FINAL REPORT

BOOTHBAY SUB-REGION SMART GRID RELIABILITY PILOT PROJECT

Prepared by
GridSolar, LLC

for

Docket No. 2011-138

CENTRAL MAINE POWER Co., Request for Approval of Non-Transmission Alternative (NTA) Pilot Project for the Mid-Coast and Portland Areas

JANUARY 19, 2016

GridSolar, LLC.
148 Middle St. Portland, ME 04101
(207) 772-6190
info@gridsolar.com
http://gridsolar.com/

TABLE OF CONTENTS

1 Executive Summary

Over the last decade, the Public Utilities Commission has repeatedly debated the question of whether non-transmission alternatives (NTAs) – distributed generation, efficiency, demand response, storage, and new smart grid technologies – can solve electric grid reliability needs at lower cost and with less pollution than new transmission lines or transmission system upgrades. In 2012, the Commission established the Boothbay Smart Grid Reliability Pilot project (Pilot) to test the NTA hypothesis.

The Boothbay Pilot, which is the first of a larger set of NTA pilot projects to be developed in the Mid-Coast and Portland regions, sought to demonstrate whether a portfolio of NTAs could reduce effective load under peak conditions on specific transmission assets in the Boothbay sub-region of Central Maine Power Company's (CMP or Company) electric grid by 2 megawatts (MW), thereby avoiding identified grid performance violations that would otherwise require an estimated $18 million rebuild of the 34.5 kV electric line from Newcastle to Boothbay Harbor. In addition, the Pilot sought to discover the availability and pricing under competitive procurement of a full range of NTAs in Maine, operational characteristics and limitations, and whether NTA's could be so used at scale in other regions of the CMP and Emera Maine grids in Maine.

Pursuant to Commission Order, GridSolar, LLC (GridSolar) was designated as the project coordinator, and GridSolar and CMP jointly developed operations, measurement and verification plans, which established applicable NTA eligibility requirements and performance criteria, communications and operations protocols, legal and payment provisions, and procedures to validate and report on results.

In 2012 and 2013, GridSolar issued two Requests for Proposals for NTAs. The responses demonstrated healthy competition; each solicitation exceeded bid targets and the offer prices declined over time. The accepted bids yielded a full range of NTA resources, including efficiency, PV Solar, demand response, back up generation, and energy storage. Based on reduced reliability requirements due to declining peak loads, 1.8 kW of NTAs were deployed between late 2013 through early 2015. These include the first ever large-scale (500 kW) grid-tied battery in Maine, a 500 kw diesel fueled back up generator (BUG), 308 kW of photovoltaic (PV) solar arrays, 243 kW of efficient lighting and air conditioning, 224 kW of peak load shifting, and 29 kW of demand response units.

At the same time, GridSolar developed a Smart Grid Operations Center that includes a remote Command Interface system with CMP and secure digital SCADA (supervisory control and data acquisition) communications networks to interact with NTA resources in the field. The Command Interface enables CMP to remotely see available NTA capacity, schedule testing or dispatch emergency NTA parameters, including date, time, load, duration and circuit location, and monitor dispatch and performance. The SCADA systems are then used to monitor, dispatch and control NTA resources. The systems will notify via alarm the GridSolar Operations Center manager and, using GridSolar programmed algorithms, define a dispatch order for needed NTA resources and provide a signal to each resource. All actions are monitored and confirmed in real time and the data is recorded, allowing NTA performance to be compared against actual substation loads to confirm compliance with grid operational criteria. Because the GridSolar network operates customer-side NTA assets with direction from CMP grid control systems, it is entirely complimentary to rather than duplicative of CMP's existing grid control infrastructure.

Testing in 2014 and 2015 repeatedly demonstrated that the NTA concept works. The GridSolar Operations Center contacted and turned on contracted NTA resources on within minutes of receiving a dispatch order from CMP, and those NTAs directly reduced upstream substation loads at levels sufficient to meet grid reliability criteria and offset the need for more expensive transmission investments.

These results demonstrate that a wide range of NTA solutions are available in Maine that can meet reliability requirements and which are both scalable and replicable in other areas of the CMP and Emera Maine electric grids. All NTAs, individually and together, met reliability needs in the pilot area for less than the transmission only solution. The net cost of the accepted NTAs, together with administrative and operational expenses, is projected to be less than 33% of the cost of building a new power line and will save ratepayers approximately $18.7 million over the 10-year project life through 2025. Even if the Pilot were terminated early at the end of 2016 (the worst case scenario), it would result in net savings of $2.5 million; were it terminated at the end of 2020, the savings would be $9.2 million.

The Pilot has also identified the potential for NTA solutions to further reduce ratepayer costs to address identified transmission needs through growing NTA on NTA competition and because NTA project sponsors are willing and able to bear a significant portion of system costs in return for other customer benefits NTAs provide. In comparison to the transmission system upgrade alternative, the NTA solutions also result in net reductions in energy use, greater use of renewable energy sources, lower emissions and reductions in fossil fuel consumption. As the NTAs are predominantly located at electricity customer sites, the NTA solution also results in enhanced customer engagement, greater customer participation in energy efficiency initiatives, more customer choice, and cost savings for participating businesses and homeowners.

The Pilot also suggests the potential for NTAs, as distributed grid resources, to provide substantial value beyond simple reduction of load on transmission system assets. Already, NTA data is providing deeper grid visibility, which enhances the ability to deploy smarter NTA (and transmission) assets over time, when, where and as needed. Moreover, these resources can respond dynamically under changing system conditions for more fine-grained grid operation.

Given the project success to date, GridSolar recommends that the Commission (1) extend the Pilot to the full 10-year project period (through 2024) and authorize GridSolar to acquire additional NTA capacity if and as needed, (2) proceed apace with the development of larger NTA Pilot Projects for the Mid-Coast and the Portland Loop regions in Docket 2011-138, (3) incorporate these results into consideration of the need to designate a statewide Smart Grid Coordinator, and (4) utilize this information in future reviews of proposed new transmission lines and projects pursuant to 35-A M.R.S.A. § 3132 and 3132-A.

In terms of how to develop and operate NTAs most effectively, the Pilot has also clearly shown the distance between the theoretical concept that distributed NTA resources might be able to offset and meet reliability requirements, and the end state necessary to consistently meet grid reliability requirements. To work, the process requires a precise statement of requirements, development of specific NTA projects that meet size, location, and performance criteria, placed under contract, integrated with the grid, tested, monitored, operated, and in some cases re-commissioned, reconfigured, or replaced. NTA solutions require careful up-front coordination, a dedicated communications and dispatch infrastructure, and ongoing administrative support and oversight – which, arguably, will be most successfully done by an entity with a commercial interest in the continuing (and expanding) success of NTA solutions and the obligation to see it through.

The operational capacity developed in the Boothbay Pilot has been purpose-built by GridSolar to be both modular and scalable. It is working well in Boothbay, will be further refined and improved, and is available to advance NTA solutions and other smart grid functions elsewhere in Maine. To enhance this system and future NTA projects, GridSolar has included at the end of the report a number of general and resource-specific recommendations for future operations, including the need to add a reserve margin to protect against occasional equipment failures, more intensive commissioning and operational testing, better and more extensive data collection and processing, inclusion of real-time circuit and substation data in the Command Interface, and contract modifications to allow NTA resources to be relocated when the host business ceases operations.

GridSolar, LLC.
148 Middle St. Portland, ME 04101
(207) 772-6190
info@gridsolar.com
http://gridsolar.com/

2 Background and Context

This section of the Final Report sets out the context, procedural history, Pilot project design, and reporting requirements for the Boothbay Smart Grid Reliability Pilot Project.

2.1 Procedural History and Background

2.1.1 The Maine Power Reliability Project (MPRP), Docket No. 2008-255.

As part of the MPRP Stipulation approved by the Commission on June 10, 2010, in Docket 2008-255, CMP and GridSolar agreed to collaborate to develop two NTA Pilot Projects to address grid reliability needs in the Mid-Coast and Portland Loop areas of the CMP electric grid.[1] The stipulated purposes of the Pilot program were to test the ability of NTAs, such as distributed renewable and non-renewable generation, demand response, and energy efficiency, together with smarter management of the distribution system in the Pilot regions, to provide system reliability and offset the need for new electric transmission investments. The Pilot program was also envisioned as a means to identify and test solutions for issues related to the design, installation, ownership, and operation of both the NTA resources and the underlying Smart Grid Platform.

2.1.2 The Non-Transmission Alternative Pilot Plan and Smart Grid Platform Proposal for the Mid-Coast Area, Docket No. 2011-138.

To start the Pilot projects, CMP first developed a new grid reliability needs analyses for the Mid-Coast area. On March 25, 2011, CMP and GridSolar filed with the Commission a *Non-Transmission Alternative Pilot Plan and Smart Grid Platform Proposal* (Vol.1), together with the new *Mid-Coast Needs Assessment* (Vol 2). On April 12, 2011, the Commission issued a Notice of Proceeding establishing Docket 2011-138 to review the proposal. As set forth in the Notice, the results of CMP's needs analysis showed that the transmission alternative to meet grid reliability standards in the Mid-Coast area over the next 10 years would cost $100 million, and that in order to avoid the transmission reinforcement, a hybrid solution, including certain transmission upgrades, together with 39 to 45 MW of load reduction or distributed generation (NTAs), must be put in place to keep substation loads below critical levels.

Six parties sought and were granted intervenor status.[2] During the course of the subsequent proceedings, the Hearing Examiner requested that CMP and GridSolar analyze an additional NTA solution, Hybrid 3, premised on slightly different transmission system improvements than the Hybrid 2 recommended in the March 25, 2011 filing, and to evaluate Hybrid 3 using different system conditions than those analyzed in the initial filing. In addition, CMP determined that any transmission, non-

---

[1] *See* Central Maine Power Company and Public Service Company of New Hampshire*, Request for Certificate of Public Convenience and Necessity for the Maine Power Reliability Program Consisting of Approximately 350 Miles of 345 kV an 115 kV Transmission Lines (MPRP),* Docket No. 2008-255, Order Approving Stipulation (June 10, 2010) (hereinafter as "*MPRP Stipulation*").

[2] Intervenors included the Office of the Public Advocate (OPA), Conservation Law Foundation (CLF), Environment Northeast (ENE), the Efficiency Maine Trust (EMT), the Industrial Energy Consumer Group (IECG), and the Maine Renewable Energy Association (MREA).

transmission or hybrid option under consideration should undergo supplemental testing based on new bulk electric system (BES) standards expected to be implemented as a result of FERC Order No. 743.

