

## North Dakota Renewable Energy Program Status Report

Recipient: Packet Digital LLC  
Contract Number: R-040-051  
Report for time period of: July 31, 2020 - August 31, 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 set up 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 -- **Progress was already reported in interim 5 report.**

- Task 1 – Refine overall enclosure design to make the assembly process easier and less expensive.
- Task 2 – Add more protection features to better withstand the MIL-STD tests.
- Task 3 – Survey and evaluate plastic injection mold options for the front panel.

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 -- **Progress was already reported in interim 5 report.**

- Task 1 – Electronic assembly into the custom enclosure and integration with solar panel.
- Task 2 – Conduct field test.

Objective 5: FCC compliance testing -- **Some of the progress was already reported in interim 5.**

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
  - FCC retesting is planned to be done in mid September.

Objective 6: MIL-STD testing and certification -- **Some of the progress was already reported in interim 5.**

Below are additional updates:

- Task 1 – Identify MIL-STD accredited testing laboratory to work with -- **Progress was already reported in interim 4 report.**
- Task 2 – Build four identical systems and proceed with the testing.
  - Four PSG1 systems were built and functionally verified before being sent for MIL-STD tests.
  - MIL-STD tests were performed at the Element Materials Technology test facility in Minneapolis from July 20th to July 31st, 2020.
  - Four units of PSG1 were tested in parallel in order to save time.
  - PSG1 successfully passed all the tests that have been prepared for.
- 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.
  - PSG1 passed all the planned MIL-STD tests, no contingency plan required.

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 -- **Some of the progress was already reported in interim 5.** Below are additional updates:
  - MIL-STD compliance tests were conducted for two weeks at the Element Materials Technology test facility in Minneapolis, MN. PSG1 passed all the tests that have been planned for:
    - Low Temperature, MIL-STD-810G Method 502.6, Procedures I and II
    - High Temperature, MIL-STD-810G Method 501.6, Procedures I and II
    - Humidity, MIL-STD-810G Method 507.6
    - Rain, MIL-STD-810G Method 506.6, Procedures I and II
    - Vibration, MIL-STD-810G Method 514.7
    - Shock, MIL-STD-810G Method 516.7, Procedures IV
    - Blowing Dust, MIL-STD-810G Method 510.6, Procedures I
    - Blowing Sand, MIL-STD-810G Method 510.6, Procedures II
  - FCC compliance retest is planned to be done in mid September.

**Additional Information**

- We received feedback regarding the two (2) PSG1 systems that were shipped to our partner Nishati for our military customer, the United States Marine Corp (USMC). It has come to our attention that the USMC is planning to do a reverse polarity test on the units. This was an unexpected test since the units were designed in a manner that will prevent reverse polarity conditions. The design uses connectors that will not allow users to accidentally reverse the polarity. Users will have to deliberately cut the connector cables and reverse the connection in order to do this.
- As a resolution, an external reverse polarity protection circuit is being designed to be added to the PSG1. Individual components have been identified, prototype has been built, and the protection circuit has been tested under reverse polarity condition for multiple times. The protection circuit successfully protects PSG1 under a reverse polarity condition. Discussion is ongoing with Nishati for more detail on the implementation of this additional protection circuit.

**Budget**

Project Associated Expense	NDIC Share	NRL Share	Total
Total Personnel Cost	\$389,898.60 <sup>1</sup>	\$500,000.00	\$889,898.60

Software and Materials	\$110,101.40 <sup>2</sup>	\$0.00	\$110,101.40
Total	\$500,000.00	\$500,000.00	\$1,000,000.00

<sup>1</sup> Direct personnel costs plus indirect overhead and G&A

<sup>2</sup> 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.

<b>EXPENDITURES FOR INTERIM 6 REPORTING PERIOD ONLY</b>			
<b>Project Expense</b>	<b>NDIC</b>	<b>NRL</b>	<b>Total</b>
Total Personnel Costs	\$60,052.65	\$0	\$60,052.65
Software/Materials/Subs	\$22,663.88	\$0	\$22,663.88
Total	\$82,716.53	\$0	\$82,716.53

<b>CUMULATIVE EXPENDITURES</b>			
<b>Project Expense</b>	<b>NDIC</b>	<b>NRL</b>	<b>Total</b>
Total Personnel Costs	\$362,823.56	\$419,336.36	\$782,159.92
Software/Materials/Subs	\$49,330.82	\$91,674.02	\$141,006.84
Total	\$412,154.38	\$511,010.38	\$923,164.76