

# North Dakota Renewable Energy Program Status Report

Recipient: Packet Digital LLC

Contract Number: R-032-041

Report for time period of: December 01, 2018 - February 28, 2019

## 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, and a variety of commercial uses such as but not limited to outdoors activities (RV campers, remote cabins, etc.), household backup power generation, and remote job sites. The end product will eliminate the fuel requirement and noise and reduce the life cycle cost of standard electromechanical power generation.

## Project Tasks

Considerable progress has been made on this project, primarily focusing on the electronic tests and debug activities. Electronic enclosure mechanical design has been finalized and fabrication order has been placed.

- Objective 4 for additional hardware, custom enclosures and transport cases evaluation and development is nearing completion, hardware and enclosure fabrications are in progress. This includes the separate inverter enclosure and its related hardware design.
- Laboratory tests for individual supporting blocks followed by module to module interaction tests are in progress:
  - MPPT algorithm was tested with laboratory equipment and optimized for use with Expedition 570 solar panel.
  - Solar power curve tracing circuit tested and verified.
  - Bidirectional battery charger and sharing port circuit tested and optimized with digital control.
  - USB charger and bootloader features implemented and verified.
  - Available solar power indicator and power usage indicator implemented, tested, and verified.
- Part of objective 5 for system integration and testing has been done in the laboratory as well as in the field. Issues found during tests have been investigated and corrective actions have been implemented in the second revision of the design. Electronic printed circuit boards (PCBs) for the second revision of the design have been fabricated and currently being evaluated.

- Field test of the overall system (first revision) with Expedition 570 solar panel has been done a few times. Due to the winter conditions in Fargo at the time the tests were conducted, full solar panel power output could not be produced but overall system functionality was tested and verified. Several issues were discovered during the field tests and are addressed in the second revision of the design. Pictures of the field test are provided in appendix A.

## **Deliverables**

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

- First revision of the power electronics PCB assembly stage is complete. Tests revealed several issues that necessitates design modification which were implemented in the second revision of PCB assembly. This second revision of PCB assembly is in progress.
- First revision of the MPPT PCB assembly is complete. MPPT algorithm tested and verified. Further tests under various different operation conditions including field tests revealed several issues that necessitates design modification which were implemented in the second revision of PCB assembly. This second revision of PCB assembly is in progress.
- Custom enclosure design for individual electronic components and integrated system has been finalized and fabrication is in progress.
- Final documentation of system testing is pending system test completion. Internal documentation is in progress as the system is being tested and optimizations are being done.
- Transition to manufacturing readiness is pending system test and verification
- Commercialization partner and distribution have been identified (Nishati), further determination is pending upon the completion of system test and verification.

## Expenditures

Expenditures for the first, second, third, and project to date are shown in the tables below. Supporting documentation is provided in a separate attachment.

<b>EXPENDITURES FOR INTERIM 1 REPORTING PERIOD ONLY</b>					
<b>Project Expense</b>	<b>NDIC</b>	<b>Packet Digital</b>	<b>NRL</b>	<b>Nishati</b>	<b>Total</b>
Total Personnel Costs	\$90,106.89	\$0.00	\$167,344.42	\$0.00	\$257,451.31
Software/Materials/Subs	\$0.00	\$0.00	\$4,211.45	\$295.00	\$4,506.45
<b>Total</b>	<b>\$90,106.89</b>	<b>\$0.00</b>	<b>\$171,555.87</b>	<b>\$295.00</b>	<b>\$261,957.76</b>

<b>EXPENDITURES FOR INTERIM 2 REPORTING PERIOD ONLY</b>					
<b>Project Expense</b>	<b>NDIC</b>	<b>Packet Digital</b>	<b>NRL</b>	<b>Nishati</b>	<b>Total</b>
Total Personnel Costs	\$113,250.91	\$15,719.77	\$0.00	\$16,973.19	\$145,943.87
Software/Materials/Subs	\$1,186.03	\$0.00	\$0.00	\$0.00	\$1,186.03
<b>Total</b>	<b>\$114,436.94</b>	<b>\$15,719.77</b>	<b>\$0.00</b>	<b>\$16,973.19</b>	<b>\$147,129.90</b>

<b>EXPENDITURES FOR INTERIM 3 REPORTING PERIOD ONLY</b>					
<b>Project Expense</b>	<b>NDIC</b>	<b>Packet Digital</b>	<b>NRL</b>	<b>Nishati</b>	<b>Total</b>
Total Personnel Costs	\$135,092.26	\$39,265.52	\$62,711.71	\$7,574.00	\$244,643.49
Software/Materials/Subs	\$10,139.90	\$0.00	\$26,714.88	\$8,966.04	\$45,820.82
<b>Total</b>	<b>\$145,232.16</b>	<b>\$39,265.52</b>	<b>\$89,426.59</b>	<b>\$16,540.04</b>	<b>\$290,464.31</b>

<b>EXPENDITURES FOR INTERIM 4 REPORTING PERIOD ONLY</b>					
<b>Project Expense</b>	<b>NDIC</b>	<b>Packet Digital</b>	<b>NRL</b>	<b>Nishati</b>	<b>Total</b>
Total Personnel Costs	\$138,062.79	\$40,313.20	\$107,046.10	\$2,532.68	\$287,954.77
Software/Materials/Subs	\$12,161.22	\$0.00	\$533.41	\$0.00	\$12,694.63
<b>Total</b>	<b>\$150,224.02</b>	<b>\$40,313.20</b>	<b>\$107,579.51</b>	<b>\$2,532.68</b>	<b>\$300,649.40</b>

<b>CUMULATIVE EXPENDITURES</b>					
<b>Project Expense</b>	<b>NDIC</b>	<b>Packet Digital</b>	<b>NRL</b>	<b>Nishati</b>	<b>Total</b>
Total Personnel Costs	\$476,512.85	\$95,298.49	\$337,102.23	\$27,079.87	\$935,993.44
Software/Materials/Subs	\$23,487.15	\$0.00	\$31,459.74	\$9,261.04	\$64,207.93
<b>Total</b>	<b>\$500,000.00</b>	<b>\$95,298.49</b>	<b>\$368,561.97</b>	<b>\$36,340.91</b>	<b>\$1,000,201.37</b>