CMP filed its Supplemental FERC Analysis and Staff Requested NTA Analysis (Supplemental Analysis) on Nov. 22, 2011. The Supplemental Analysis concluded that meeting revised FERC BES standards would raise the cost of the transmission solution for the Mid-Coast spur to between $124 million and $170 million. Using current FERC BES standards, the study concluded that Hybrid 3 would require $17 million in transmission upgrades and a 28 MW NTA solution, including 26 MW of new generation or load reduction in the Rockland-Camden sub-region and 2 MW in the Boothbay sub-region. The study further found that grid reliability issues within the Boothbay sub-region would not be affected by pending revisions to FERC's BES standards.

To accelerate implementation of a Pilot program pending finalization of the FERC BES standards, the parties put forth and the Commission approved on April 30, 2012 a stipulated agreement to start with a smaller pilot project in the Boothbay sub-region ("Boothbay Smart Grid Reliability Pilot Project" or "Boothbay Pilot"). CMP, *Request for Approval of Non-Transmission Alternative (NTA) Pilot Project for the Mid-Coast and Portland Areas*, Docket No. 2011-138, Order Approving Stipulation (April 30, 2012) (hereinafter as "*Boothbay Order*"). The Boothbay Pilot purposes and design are discussed in Section 2.2.

The stipulation for the Boothbay Pilot did not affect the Rockland-Camden or Portland Loop portion of Docket No. 2011-138, which both remain pending.

2.1.3 The Investigation into Need for Smart Grid Coordinator and Smart Grid Coordinator Standards, Docket No. 2010-267

In approving the MPRP Stipulation, the Commission concluded that although the stipulating parties endorsed GridSolar as the Smart Grid Energy Services Operator (SGESO) for the CMP territory and the NTA Pilot programs in the Mid-Coast and Portland areas, the Commission was in no way bound by this agreement. To ensure that the Commission would fully analyze the issues which the Legislature delegated to the Commission in the Smart Grid Policy Act, 35-A M.R.S.A. § 3143(5), the Commission stated that it would treat the MPRP Stipulation as a request to open an adjudicatory proceeding to address the threshold question of whether it is in the public interest to have one or more smart grid coordinators in the State to help achieve the policy objectives set forth in the Act.

Accordingly, on September 8, 2010, the Commission initiated an "Investigation To Determine Whether It Is In The Public Interest To Have One Or More Smart Grid Coordinators In The State." Notice of Investigation, Docket No. 2010-267 (hereinafter as "NOI"). The NOI specified that the investigation would be used to first define (1) the technologies, systems and function(s) considered to be part of the "smart grid" and (2) the potential role of a smart grid coordinator in furthering the reliability, efficiency and environmental policies embodied in the Smart Grid Policy Act. The NOI stated that the Commission would also examine the feasibility of implementing and operating the smart grid to achieve these policies, including investigating how coordination with ISO-NE and T&D utilities would be managed, and would analyze the associated costs and benefits to ratepayers and consider whether it is in the public interest to have one or more smart grid coordinators for the State. Finally, should the Commission ultimately find that it is in the public interest to retain one or more SGESOs, the NOI stated that the Commission would also address the standards regarding the smart grid coordinator enumerated in 35-A M.R.S.A. § 3143(5) and the steps the Commission should take to ensure that applicable regional, national, and international grid safety, security and reliability standards are met.

Eleven parties petitioned for and were granted intervenor status in Docket 2010-267, including all of the parties in Docket 2011-138. After receiving input from parties in both dockets, the Hearing Examiner did not formally consolidate the two, but did incorporate Volume 1 of the filing in Docket No. 2011-138 into the record and made it subject to discovery to the parties in Docket 2010-267. *Procedural Order*, Docket No.'s 2010-267 and 2011-138 (May 3, 2011). Subsequently, based upon a general consensus of the parties that implementation of a Pilot project would likely provide valuable information to the Commission regarding the SGESO investigation, the Hearing Examiner indefinitely suspended the schedule in Docket 2010-267 and the focus turned to development of the Boothbay Smart Grid Reliability Pilot Project in Docket 2011-138.

Upon approval of the Boothbay Smart Grid Reliability Pilot Project in Docket 2011-138, the parties stipulated to and the Commission ordered the dismissal, without prejudice, of the Investigation into Need for Smart Grid Coordinator and Smart Grid Coordinator Standards, Docket No. 2010-267. The consensus of the Parties and the Commission was that the development and implementation of the Boothbay Pilot would provide the Commission and other interested parties with information useful to the determination of the need for a SGESO and SGESO standards.[3]

2.2 The Boothbay Smart Grid Reliability Pilot Project Stipulation

2.2.1 Pilot Project Design.

The Stipulated purpose of the Boothbay Pilot is to test the ability of NTAs to reliably reduce load by 2 MW in the Boothbay sub-region of CMP's electric grid in order to avoid the need for an estimated $18 million rebuild of the 34.5 kV electric line from Newcastle to Boothbay Harbor.[4] In addition, the Pilot Project was also approved to advance the goals and policies of the Maine Smart Grid Policy Act, 35-A M.R.S.A. § 3143, and to help answer four questions about how to best meet those goals and policies:

a. Whether and what type of NTAs can be acquired at reasonable cost to meet grid reliability requirements;

b. Whether and the best means by which the new Advanced Metering systems being deployed by CMP can provide the information and communications requirements to support NTA

[3] *Investigation into Need for Smart Grid Coordinator and Smart Grid Coordinator Standards*, Order Approving Stipulation, Docket No. 2010-267 (Oct. 29, 2012).

[4] The 2 MW load reduction target is not a static figure; rather it represents CMP's estimate of the amount of load reduction (or in-region generation) that would be necessary to avoid voltage or thermal violations in the Boothbay sub-region at a system-wide peak load level of 2,000 MW. The NTA target will rise and fall commensurate with peak load growth in the future.

solutions to grid reliability issues;

c. Whether NTAs are capable of responding in the manner necessary to provide grid reliability service to CMP; and

d. Whether the results of this Pilot Project can be scaled to meet the grid reliability requirements of other regions of the CMP and BHE networks in Maine.

Boothbay Order at 9.

The Commission designated GridSolar as the Pilot Project Coordinator and directed GridSolar to solicit NTA proposals using a competitive bidding process. Consistent with § 3143 and the Pilot purposes, the *Boothbay Order* required GridSolar to select and recommend contracts for Commission approval based upon a balancing of the cost, reliability and diversity of NTA resources. To the extent feasible, GridSolar was directed to include a minimum of 250 kW of NTA resources in each of the following categories:

- Energy efficiency,
- Demand response,
- Renewable distributed generation, at least half of which should be photovoltaic (PV) solar energy, and
- Non-renewable distributed generation, with preference given to resources with no net emissions of greenhouse gasses.

Each NTA had to meet the "MPRP Non-Transmission Alternative (NTA) Performance Specifications" attached to the Stipulation, which would be updated as necessary consistent with ISO New England resource requirements.

Upon approval of the submitted NTA contracts by the Commission, the *Boothbay* Order directed GridSolar to operate the project consistent with the *NTA Pilot Project for Boothbay Sub-Region of Mid-Coast Region, Operating Plan, Budget and Schedule* (*NTA Pilot Plan*) submitted jointly by GridSolar and CMP as part of the Stipulation. The NTA Pilot Plan separated the three-year phase one of the project into three concurrent and overlapping tasks: (1) the competitive bidding and NTA contracting process, (2) development and implementation of the GridSolar communications and dispatch center, and (3) measurement, verification and reporting. The Order also directed GridSolar and CMP to pre-file a Measurement and Verification Plan (M&V Plan) defining how GridSolar and CMP will measure and verify the successes and failures of the Pilot plan in meeting objectives, including submission of progress reports and a final report with recommendations regarding whether the results of the Boothbay Pilot can be scaled to meet the grid reliability requirements of other regions of Maine's electric grid.

Finally, the projected operating costs for the Pilot were set forth in the Phase 1 Budget included in the NTA Pilot Plan. CMP and GridSolar agreed to seek Commission approval if they approached or exceed the budget. The Parties to the Stipulation agreed that because the Smart Grid Platform and Boothbay Pilot are intended to further the development of NTAs so as to reduce the need for transmission, the associated costs should be deferred by CMP and recovered in transmission rates with carrying costs equal to CMP's most recently approved Maine jurisdictional weighted average cost of capital. The Parties agreed to support and/or seek such ratemaking treatment for the Boothbay Pilot costs and related Smart Grid Platform investments in transmission revenue requirement rate proceedings, including before FERC. In addition, CMP agreed to seek inclusion of the costs associated with the Boothbay Pilot, including all costs associated with preparing the Boothbay Pilot Plan and implementation of the Boothbay Pilot, in Local Network Service (LNS) rates to the extent permitted under rules and tariffs. In the event that costs cannot be not fully recoverable through transmission rates, the Parties agreed that such prudently incurred costs shall be recovered in distribution rates in a manner that matches allocation and rate design for transmission rates.

2.2.2 Reporting Requirements

The Commission directed GridSolar to provide Interim Reports in 2013 and 2014, that track and report on the implementation, successes and failures of the Boothbay Pilot, including detailed results of field audits or actual events in which CMP called upon the NTA resources to deliver capacity to the Boothbay Region. To the extent that any conclusions could reasonably be drawn, each Interim Report should also include an assessment of whether the results of the Boothbay Pilot can be scaled to meet the grid reliability requirements of other regions of the CMP and BHE networks.

The Commission further directed Grid Solar to provide a Final Report at the close of 2015, including a presentation of performance in calendar 2015 and a comparison of 2015 to 2014, in addition to the same items and format of the prior Interim Reports. The Final Report must also include a recommendations section based on GridSolar's assessment of the performance of the Boothbay Pilot.

In addition to the Interim and Final Reports, the Commission identified other specific reporting requirements in its various orders. These included the following requirements:

- Pursuant to Task 2 in the NTA Pilot Plan, once the RFP process is reviewed and subject to comment as described above, and subsequently issued, CMP and GridSolar shall develop a NTA operations plan, including establishment of a NTA operations center, communications and dispatch protocols, field testing protocols and field testing, cyber security plan, and a measurement and verification plan. By March 31, 2013, CMP and GridSolar shall submit to the Commission an operating plan and interim progress report regarding the establishment of communications and dispatch protocols and a plan for field testing of NTA responsiveness to grid conditions. This plan shall also include an explanation of how CMP and GridSolar will meet FERC Standards of Conduct regarding sharing of information about grid operations with each other and with participants in the Boothbay Pilot.

