North Dakota Renewable Energy Program
Status Report

Recipient: Packet Digital LLC
Contract Number: R-040-051
Report for time period of: February 1, 2020 - March 15, 2020

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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
Please describe the progress on all project tasks achieved during the reporting period:

Objective 1: Refine PSG1 electronic design to simplify manufacturing and assembly process -- **Progress was already reported in interim 2 report.**

- Task 1 – Refine the electronic board designs to reduce the amount of wiring and interconnect needed.
- Task 2 – Assemble the electronics and perform laboratory tests to verify functionality.

Objective 2: Refine PSG1 custom enclosure -- **Some of the progress was already reported in interim 3.** Below are additional updates:

- Task 1 – Refine overall enclosure design to make the assembly process easier and less expensive.

    - Latest iteration of the enclosure design refinement has been sent to the vendor in Asia and is currently being produced. Due to the coronavirus outbreak, the vendor has paused all production for about a month.
- Task 2 – Add more protection features to better withstand the MIL-STD tests.
    - With protection features added, water intrusion test at the depth of 1m was done successfully at the Hulbert Aquatic Center facility in West Fargo. The result of this test showed that PSG1 is IP67 compliant.
- Task 3 – Survey and evaluate plastic injection mold options for the front panel -- **Progress was already reported in interim 2 report.**

Objective 3: Design modification of PSG-C1000 to make it lighter -- **Progress was already reported in interim 2 report.**

- Task 1 – Survey and evaluate economical options for lighter energy storage that will work for PSG-C1000.
- Task 2 – Modify current PSG-C1000 electronic design to support the selected new energy storage.

Objective 4: System integration and field test -- **Some of the progress was already reported in interim 3.** Below are additional updates:

- Task 1 – Electronic assembly into the custom enclosure and integration with solar panel.
    - Integration and functional verification of the electronic boards were successfully done in the lab.
    - System integration with solar panels was done and was ready for the field test.
- Task 2 – Conduct field test.
    - A field test was done with good initial results, all functions worked as intended. However the test had to be stopped early due to a minor technical issue. Another field test is scheduled for late March.

Objective 5: FCC compliance testing -- **Some of the progress was already reported in interim 3.** Below are additional updates:

- Task 1 – Identify FCC accredited testing laboratory to work with and proceed with the testing -- **Progress was already reported in interim 2 report.**
- Task 2 – Contingency plan, in the event that FCC test fails, Packet Digital will perform design refinement and re-test.
    - Electronic design modification was completed and functionally verified.
    - Using the recently bought spectrum analyzer and near field probe, the level of radio frequency emission was measured and compared with the original design. The result showed a reduced level of EMI.
    - To further reduce the EMI level, the use of RF shield fabric will be evaluated. This fabric can have dual purpose, as an EMI shield and also as a cover to conceal the PSG1, which could be beneficial for clandestine military operations.

Objective 6: MIL-STD testing and certification

- Task 1 – Identify MIL-STD accredited testing laboratory to work with.
    - Several certified test laboratories have been contacted for MIL-STD compliance test quotes and availability.

    - Considering the availability of MIL-STD tests being offered, service coverage, reputation, cost and location, Element Materials Technology was selected as the test facility for this MIL-STD compliance test.
- Task 2 – Build four identical systems and proceed with the testing.
    - Four identical systems are currently being built, however, the coronavirus outbreak is causing significant delay in the fulfillment of the needed parts.
    - Scheduling for the MIL-STD test has been coordinated with the Element Materials Technology test laboratory.
- Task 3 – Contingency plan, in the event that any of the MIL-STD tests fail, Packet Digital will perform the necessary design reinforcement and re-test.

Objective 7: Looking into potential new design to support further hybridization with gasoline/diesel power generator

- Task 1 – Perform market survey to investigate the potential market demand for such a hybrid system.
    - Market survey for hybrid solar and diesel power generators is ongoing.
- Task 2 – Perform initial design architecture, capturing general functionalities of the hybrid system.
    - Will be started after the market survey is complete.

Deliverables

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

- Report on the improvement in electronic design to simplify manufacturing and assembly process -- **Already reported in interim 2 report.**

- Report on the improvement in custom enclosure to simplify manufacturing and assembly process -- **Already reported in interim 3 report.**

- Report on the weight reduction of PSG-C1000 inverter module -- **Already reported in interim 2 report.**

- Report on the FCC and MIL-STD compliance of the product.
    - Electronic design refinement to reduce EMI is completed, currently building the system for FCC compliance re-testing.
    - Due to the coronavirus outbreak that is causing delay in the production, the original schedule date for MIL-STD compliance test is pushed back tentatively to late April 2020.
    - PSG1 has been internally evaluated and tested for IP67 compliance and it successfully passed the test.

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. Supporting documentation is provided as a separate attachment.

EXPENDITURES FOR INTERIM 4 REPORTING PERIOD ONLY				
Project Expense	**NDIC**	**Packet Digital**	**NRL**	**Total**
Total Personnel Costs	$44,299.07	$0.00	$	$44,299.07
Software/Materials/Subs	$7,631.39	$0.00	$	$7,631.39
Total	$51,930.47	$0.00	$	$51,930.47

CUMULATIVE EXPENDITURES				
Project Expense	**NDIC**	**Packet Digital**	**NRL**	**Total**
Total Personnel Costs	$242,051.11	$0.00	$289,787.98	$531,839.09
Software/Materials/Subs	$20,653.24	$0.00	$38,759.72	$59,412.96
Total	$262,704.35	$0.00	$328,547.70	$591,252.05