of access road for delivery trucks to URI. Testing of the apparatus will be conducted and further optimized.