- As part of the report due by March 31, 2013, CMP and GridSolar shall propose a M&V Plan to track and report on the successes and failures of the Pilot Project. The M&V Plan for energy efficiency resources shall be developed with the Efficiency Maine Trust and shall not be inconsistent with M&V standards and protocols in use by efficiency resources located in Maine and participating in the ISO-NE Forward Capacity Market. The M&V Plan shall document each aspect of the NTA Pilot Project and shall include progress reports and a final report, as detailed in Attachment 1. Consistent with the purposes of the Boothbay Pilot, the final report shall include recommendation(s) regarding whether the results of the Boothbay Pilot can be scaled to meet the grid reliability requirements of other regions of the CMP and BHE networks.

Additional reporting requirements were set forth in the NTA Pilot Plan attached to the Stipulation. Specifically, Task 3 directed the Smart Grid Coordinator to provide an annual report at the end of each operating year to include the following analyses:

1. A detailed description of the Pilot's use of digital information and control technology and the extent to which it has improved the reliability, security and efficiency of the electric system within the Pilot Area and beyond including any transmission or energy costs avoided as a result of the Pilot;

2. A detailed description of the Boothbay Pilot's deployment and integration into the electric system of renewable capacity resources that are interconnected to the electric grid at a voltage level less than 69 kilovolts including an inventory of the specific kinds of resources, their individual and collective capacity and total kWh generated per resource;

3. A detailed description of the Boothbay Pilot's deployment and integration into the electric system of demand-response technologies, demand-side resources, energy-efficiency resources and distributed generation resources including an inventory of the specific kinds of resources, their individual and collective capacity, total kWh generated per resource, an emissions profile for each non-renewable resource, total annual emissions of regulated pollutants (including CO2) for each non-renewable resource, any reductions in the emission of regulated pollutants (including CO2) resulting from the Boothbay Pilot, any reduction in energy consumption resulting from the Pilot and any reduction in fossil fuel consumption resulting from the Pilot;[5]

4. A description of how the Boothbay Pilot has resulted in the deployment or enhanced use of smart grid technologies, including real-time, automated, interactive technologies that optimize the physical operation of energy-consuming appliances and devices, for purposes of metering, communications concerning grid operation and status, and distribution system operations;

5. A description of all processes used to solicit NTA resources and an accounting of the number of responses to solicitations for resources, the nature of the resource offered in the response, and the quantity of energy production offered by each respondent;

6. A description of the direct and ancillary economic benefits of the Pilot Project including investment in NTA resources and associated job creation;

[5] Emission assessments will be based on specific NTA data where available or on industry standards otherwise and will include only direct emissions and not life-cycle emissions.

7. A description of areas of additional potential savings or economic benefit that are not currently utilized under the Boothbay Pilot and an estimate of the potential savings (e.g., participation in the Forward Capacity Market);

8. A description of any deployment and integration into the electric system of advanced electric storage and peak reduction technologies through the Boothbay Pilot;

9. A description of how the Boothbay Pilot has resulted in the provision to consumers of timely energy consumption information and control options;

10. A description of how the Boothbay Pilot has resulted in the elimination of barriers to adoption of smart grid functions and associated infrastructure, technology, and applications; and

11. To the extend not otherwise provided a description of the SGC's control center, its staffing, equipment and functions, its costs and a description of how the control center operated during those times when Boothbay Pilot resources were activated, problems encountered with the resolution of those problems and ongoing unresolved problems.

2.2.3 Reports filed as part of the Pilot Project

GridSolar has filed the following reports with the Commission:

- *Evaluation of Responses to the Request for Proposals for Non-Transmission Alternatives for the Boothbay Pilot Project and Recommendations to the Commission*, December 12, 2012
- *Implementation Plan & Final NTA Service Contracts*, April 5, 2013
- *Evaluation of Responses to the Request for Proposals – RFP II for Non-Transmission Alternatives for the Boothbay Pilot Project and Recommendations to the Commission*, August 21, 2013
- *Boothbay Pilot Status Report*, February 1, 2014
- *Interim Report Boothbay Sub-Region Smart Grid Reliability Pilot Project*, March 4, 2014
- *Amended Project Update: Boothbay Sub-Region Smart Grid Reliability Pilot Project*, July 25, 2014
- *Project Update: Boothbay Sub-Region Smart Grid Reliability Pilot Project*, October 22, 2014
- *Project Update – Q4 2014: Boothbay Sub-Region Smart Grid Reliability Pilot Project*, February 24, 2015
- *Financial Supplement: Boothbay Smart Grid Reliability Pilot Project 2014 Annual Report*, April 14, 2015.
- *2015 Annual Report: Boothbay Sub-Region Smart Grid Reliability Pilot Project*, October 28, 2015

2.2.4 Measurement and Verifications (M&V) Plan

The Measurement and Verification Plan defines the performance and verification criteria for each NTA resource category. The M&V Plan established a methodology to establish an initial Capacity Rating for each type of NTA Resource, explained how measurement and verification of these Capacity Ratings will be performed periodically by GridSolar, and how periodic adjustments will be made to the initial

Capacity Ratings based upon the measurement and verification findings.

GridSolar prepared a working draft of its M&V Plan in the spring 2013. This document was circulated among the parties for comment. Comments were received from CMP, which were incorporated into a final version field in September 2013.[6] Later, further comments were received and were adapted into a second version issued January 31, 2014. GridSolar has received no further comments. This M&V Plan, which is referenced as Version 2, is provided as an attachment to this Final Report as Section 8.3.[7]

The primary differences are that Version 2 defined energy conservation by specific categories – lighting, HVAC and other – so that more detailed measurement calculations could be used. Version 2 also clarified dynamic adjustments that will be made in the event that an NTA resource is no longer in place, is inoperable, or has ceased to function, or operates in a manner different from that which was proposed (including performance degradation).

[6] *See GridSolar – Boothbay Smart Grid Reliability Pilot Project Measurement and Verification Plan* (Sept. 20, 2013), Docket No. 2011-138.

[7] As noted in the Appendix to this M&V Plan, certain NTA resources came on line prior to issuance of Version 2. These are “grandfathered” and operate under Version 1, however these resources are unaffected by changes between the two versions.

3 Implementation

Pursuant to the NTA Pilot Plan approved in the Boothbay Order, implementation of the Pilot was broken into three tasks. Task One involved the development, support and issuance of Requests for Proposals (RFP) for NTAs, evaluation of responses to the RFP, contracting with approved NTA resources, and construction. Task Two involved development of the GridSolar Operations Center, programming the communications and dispatch protocols, testing and NTA operations. Task Three set out the requirements for progress reports, development of the M&V Plan, Final Report and Recommendations. The results of Task One are described below.

3.1 Task One: NTA Bidding, Contracting, Development and Construction.

3.1.1 Development and Promotion of the RFP.

Eligibility to participate in the Boothbay Pilot Project was opened to any grid-tied NTA resources located on circuits supplied by CMP Line 23, a 34.5 kV feed that originates in Edgecomb and terminates in Boothbay. This includes all of the towns of Boothbay Harbor and Southport, and about two thirds of the town of Boothbay. *See* Figure 1.

Participation was by competitive bidding. A request for proposals (RFP) packet, which was circulated for review and approved by the Parties and the Commission during the summer of 2012, included the following elements:

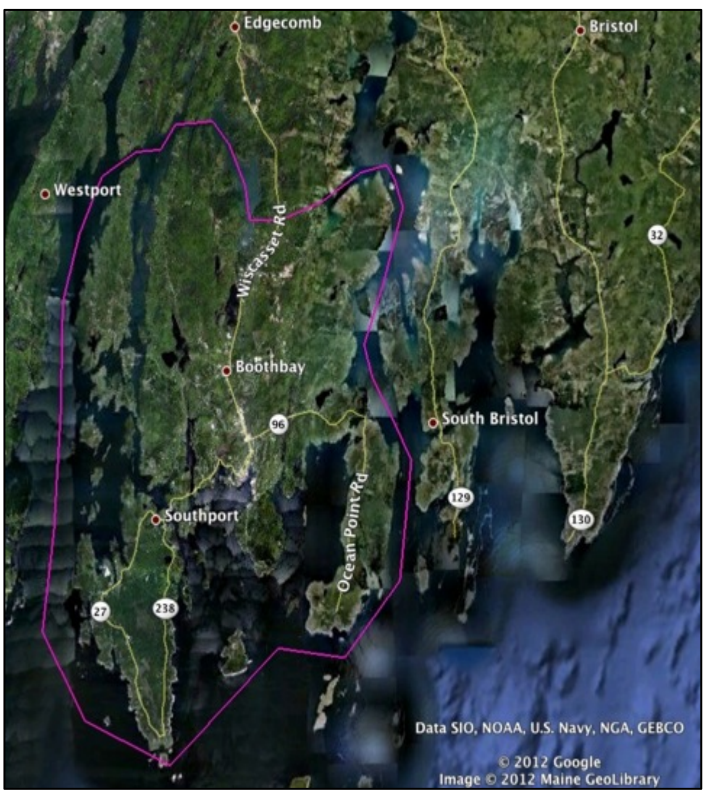


Figure 1: Map of Boothbay Smart Grid Pilot Project Area.

- Request for Proposals;
- Required operations, performance, communications, and measurement and verification (M&V) protocols;
- Draft NTA contract and terms;
- RFP selection criteria and timeline; and
- An RFP outreach plan.

To promote the RFP, prior to issuance GridSolar worked with the Efficiency Maine Trust and others to develop and contact a list of all potential NTA providers in Maine, including all known PV solar installers, energy efficiency companies and auditors, companies that sell and service electrical generators, battery storage providers, and other potential participants. Information about the project was posted on the GridSolar website and released to both the national industry press and to statewide and local media outlets – and the project got extensive coverage. GridSolar placed paid advertisements with the Boothbay newspaper (print and online editions) and, working in coordination with the Boothbay Chamber of Commerce, sent notices about the project to all chamber members (approximately 330 local businesses). Prior to release of the RFP, GridSolar held a well-advertised and attended public information session in Boothbay. During the bidding process, GridSolar provided a hotline and publicly posted answers to questions posed by respondents. GridSolar also conducted a number of meetings with potential providers when requested, including solar installers, EnerNOC, Viridity and TESM, and with potential host customers for different types of NTA resources, including the Bigelow Laboratory, St. Andrews Hospital, the Maine State Aquarium, local municipalities (town offices, water district and sewer district) and industrial customers (including a number of boatyards).

