North Dakota Renewable Energy Program
Phase II Status Report

Recipient: Packet Digital LLC
Contract Number: R-040-051
Report for time period of: May 1, 2019 - July 31, 2019

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Description of Project

Packet Digital LLC, Nishati, and the U.S. Naval Research Laboratory (NRL) are collaborating to develop and commercialize transportable solar power generation modules capable of delivering up to 1kW, when setup in parallel, for remote military installations, emergency shelters and camps. The end product will eliminate the fuel requirement and noise and will reduce the life cycle cost of standard electromechanical power generation.

Project Tasks

Substantial progress has been made during this period, primarily focusing on the electronic tests and debug activities on the product from Phase I design. Activities in this period include:

- Rigorous field tests at Nishati's test center in Gilbert, AZ. The portable solar generation system was tested for functionality and performance under the hot Arizona climate with average daily temperature above 100^{o}F, day and night continuously. Any issues encountered or ideas that came up during field test were communicated immediately for remote firmware updates.

- Firmware updates to support feedback from field tests. Multiple firmware updates were sent for various improvements such as but not limited to: removal of low frequency oscillations on the

inverter, stability improvement in the control loop, make the system more resilient to solar panel shadowing effect, and user indicator of 80% battery capacity threshold during charging.

- Rebuilding one module that got damaged due to debris induced short circuit (see Appendix A).
- In house laboratory hardware tests. After rebuilding the damage module, several tests were done in the lab to ensure proper functionality as well as fine tuning of the overall system.
- Battery runtime tests, resulting in more understanding about the BB2590 internal operation which allow Packet Digital to develop battery charge and discharge algorithm improvement to extend the overall battery runtime. Using the current BB2590 batteries that Packet Digital purchased, the average runtime was improved to about 8% with this algorithm.
- Development and implementation of algorithm to solve inverter lockup condition. The inverter that is used in the system has a built-in under voltage protection that will lock the inverter output when repeated under voltage condition is detected. This situation is undesirable since it requires manual user intervention to reset the inverter. The new algorithm that Packet Digital implemented removes this limitation.
- The original design from Phase I was successfully field tested at Nishati's test center. Upon completing the in house lab test, and implementing the new algorithms, PSG1 was sent back to Nishati for further field tests in their facility and the test results were beyond satisfactory.
- Objective 1 for Phase II, electronic boards design refinement followed by assembly and tests will start in August 2019.

Deliverables

Please describe the progress on project deliverables, as stated in your contract, achieved during the reporting period:

- Activities in this reporting period provide important information which will be used as a foundation for the electronic design improvement work as one of the project deliverables stated in the contract. Electronic design improvement work will start in August 2019.

Budget

Project Associated Expense	NDIC Share	NRL Share	Total
Total Personnel Cost	$389,898.60[1]	$500,000.00	$889,898.60
Software and Materials	$110,101.40[2]	$0.00	$110,101.40
Total	$500,000.00	$500,000.00	$1,000,000.00

[1] Direct personnel costs plus indirect overhead and G&A
[2] Direct materials costs plus G&A

Expenditures

Expenditures for the project to date are shown in the table below.

EXPENDITURES FOR INTERIM 1 REPORTING PERIOD ONLY				
Project Expense	**NDIC**	**Packet Digital**	**NRL**	**Total**
Total Personnel Costs	$44,422.74	$0.00	$130,329.46	$174,752.20
Software/Materials/Subs	$148.51	$0.00	$27,979.21	$28,127.72
Total	$44,571.25	$0.00	$158,308.67	$202,879.92

CUMULATIVE EXPENDITURES				
Project Expense	**NDIC**	**Packet Digital**	**NRL**	**Total**
Total Personnel Costs	$44,422.74	$0.00	$130,329.46	$174,752.20
Software/Materials/Subs	$148.51	$0.00	$27,979.21	$28,127.72
Total	$44,571.25	$0.00	$158,308.67	$202,879.92