3.1.2 The Market Response to RFP I and RFP II.

The Pilot project area – the towns of Boothbay, Boothbay Harbor and Southport – consists primarily of small commercial seasonal businesses, residential and vacation communities, with some boatbuilding and smaller industrial loads and very little commercial office space. Despite the limited opportunities in the project area, the response to the RFP was vigorous. GridSolar issued the RFP in two rounds. Each solicited in response more than double the total NTA resources needed to meet the grid reliability requirements established by CMP's needs assessment, and each time the full suite of resources targeted by the Pilot design for testing were represented.

RFP I, issued in September, 2012, received a total of 12 bids from 6 separate NTA resource providers totaling almost 4.5 MWs in five NTA resource categories, including Solar PV, Efficiency, Demand Response, Battery Storage and Back-Up Generation. (*See Evaluation of Responses to the Request for Proposals for NTAs for the Boothbay Pilot Project and Recommendations to the Commission (Dec. 13, 2012)*, Section 8.1.1, Fig. 1.) After GridSolar's recommended bid selection was finalized, the 1 MW Maine Micro Grid offer was withdrawn due to its inability to secure financing support.[8] To provide adequate interim reliability, the Commission directed GridSolar to install a temporary 500 kW back up diesel generator and to issue a second RFP. CMP, *Request for Approval of Non-Transmission Alternative (NTA) Pilot Project for the Mid-Coast and Portland Areas*, Docket No. 2011-138, Order Approving RFP I (May 28, 2013).

RFP II, issued in May 2013, received a total of 22 bids from 10 separate NTA resource providers totaling just over 4 MWs in five NTA resources categories: Solar PV, Efficiency, Demand Response, Battery Storage, and Back-Up Generation. (*See Evaluation of Responses to the Request for Proposals – RFP II for NTAs for the Boothbay Pilot Project and Recommendations to the Commission (Aug. 21, 2013)*, Section 8.1.2, Fig. 1.) In addition, the property owner hosting the 500 kW temporary BUG submitted a bid to take over operation of the BUG for the duration of the Pilot.

[8] Maine Micro Grid subsequently explained that its financing arrangement failed because the 3-year NTA contract (with option to extend to 10 years if approved by the Commission) could not provide investors with certainty that the required 6-year holding period for the federal Investment Tax Credit – equal to 30% of the installed costs of the PV array and battery – would be satisfied.

10 year Levelized Cost	RFP I			RFP II			Price Difference	Net Price
	Bids	Capacity	$/kW Month	Bids	Capacity	$/kW Month		
Efficiency	2	156	$8.14	5	235	$16.60	104%	$13.22
PV Solar*	7	489	$24.86	8	456	$21.57	-13%	$23.28
BUG	1	100	$130.00	2	600	$44.95	-65%	$57.10
DR	1	250	$66.50	1	250	$57.65	-13%	$62.07
Battery**	5	3500	$76.18	6	2500	$72.83	-4%	$74.78
Total Available	**16**	**4496**	**$68.89**	**22**	**4041**	**$58.69**	**-15%**	**$64.06**

* Levelized Cost of Solar 20 years, 8% Discount Rate used for all resources

** Only the largest battery bid by each provider is included

Figure 2: Price Comparison of All Bids Received, RFP I & II.

The RFP responses provided the first glimpse at the availability and cost of NTAs in Maine. All bids submitted for both RFPs met the established eligibility criteria and, individually and in the aggregate, and were more cost effective than the transmission solution. (Figure 2; *See also Interim Report Boothbay Sub-Region Smart Grid Reliability Pilot Project*, at Ex. 3 (March 4, 2014), summarizing results for each RFP by NTA resource category, including prices for each phase of the project (Years 1-3, Years 4-10) and the levelized 10 to 20 year costs.)

Notably, in the response to RFP II, the number of bids received and NTA resource providers went up, while the price for all NTA resources went down except energy efficiency – which was expected, since the lowest cost efficiency opportunities (lighting) were developed first. Yet even energy efficiency is continuing to improve and diversify as an NTA resource. Efficiency Maine Trust reported continuing demand for additional lighting retrofits at the RFP I price, and the second level efficiency resource (heat pump air conditioning) was the lowest bid of all the RFP II NTA resources.

The NTA resources bid into each of the RFPs are all scalable and could be easily expanded were the reliability target larger. The BUG and Battery Storage resources are single unit facilities that, for a similar price, could be duplicated multiple times within the Pilot project region with relatively little additional effort. So also could the Ice Bear demand response units (which average 6-8 kW per unit). Similarly, Efficiency Maine Trust, which bid and provided the energy efficiency NTAs under RFP I, has indicated to GridSolar that it could have expanded its efficiency program had the design of the RFP permitted a more flexible bid response and longer duration commitment. For Solar PV systems, the amount bid represents a small fraction (well below 1%) of the total rooftop area in the region, and this does not include solar PV that could be developed on brown-field or green-field sites. Overall, none of the NTAs resources bid into either RFP I or RFP II are limited to development in the Boothbay region; nor are they uniquely specific to the reliability issues on CMP's distribution system in that region. Rather, the scale and scope of all of the NTAs are expandable to virtually any level of required capacity, and are applicable to other regions of the Maine electric grid.

These results answer the first question posed by the Pilot and demonstrate that a wide range of NTA resources categories are available in the marketplace in Maine at a reasonable cost to meet grid reliability requirements.

3.1.3 Evaluation and Selection of NTAs.

Following each RFP, GridSolar submitted for review by the Parties and the Commission an evaluation of each bid together with GridSolar's recommendation of which NTA resources to accept, balancing cost, reliability (performance), diversity and emissions, while, in keeping with the Pilot purposes, ensuring a minimum of 250 kw each of conservation and efficiency, demand response, renewable distributed generation, and back up generation. Each criterion is explained below.

1. Cost. Because the Pilot project's initial duration is substantially shorter than the useful life of the NTA resources, GridSolar measured costs in two ways: (1) on an annual revenue requirement basis, and (2) on an expected life levelized equivalent cost per kW-month for the full 10 year extended Pilot term. The first computes the revenue requirement for each NTA resource as the Capacity Rating multiplied by the bid price each year. The second computes the net present value of the annual bid prices over the expected 10-year project life (20 for solar) at an 8% discount rate and calculated the amount per kW-month, which, if held constant over the expected life, would result in the same net present value.[9]

2. Reliability. To evaluate reliability, GridSolar developed initial capacity ratings for each NTA resource category applicable to Maine conditions, and provided a methodology for adjustments based on periodic inspections and performance audits. *See* GridSolar, *Boothbay Smart Grid Reliability Pilot Project Measurement and Verification Plan* (Sept. 20, 2013). In addition, for RFP II, GridSolar adjusted downward the expected total capacity of those PV Solar bids without firm development contracts.

3. Diversity. In terms of diversity of resources, GridSolar found that batteries were almost four times more expensive than fossil fuel fired generators and provided no significant reliability or environmental advantage. Nevertheless, GridSolar included the least cost battery option so as to meet the Pilot Project purposes of demonstrating each technology under actual conditions.

4. GHG Emissions. The criterion to utilize fossil fuel-fired NTAs with the lowest GHG emissions rate was never applied, since only diesel fueled non-renewable BUGs were proposed (no unbundled propane-fired BUGs were proposed).[10] In trying to compare the BUG to storage, GridSolar concluded that there is not a significant difference, relative to Maine's emissions reduction goals, in the emissions caused by daily battery cycling (which would be equal to emissions at ISO-NE off-peak marginal emission rate from charging events, including line losses, minus avoided emissions at on-peak rates), compared to emissions from less frequent operation of the new EPA tier-4 emissions compliant diesel BUG. In terms of evaluating BUG emission we

[9] Each RFP had one bundled bid for multiple technologies, but because the bundled bid was withdrawn in the first RFP and because it was the excluded high bid in the second RFP, it was never necessary to try to unbundle the cost of each component.

[10] The 500 kW diesel BUG was added to the project at the Commission's directive after the Maine Micro Grid proposal, which did include a 100 kW propane-fired BUG as part of a bundled BUG-Solar-Battery-Demand Response bid, was withdrawn.

reached two conclusions. First, the Cat-5 diesel BUG engine is the same as that in a typical back-hoe, front end loader or dump truck used in excavation and construction. Thus, is highly likely that, just comparing hours of operations, use of the diesel BUG (or battery cycling) would result in substantially lower emissions than just the construction phase of a new power line. Second, when the BUG is operating it is displacing a grid-based generator. Since the BUG will operate during peak loading hours its GHG emissions will be substantially less than those of the generator. In addition the generator will need to carry far greater line losses than the BUG before it reaches the point of consumption.

After eliminating the high bids, the net results are as shown in in Figure 3. Additionally, copies of GridSolar's complete recommendations for each RFP are provided in the *Interim Report Boothbay Sub-Region Smart Grid Reliability Pilot Project*, at Ex.'s 1 &2 (March 4, 2014).

Recommended NTA resources, by Capacity (kW) and Price ($/kW Month)						**Weighted 3**	**Weighted 10 Yr.**
	RFP I*	**RFP II**	**Totals**	**Pct.**	**Units**	**Year Price**	**(Levelized) Price**
Efficiency	237.00	111.25	348.25	19%	7	$23.51	$10.47
Solar	168.83	106.77	275.60	15%	14	$46.05	$13.19
BUG (same)	500.00	500.00	500.00	27%	1	$17.42	$20.63
Demand Response	0.00	250.00	250.00	13%	1	$110.00	$57.65
Battery	0.00	500.00	500.00	27%	1	$163.70	$75.99
Total	905.83	1468.02	1873.85		24		

* RFP I excludes Maine Micro Grid project; Efficiency increased to reflect EMT contract option.

Figure 3: Combined RFP I & II, Selected NTA resources.

3.1.4 Contracting and NTA Development.

GridSolar submitted the above recommendations for each RFP to the Parties, staff and the Commission. No changes were requested. GridSolar then negotiated final contracts with each NTA resource and submitted those contracts for Commission review and approval.

Throughout the implementation processes, GridSolar was highly sensitive to the innovative nature of the Boothbay Pilot and uncertainties in the NTA provider communities about how the Pilot would be administered and funded. GridSolar established reasonable timeframes and conditions of performance to allow NTA providers the flexibility to deal with their own business, construction, and permitting issues related to implementation. In particular, once bids were received and accepted, GridSolar sought to give local NTA providers the greatest possible latitude and every opportunity to perform. This latitude created certain timing delays in terms of bringing NTA resources on-line. Because load growth in the Pilot Area slowed (as it did throughout the CMP service territory), there was no urgency to get the full 2 MW on-line and it became more important to test the ability of various NTA providers to complete project development.

Ultimately, two resource categories underperformed compared to the capacity of their accepted bids – third party (non-EMT) efficiency and PV solar. In the case of efficiency, developers were unable to finalize contracts with resorts in the Boothbay region to replace older air conditioning units with efficient air source heat pumps. In the case of PV solar, several developers were unable to recruit hosts for their full allotment of solar arrays. The developers reported to GridSolar that some of their clients ultimately declined to participate due to a mix of financial issues, including competition for capital resources, inability to monetize tax benefits, and more pressing problems with their core business operations. Solar developers also commented that the NTA price for the PV Solar resources was at or just under the tipping point needed to spur investment by consumers – particularly for the small seasonal businesses typical of the Boothbay peninsula.

To fill the gap, on March 20, 2014, GridSolar submitted a proposed 130 kW NTA contract with the Efficiency Maine Trust (EMT) to provide additional energy efficiency NTA resources in lieu of efficiency capacity that had been released by approved bidders. The price for capacity in the replacement contract with EMT was less than the bid price accepted for each of the RFP II bids that were being released.

After a technical conference, GridSolar, Commission staff, and the parties agreed that – due to reductions in CMP's peak load forecast since RFP II was approved – the full amount of NTA resources approved in RFP II were not needed. As noted in the Recommended Decision:

> A benefit of the NTA approach is that lump-investments and resource deployment can be more closely timed with need. To the extent additional NTA resources are needed later to meet any increased load, they could be deployed at that time. The delay in investment saves ratepayers money.

CMP, *Request for Approval of Non-Transmission Alternative (NTA) Pilot Projects for the Mid-coast and Portland Areas*, No. 2011-138, Recommended Decision at 4 (July 10, 2014). In line with this decision, GridSolar informed the remaining RFP II awardees with pending projects that it would release, without penalty, any bid that did not have a signed contract as of the June 1, 2014 deadline. No bidder objected to this release.

Other NTA resources – including a few of the Ice Bear units, the BUG and the battery – experienced delays during the development stage due to procurement, construction, equipment and/or permitting issues. Those issues are chronicled in GridSolar's status reports. None proved to be critical problems, and ultimately all resources have since come on line and are meeting their contract requirements. Commissioning and operational issues for each NTA resource are discussed in Section 7.2, below.

3.2 Task Two: Development of the GridSolar Operation Center

3.2.1 Background

GridSolar has worked closely with CMP to develop the communications requirements and protocols needed to enable the NTA resources participating in the Boothbay Pilot project to fully meet all applicable grid reliability performance criteria. Certain of the NTA resources are "passive" in nature and will operate based on conditions specific to their circumstances. These include energy efficiency measures, the pre-programmed (load shifting) Ice Bear units, and PV solar systems. These NTA resources are always in the "on" position and will deliver grid reliability benefits to the extent that they are operating during the time of need. These passive NTA resources do not require communications for dispatch purposes, but only for measurement and verification.

"Active" NTA resources need to be turned "on" when dispatched in order to provide grid reliability benefits. These include battery storage, BUGs and the Ice Bear units programmed to operate in demand response mode. Each of these units must accommodate two-way communications between GridSolar and the NTA resource to permit GridSolar to send dispatch instructions (or to remotely control the NTA resource) and to monitor compliance with and performance in response to those instructions. As a general matter, two-way communications capability is integrated into most active NTA resources.

Demand response resources represent a much broader array of NTA resource types, ranging from devices that shift loads to off-peak periods, to devices that cycle loads on and off, to actions that simply curtail electricity usage. The demand response industry, represented by firms such as EnerNOC, has demonstrated that these resources can be utilized to respond to grid reliability conditions and with a very high degree of reliability. In certain cases, control over the resources is given to a third-party (e.g., EnerNOC, Comverge), which dispatches the NTA based on directions from the system operator. In other cases, control remains with the demand response resource and that owner responds to commands from the third-party. Ice Energy's Ice Bear units that are being deployed for the Boothbay Pilot project are equipped with internet-based communication systems that permit remote control, operation and monitoring by both Ice Energy and GridSolar.

In addition to the ability of GridSolar to communicate with the NTA resources, GridSolar and CMP must be able to communicate directly with each other so that CMP (i) knows at any time the NTA resource capacity is available to be dispatched against loads, (ii) can direct GridSolar to dispatch a specified amount of NTA resource capacity for a specified period, and (iii) can verify whether or not such capacity is actually dispatched and operating to reduce loads in the Pilot area.

3.2.2 GridSolar Operations, Monitoring and Dispatch Network

To meet the above requirements, GridSolar built a secure and dedicated wide area SCADA (supervisory control and data acquisition) communications network. SCADA systems are in widespread use throughout the electric grid in Maine and elsewhere, and increasingly are being used as the backbone of smart grid applications throughout the country. GridSolar's SCADA network transmits real-time information, two-way communications, and operational commands between the GridSolar operations center in Portland and the BUG unit in Boothbay. The system includes both a wired port-to-port static IP connection between the GridSolar Operations Center and the generator, and a wireless (cellular) virtual private network (VPN) backup connection. Onsite, the BUG has electronic remote control capabilities that are fully compliant with CMP interconnection requirements, and which include real-time monitoring, remote on/off switching, five minute delayed start (per CMP interconnection requirements), instantaneous off in the event of grid failure, and system protection (anti-islanding). The battery and demand response NTAs which use the NTA providers' proprietary network, controls, command interface software and data logging and reporting architecture. GridSolar is also connected to the battery storage NTA via a VPN and the DR Ice Bear units by a secure web infrastructure.

To operate the network, GridSolar has developed a Command Interface system using the model view control software design pattern, which divides the NTA command environment by region, and circuit.

This design is both scalable and modular, meaning that the system can be expanded to include additional regions or utility service territories and, at the same time, can be operated so that any given module (e.g. NTAs on a specific circuit) can be precisely deployed to meet that circuit's specific real-time reliability needs. Command decision-making is structured so that a CMP employee can log-in remotely and input either scheduled or emergency NTA parameters, including date, time, load, duration and location(s). The system will notify via alarm the GridSolar 24x7 employee and meanwhile, using GridSolar-programmed algorithms, it will define a dispatch order for needed NTA resources (including units, load, and duration) and provide a signal to each assigned NTA resource. All actions and results are logged and recorded, so that GridSolar and CMP can debug and debrief after each event.

System monitoring and verification includes real-time monitoring of passive PV Solar NTA resources over 25kW and after-the-fact verification (via monthly reports) for smaller PV Solar resources and efficiency resources. Additionally, pursuant to the Commission's May 28, 2012 Order, CMP has provided 2012 peak load levels on the critical buses in the region as a baseline, and then for each test or reliability event, voltage levels on each of these buses during the event and for two hours pre- and post-deployment of NTA resources, as well as thermal measurements/calculation for Section 23.

System security is achieved through "unified threat management", a combination of high tech routers, anti-virus software, client to site tunnels and firewalls. The security restricts communication between recognized devices, restricts the type of data permitted, supplies encryption and provides 24/7 remote support. The System includes authentication and permission-based user account functions.

The GridSolar Operations Center is located at 148 Middle Street in Portland. Because of the scope and scale of the Boothbay Pilot, the Operations Center is not physically staffed 24 x7. Instead, the GridSolar Program Manager maintains electronic communications with the Operations Center that enables essentially full functionality, including control of active NTA resources using remote interfaces and communications.

GridSolar has worked in coordination with CMP to develop an NTA Operations Manual. The current version of this manual - Version 1.4 – is provided as attachment 8.4 of this Final Report.

4 Final NTA Inventory, Testing and Operations.

4.1 Final NTA Inventory

The full inventory of the Boothbay Pilot NTAs as of the end of 2015 is summarized in Table 1, sorted by category.[11] (Consistent with terminology GridSolar has used in other documents, we refer to NTA resource categories or types as "buckets".) The buckets are efficiency, solar PV, demand response and peak load shifting, back-up generation, and energy storage. A total of 1,804.68 kW of nameplate capacity has been procured, with an effective initial capacity rating of 1,678.71 kW.

Table 1: Boothbay Reliability Pilot Project, Summary of NTA Resources by Bucket as of Q4-2015

Bucket	Nameplate (kW)	Initial Capacity (kW)	Current Capacity (kW)	Capacity Price $/kW/Month	Total Costs ($)	Total Generation/ Reduction (kWh)	Total Nox (lb/MWh)	Total SO2 (lb/MWh)	Total CO2 (lb/MWh)
Efficiency									
Operational	243.64	256.42	256.42	$27.47	$183,676	2,176,085	-294.54	-63.21	-1,891,130.39
Efficiency Total	**243.64**	**256.42**	**256.42**	**$27.47**	**$183,676**	**2,176,085**	**-294.54**	**-63.21**	**-1,891,130.39**
Solar PV									
Operational	308.25	214.49	212.36	$49.78	$240,309	650,367	-109.89	-77.57	-584,333.56
Solar PV Total	**308.25**	**214.49**	**212.36**	**$49.78**	**$240,309**	**650,367**	**-109.89**	**-77.57**	**-584,333.56**
Backup Generator									
Operational	500.00	455.00	455.00	$17.42	$439,473	20,017	2.51	-2.39	24,144.45
Backup Generator Total	**500.00**	**455.00**	**455.00**	**$17.42**	**$439,473**	**20,017**	**2.51**	**-2.39**	**24,144.45**
Demand Response									
Operational	29.20	29.20	29.20	$110.00	$66,194	180			
Demand Response Total	**29.20**	**29.20**	**29.20**	**$110.00**	**$66,194**	**180**			
Energy Storage									
Operational	500	500	500.00	$168.70	$739,945	12,226	-0.13	-0.04	89.05
Energy Storage Total	**500.00**	**500.00**	**500.00**	**$168.70**	**$739,945**	**12,226**	**-0.13**	**-0.04**	**89.05**
Peak Load Shifting									
Operational	223.60	223.60	223.60	$110.00	$485,084	74,872			
Peak Load Shifting Total	**223.60**	**223.60**	**223.60**	**$110.00**	**485,084**	**74,872**			
Grand Total	**1,804.68**	**1,678.71**	**1,676.58**	**$73.76**	**2,154,681**	**2,933,747**	**-402.05**	**-143.21**	**-2,451,230.45**

Table 1 shows the average price (in $/per kW/month of capacity) for resources in each bucket and the total costs paid through December 2015. The total costs are just over $2.1 million, which is under budget. This is primarily due to the fact that development of the most expensive NTA resource – Battery Storage – was delayed and has only been on-line and receiving payments since April 2015. Long term, the overall cost of the project is expected to be close to the budget forecast. (See Section 5.)

[11] An updated and fully functional digital inventory in excel format is also attached as Appendix 8.6 which includes detailed project data through the end of 2015, showing NTA capacity by project and by resource category, costs, energy savings, emissions reductions and fuel usage – each item included as required by the M&V Plan.

Table 1 also shows the actual generation and/or usage reduction in kilowatt hours (kWh) for each of the NTA resource buckets since each individual NTA resource went on-line. Most of the kWh generation/savings are in two buckets – efficiency and solar PV, since these are passive resources that are always on. The peak load shifting and energy storage buckets show energy savings during the hours these resources operated. These figures are not net of energy used by these same resources to store energy. The distributed generation and demand response NTA resource buckets are active, in that they are operated in an on-demand mode and called upon only when undergoing testing or in response to a grid reliability dispatch by CMP. As a result, their energy generation/savings volume is very low.

The final set of figures reported in Table 1 are GridSolar's calculations of the net reduction in air emissions – specifically CO_2, SOx and NOx, attributable to the operations of the NTA resources. Since these reductions are related to the reduction in kWhs, those NTA resources with the highest generation (usage reduction) levels have the largest emissions reductions. [12]

4.2 NTA Testing - 2014

In 2013 and 2014, GridSolar and CMP developed, deployed and conducted initial tests of the GridSolar NTA communications and dispatch system. The first level of development and testing focused on the interface between GridSolar and CMP. Once that interface passed beta testing, security improvements, acceptance testing and a simulation, the first live test to include dispatch of active NTA resources was conducted on July 1, 2014. At this time, the Pilot resources totaled 1,202.96 kW of nameplate capacity.

As illustrated in Figure 4, the test successfully demonstrated that deployment of active (478.42 kW) and passive (585.92 kW) NTA resources will directly reduce upstream substation loads (1,078.5 kW total), and can be used to provide load relief at levels sufficient to avoid construction of new transmission lines.

For the full details of the July 1, 2014 test, including run times, substation loads before during and after, and NTA performance by category, see Appendix 8.2.1, excerpted from GridSolar, *Amended Project Update, Boothbay Sub-Region Smart Grid Reliability Pilot Project* (July 25, 2015).

GridSolar conducted a second live test on July 22, 2014, when CMP made a request for all Active NTA resources (484.2 kW). In response GridSolar called on the diesel backup generator (BUG) and the demand response (DR) Ice Bear units. The Ice Bear units came on-line as expected; however, the BUG was unable to synchronize with the electric grid. It was discovered that the electronic control panel required replacement. After receiving 2 inadequate panel replacements, Milton CAT was able to implement a successful replacement and had the generator available and online by August 6, 2014. During the time in which the generator was unavailable, CMP made another request on July, 29, 2014 for all available Active NTA resources (29.2 kW). This test was successful. *See* Appendixes 8.2.2 & 8.2.3, excerpted *GridSolar*, *Project Update, Boothbay Sub-Region Smart Grid Reliability Pilot Project* (Oct. 22, 2015).

---

[12] GridSolar has not attributed any emissions reductions to peak-shifting or storage NTAs. We assume that the small reduction in emissions that accompanies shifting loads from on-peak to off-peak periods during the summer is offset by the additional electricity used in the conversion process.

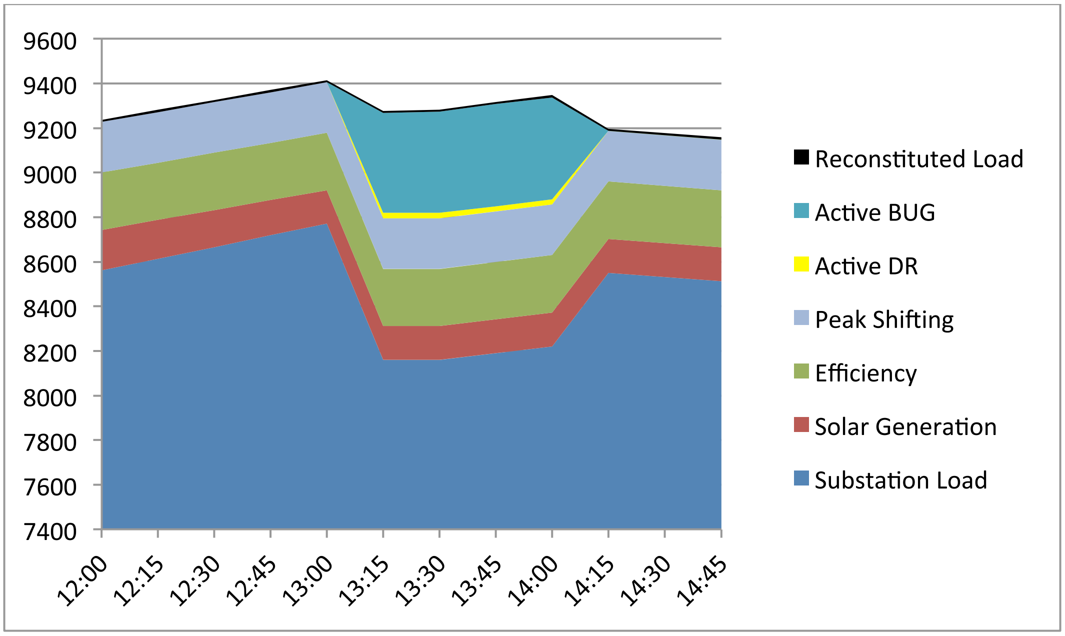


Figure 4: Graphic representation of actual load (blue) and avoided load (all others) at Boothbay substation 209 during July 1, 2014 NTA test, which ran from 13:08 to 14:07.

A third request was made by CMP on August 25, 2014 for all Active NTA resources. On this occasion the DR Ice Bear units again performed as expected. However, the diesel backup generator (BUG) failed to start when the protective relay measured grid conditions outside of CMP's operational standards. Pursuant to CMP's interconnection requirements, the relay breaker in the BUG tripped to the open position to prevent operation. GridSolar closed the breaker the same day, and the generator was again made available. *See* Appendix 8.2.4, excerpted GridSolar, *Project Update, Boothbay Sub-Region Smart Grid Reliability Pilot Project* (Oct. 22, 2015).

Subsequent tests scheduled for November 2014 were cancelled by CMP due in part to the unavailability of the BUG caused by a breaker malfunction. The breaker was replaced in December and, based on a series of 13 separate tests, GridSolar conclusively determined that the problem was resolved. See GridSolar, *Project Update -- Q4 2014, Boothbay Sub-Region Smart Grid Reliability Pilot Project* (Feb. 24, 2015).

4.3 NTA Testing - 2015

As of April 1, 2015, the battery system completed installation and the full suite of NTA resources became operational. CMP and GridSolar operated a full system test of the active NTA resources on April 29, 2015 to confirm operational readiness. CMP submitted two commands to GridSolar. The first requested 500 kW for one-hour, beginning at 9:00 AM. The second requested the remaining units available for 30 minutes beginning also at 9:00 AM. GridSolar responded by dispatching the Battery for one-hour and the BUG and demand response Ice Bears for 30 minutes. All of the active NTA resources performed at capacity for the duration of the test.

Subsequently, over the course of the 2015 peak load season, the Pilot Project underwent six different, comprehensive tests. Each test is profiled is detail in the appendixes, including:

- Attachment 8.2.5 – July 10, 2015
- Attachment 8.2.6 – August 17, 2015
- Attachment 8.2.7 – August 18, 2015
- Attachment 8.2.8 – August 19, 2015
- Attachment 8.2.9 – August 20, 2015
- Attachment 8.2.10 – August 21, 2015

Overall, the 2015 tests repeatedly demonstrated an ability to dispatch NTA resources in response to CMP requests for load relief within 5 minutes. The communications interface between CMP and GridSolar has worked as designed and has demonstrated that GridSolar, a third-party entity, can respond to utility requests for load relief in a timely and effective manner. This is illustrated in Figure 5, which shows load relief at Boothbay Substation 209 using real time NTA performance data from the July 10, 2015 test.

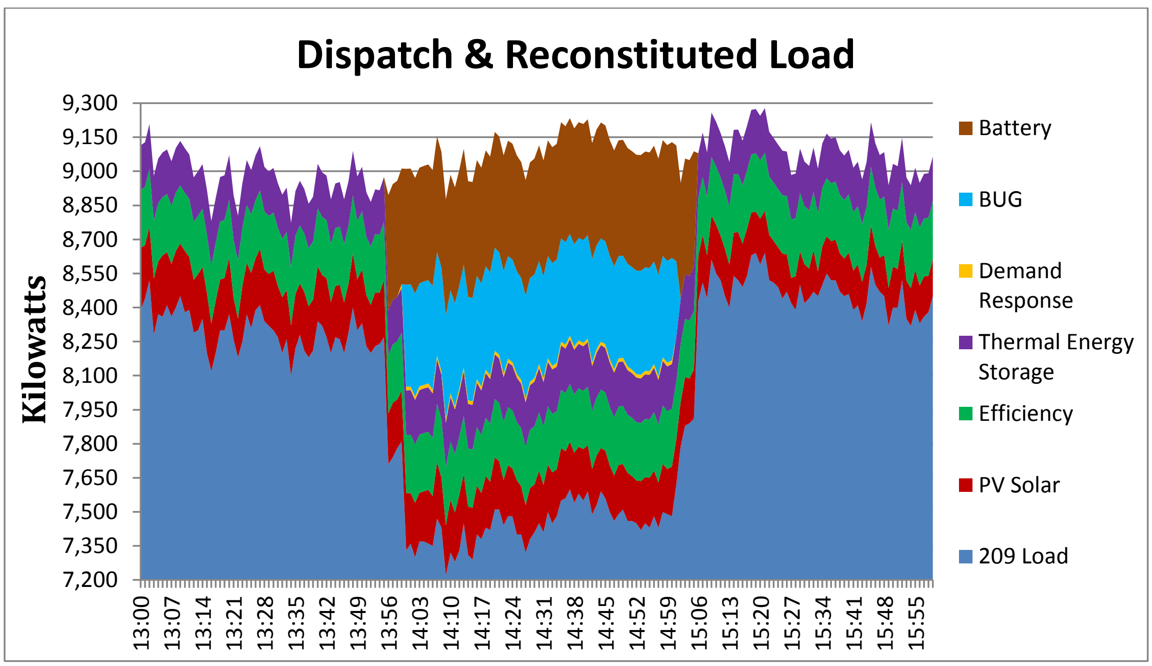


Figure 5: Actual Loads, Reconstituted Loads and NTA Performance at Boothbay Substation 209, July 10, 2015.

But, as with all electrical generators, the Active NTA resources are not 100% reliable. As described later in this report, several times during 2015 testing equipment issues temporarily knocked out certain NTA Resources. The majority of the problems experienced during testing were commissioning problems and should not recur. In conventional generating plants that operate continuously (or frequently) most or the "bugs" in the design or implementation of such generating resources are discovered and corrected in the first months of operation. Aside from testing, however, the GridSolar Active NTA resources are essentially never turned on, as they are only needed to meet actual peak load conditions – which have not yet occurred. In future deployments of Active NTA resources, GridSolar believes that it is advisable to subject each NTA resource to more intensive initial testing, as well as more frequent operations testing. This would need to be part of any bid-specification issued for Active NTA resources in future situations.

A few of the problems experienced were operational in nature, including for example frozen equipment in the second year of operations of the Ice Bears. Accordingly, any expansion of this Pilot into the broader Mid Coast region or elsewhere in Maine should include a small reserve margin to account for this situation. The relative size of this reserve margin as a percent of the total NTA deployment should drop as that total deployment increases. This is because many of the typical operational problems associated with the Active NTA resources can be addressed and resolved within a one-to-two- hour window.

5 Budget and Financial Summary

The Financial Supplement to GridSolar, LLC's Q4 2014 Project Update Report, filed with the Maine Public Utilities Commission on February 24, 2015, reports all costs and expenditures incurred by GridSolar in performing the Boothbay Pilot from the start of the project in May 2012 through the end of 2014. No revenues are shown, since all costs are recovered through payments from CMP. We have updated this report to include activities through the end of December 2015. These figures are presented in Table 4.

- Budget: The Stipulation and Commission Order ("Stipulation") establishing the Boothbay Pilot Project approved a budget that included only the start-up costs in 2012 and one full year of operation in 2013.[13] Ongoing operating costs beyond 2013 are authorized pursuant to the Commission-approved Smart Grid Energy Services Operating Contract between GridSolar and CMP; however, no budget amounts have been established. For purposes of this Report, we have added a second and third year of operations (Calendar Years 2014 and 2015) to the budgeted costs by inflating the 2013 amount by 5% for 2014 and that amount by 5% for 2015. The budget for 2015 is shown in Table 2. This includes expected monthly payments to NTA resources, show below.[14]

Table 2: GridSolar Budget for Boothbay Pilot - Calendar Year 2015

Month	Operational	Capital	NTA resources	Total
January	$11,000	$1,000	$139,354	**$151,354**
February	$11,000	$1,000	$139,354	**$151,354**
March	$11,000	$1,000	$139,354	**$151,354**
April	$11,000	$1,000	$139,354	**$151,354**
May	$11,000	$1,000	$139,354	**$151,354**
June	$11,000	$1,000	$139,354	**$151,354**
July	$11,000	$1,000	$139,354	**$151,354**
August	$11,000	$1,000	$139,354	**$151,354**
September	$11,000	$1,000	$139,354	**$151,354**
October	$11,000	$1,000	$139,354	**$151,354**
November	$11,000	$1,000	$139,354	**$151,354**
December	$11,000	$1,000	$139,354	**$151,354**
**10% Contingency*	$13,200	$1,200		**$14,400**
Total				**$1,830,653**

[13] This only relates to the operating budget for GridSolar. It does not include and payments to NTA resources pursuant to the authorized NTA Agreements.

[14] NTA payments are budgeted at their NTA Agreement Capacity Prices and are not subject to any inflation adjustment.

Monthly NTA resources Payments

NTA resource	Cost/Month
Brown Bros	$1,514.57
EMT	$5,523.65
Heliotropic	$867.48
Flagship Inn	$1,317.65
MWM	$8,710.00
ReVision Energy	$5,601.75
ReVision YMCA	$1,555.20
Tugboat Inn	$744.75
Boothbay Harbor Inn	$1,504.25
Ice Energy	$27,500.00
Convergent	$84,350.00
Hagan	$165.10
Total	**$139,354.40**

- Actual Operating Expenses: Actual project costs are broken down into two categories: Operating Costs and NTA resource Payments. The Operating Costs represent GridSolar's personnel and operating expenses. These are directly comparable to the budgeted amounts approved in the Stipulation and the GridSolar-CMP contract. As shown in Table 3, GridSolar's cumulative operating costs were approximately 30% under budget through 2014.

- Actual NTA resource Payments: The NTA resource category represents contract payments to NTA resource providers. The NTA resource category is further broken down into costs related to the 500 kW diesel back-up generator - the BUG - and payments to all other NTA resources. For the BUG, the subcategory accounting includes GridSolar's costs to develop and operate the BUG prior to turning over the unit to MWM, LLC, pursuant to the NTA Agreement approved by the Commission.[15] NTA Payments reflect payments directly to all other NTA resources under the terms of each of their respective agreements approved by the Commission.[16]

[15] In the future, we would expect a private developer to carry out all development activities associated with BUG NTA resources and the costs to be recovered through NTA monthly payments over the life of the NTA contract.

[16] The NTA payments to the ICE Bear units and Convergent Battery are made directly from CMP to the resource provider. These are included in the table as if made by GridSolar.

Table 3: GridSolar Budget and Actual Expenditures – 2012 to 2014

GridSolar Budget and Actual Expenses for the Boothbay Pilot Project – 2012 through 2014		2012	2013	2014	Cumulative
Budget	[1]	$92,000	$134,000	$140,700	$366,700
Actual					
Personnel	[2]	$46,904	$92,450	$95,343	$234,697
Expenses	[3]	$0	$11,515	$13,368	$24,883
Subtotal		$46,904	$103,965	$108,711	$259,580
NTA resources					
BUG					
Development	[4]	$0	$119,014	$29,819	$148,833
Operations		$0	$39,514	$43,923	$83,437
Personnel		$0	$20,225	$19,988	$40,213
NTA Payments	[5]	$0	$0	$52,260	$52,260
BUG - Subtotal		$0	$178,753	$145,989	$324,742
All Other NTA Payments		$709	$45,568	$411,515	$411,515
Subtotal NTA resources	[6]	$709	$224,321	$557,505	$557,505
TOTAL		$47,613	$328,286	$666,216	$1,042,115

[1] From Stipulation in Docket 2011-138, dated April 24, 2012
Stipulation only covered through end of 2013. We have included 2014 at 5% above 2013.

[2] Personnel includes all GridSolar principals and Project Manager time, except for time of Project Manager related to development of 500 kW diesel BUG. This is reflected in Personnel Costs under BUG in NTA resources.

[3] Expenses include all expenses (including equipment costs) related to the operations of the Boothbay Pilot Project, except those related to the development of the 500 kW BUG (which are included in NTA resources) and all payments to NTA resources.

[4] Development costs include all civil and electrical engineering costs related to site preparation.

[5] The BUG converted to monthly NTA Payments in July 2014.

[6] NTA resources include all NTA resources in Stipulation except the 500 kW Battery Storage unit.
This unit has a Commercial Operations Date of April 1, 2015.

Table 4 provides a detailed month-by-month accounting of costs from May 2012 through December 2015, broken down by expenditure category. The first set of figures show four categories – GridSolar expenses and personnel costs, costs for the BUG and NTA Payments. As noted earlier, GridSolar took on the primary role of commissioning the BUG unit prior to turning it over to MWM, LLC. This accounts for the higher cost levels prior to mid-2014. After that point, GridSolar still has certain cost obligations related to the unit. The breakdown for the BUG expenditures is shown in Table 5.

Table 4: GridSolar Actual Expenditures by Month for Boothbay Pilot

Month	Expenses	Personnel	BUG	NTA Payments	Total
May-12	$0.00	$1,533.34	$0.00	$0.00	**$1,533.34**
Jun-12	$0.00	$1,533.34	$0.00	$0.00	**$1,533.34**
Jul-12	$0.00	$3,356.25	$0.00	$0.00	**$3,356.25**
Aug-12	$0.00	$8,906.25	$0.00	$240.00	**$9,146.25**
Sep-12	$0.00	$15,460.42	$0.00	$468.77	**$15,929.19**
Oct-12	$0.00	$9,295.83	$0.00	$0.00	**$9,295.83**
Nov-12	$0.00	$3,850.00	$0.00	$0.00	**$3,850.00**
Dec-12	$0.00	$2,968.75	$0.00	$0.00	**$2,968.75**
Jan-13	$0.00	$5,300.00	$0.00	$0.00	**$5,300.00**
Feb-13	$0.00	$1,518.75	$0.00	$0.00	**$1,518.75**
Mar-13	$0.00	$9,936.50	$0.00	$0.00	**$9,936.50**
Apr-13	$0.00	$11,864.92	$0.00	$0.00	**$11,864.92**
May-13	$0.00	$11,179.76	$0.00	$0.00	**$11,179.76**
Jun-13	$0.00	$4,979.16	$7,225.00	$0.00	**$12,204.16**
Jul-13	$0.00	$6,506.24	$4,979.17	$0.00	**$11,485.41**
Aug-13	$7,797.65	$8,406.25	$78,084.69	$14,463.88	**$108,752.47**
Sep-13	$0.00	$8,745.83	$34,957.83	$7,674.10	**$51,377.76**
Oct-13	$3,717.42	$8,120.83	$16,154.23	$7,795.84	**$35,788.32**
Nov-13	$0.00	$7,804.17	$29,321.66	$7,805.62	**$44,931.45**
Dec-13	$0.00	$8,087.50	$8,030.14	$7,828.84	**$23,946.48**
Jan-14	$358.30	$7,441.67	$9,466.47	$10,077.84	**$27,344.28**
Feb-14	$288.31	$14,991.67	$20,572.97	$10,077.84	**$45,930.79**
Mar-14	$288.31	$7,747.92	$8,363.97	$17,510.73	**$33,910.93**
Apr-14	$5,802.50	$7,414.59	$2,020.61	$35,667.85	**$50,905.55**
May-14	$753.31	$8,600.01	$6,996.86	$33,935.19	**$50,285.37**
Jun-14	$859.27	$7,287.51	$24,919.01	$39,270.09	**$72,335.88**
Jul-14	$0.00	$9,562.51	$8,784.13	$51,612.85	**$69,959.49**
Aug-14	$2,536.36	$5,887.51	$895.29	$53,508.16	**$62,827.32**
Sep-14	$4,563.20	$6,845.84	$1,137.50	$52,839.72	**$65,386.26**
Oct-14	$2,629.56	$7,620.84	$1,137.50	$47,247.03	**$58,634.93**
Nov-14	$288.31	$4,566.67	$4,085.94	$52,737.30	**$61,678.22**
Dec-14	$464.76	$7,376.26	$758.33	$59,290.60	**$67,889.95**
Jan-15	$882.73	$11,325.01	$758.33	$52,854.38	**$65,820.45**
Feb-15	$2,773.98	$8,218.76	$758.33	$49,751.78	**$61,502.85**
Mar-15	$7,297.39	$9,025.01	$758.33	$52,438.13	**$69,518.86**
Apr-15	$3,903.61	$6,825.01	$758.33	$136,788.13	**$148,275.08**
May-15	$2,982.85	$7,583.34	$0.00	$136,811.63	**$147,377.82**
Jun-15	$423.49	$9,960.42	$1,516.67	$136,953.04	**$148,853.62**
Jul-15	$4,051.85	$8,804.17	$379.19	$135,938.64	**$149,173.85**
Aug-15	$586.09	$9,664.59	$1,137.50	$117,635.02	**$129,023.20**

Sep-15	$5,006.02	$9,002.09	$1,111.20	$132,175.46	**$147,294.77**
Oct-15	$3,776.96	$12,953.76	$758.33	$140,551.46	**$158,040.51**
Nov-15	$831.63	$9,075.01	$758.33	$137,208.88	**$147,873.85**
Dec-15	$1,726.88	$8,087.50	$758.33	$137,208.88	**$147,781.59**
Totals	**$64,590.74**	**$345,221.75**	**$277,344.17**	**$1,876,367.66**	**$2,563,524.33**

Table 5: GridSolar Actual Expenditures on Boothbay Pilot by Month for BUG NTA Resource

Month	Development	Operation	Personnel	NTA Payments	Total
Jun-13	$0.00	$0.00	$7,225.00	$0.00	**$7,225.00**
Jul-13	$0.00	$0.00	$4,979.17	$0.00	**$4,979.17**
Aug-13	$62,163.88	$13,824.98	$2,095.83	$0.00	**$78,084.69**
Sep-13	$26,441.89	$6,315.94	$2,200.00	$0.00	**$34,957.83**
Oct-13	$7,582.81	$7,121.42	$1,450.00	$0.00	**$16,154.23**
Nov-13	$22,825.53	$6,116.96	$379.17	$0.00	**$29,321.66**
Dec-13	$0.00	$6,134.31	$1,895.83	$0.00	**$8,030.14**
Jan-14	$0.00	$6,562.30	$2,904.17	$0.00	**$9,466.47**
Feb-14	$12,309.00	$6,582.30	$1,516.67	$0.00	**$20,407.97**
Mar-14	$0.00	$6,447.30	$1,916.67	$0.00	**$8,363.97**
Apr-14	$0.00	$6,397.30	$1,137.50	$0.00	**$7,534.80**
May-14	$0.00	$6,238.53	$758.33	$0.00	**$6,996.86**
Jun-14	$17,289.63	$5,733.54	$1,895.84	$0.00	**$24,919.01**
Jul-14	$1,219.88	$5,668.41	$1,895.84	$8,710.00	**$17,494.13**
Aug-14	-$1,000.00	-$0.55	$1,895.84	$8,710.00	**$9,605.29**
Sep-14	$0.00	$0.00	$1,137.50	$8,710.00	**$9,847.50**
Oct-14	$0.00	$0.00	$1,137.50	$8,710.00	**$9,847.50**
Nov-14	$0.00	$294.27	$3,791.67	$8,710.00	**$12,795.94**
Dec-14	$0.00	$0.00	$758.33	$8,710.00	**$9,468.33**
Jan-15	$0.00	$0.00	$758.33	$8,710.00	**$9,468.33**
Feb-15	$0.00	$0.00	$758.33	$8,710.00	**$9,468.33**
Mar-15	$0.00	$0.00	$758.33	$8,710.00	**$9,468.33**
Apr-15	$0.00	$0.00	$758.33	$8,710.00	**$9,468.33**
May-15	$0.00	$0.00	$0.00	$8,710.00	**$8,710.00**
Jun-15	$0.00	$0.00	$1,516.67	$8,710.00	**$10,226.67**
Jul-15	$0.00	$0.00	$379.17	$8,710.00	**$9,089.17**
Aug-15	$0.00	$0.00	$1,137.50	$8,710.00	**$9,847.50**
Sep-15	$0.00	$0.00	$1,111.20	$8,710.00	**$9,821.20**
Oct-15	$0.00	$0.00	$758.33	$8,710.00	**$9,468.33**
Nov-15	$0.00	$0.00	$758.33	$8,710.00	**$9,468.33**
Dec-15	$0.00	$0.00	$758.33	$8,710.00	**$9,468.33**
Totals	**$148,832.62**	**$83,437.01**	**$50,423.73**	**$156,780.00**	**$439,473.36**

The annual totals for the Boothbay Pilot for all categories of costs are shown in Table 6. The cost figures for 2015 are through December 2015. Table 7 shows contracted or scheduled NTA payments that were withheld due by GridSolar and not remitted to the NTA resources to inadequate capacity being made available by the provider, as well as the reason for non-performance. There were 19 instances for a total amount through 2015 of $26,325.

Table 6: GridSolar Actual Expenditures for Boothbay Pilot by Year and by Category

Year	Expenses	Personnel	BUG	NTA Payments	Total
2012	$0.00	$46,904.18	$0.00	$708.77	**$47,612.95**
2013	$11,515.07	$92,449.91	$178,752.72	$45,568.28	**$328,285.98**
2014	$18,832.19	$95,343.00	$89,138.58	$463,775.19	**$667,088.95**
2015	$34,243.48	$110,524.67	$9,452.87	$1,366,315.43	**$1,520,536.44**
Total	**$64,590.74**	**$345,221.75**	**$277,344.17**	**$1,876,367.66**	**$2,563,524.33**

Table 7: GridSolar NTA Capacity Payments Withheld

NTA resource	Withheld	Start	End	Reason
Ice Bear - Boothbay Town Hall	$484.64	4/4/2014	4/16/2014	Communication issues, switched from AT&T to Verizon
Ice Bear - Chamber of Commerce	$1,406.06	4/4/2014	5/29/2014	Circuit board shorted and burned when it froze
Ice Bear - Meadow Mall	$367.49	4/15/2014	4/20/2014	Poor data connection
Ice Bear - Meadow Mall	$161.03	5/13/2014	5/17/2014	Poor data connection
Ice Bear - T & D Variety	$764.25	5/14/2014	8/20/2014	Bad ambient temperature sensor
Ice Bear - Department of Marine Resources	$21.86	5/15/2014	6/15/2014	Bad cable, caused unit not to phone home
Ice Bear - Spruce Point Inn	$65.57	5/20/2014	6/9/2014	Communication issues, switched from AT&T to Verizon
Ice Bear - Biovation	$655.68	5/23/2014	6/17/2014	Corrupt data required a bypass
Ice Bear - Boothbay Harbor Inn	$188.48	6/5/2014	6/9/2014	Communication issues
Ice Bear - Meadow Mall	$97.24	6/15/2014	8/21/2014	Circuit board issues, replaced
Ice Bear - Biovation	$728.53	6/18/2014	6/30/2014	Supply, return and ambient temperature sensors not configured preventing calculation
PV Solar - YMCA	$690.96	7/1/2014	8/20/2014	Inverter failure
Ice Bear - Boothbay Harbor Inn	$75.93	8/1/2014	8/30/2014	NA
Ice Bear - Spruce Point Inn	$7.27	8/20/2014	8/23/2014	Communication issues, switched from AT&T to Verizon
Ice Bear - Meadow Mall	$273.35	6/1/2015	6/30/2015	NA
Ice Bear - Animal Hospital	$810.65	6/1/2015	8/30/2015	Compressor and circuit board had to be replaced
Ice Bear - Spruce Point Inn	$254.78	7/1/2015	8/30/2015	NA
Ice Bear - Boothbay Harbor Inn	$65.41	8/1/2015	8/30/2015	NA
Battery	$19,204.91	8/1/2015	8/30/2015	Failed to complete discharging as requested

6 Discussion of Boothbay Pilot Components and Results

In this section we present a detailed discussion of the eleven (11) items outlined in Section 2.2.2.

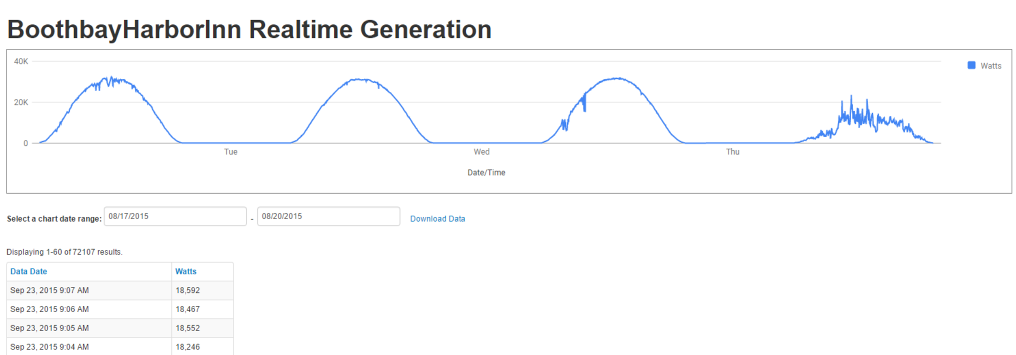
6.1 Digital Information and Control Technologies

One area where the Commission sought information from the Boothbay Pilot was in the use of digital information and control technology and the extent to which these have improved the reliability and efficiency of the electric system, including any transmission or energy costs avoided as a result of the Boothbay Pilot. As noted elsewhere in this Report, the Boothbay Pilot itself has resulted in a net reduction in transmission costs in excess of $12 million. This reduction, however, was not specifically the result of the use of digital information or control technologies; rather, it was the result of a substitution of NTA resources for transmission infrastructure.

The size and scope of the Boothbay Pilot has limited the potential to apply digital information and control technologies that might otherwise be available in a larger-scale application of NTA resources. These might include, for example, the ability to deploy state-of-the-art control technologies at the distribution circuit level to control power factor and voltage at locations on the grid where such controls are not currently deployed. In Appendix 8.6 of this Report we provide a white paper prepared by Peter Evans, President of New Power Technologies and a consultant to GridSolar on the Boothbay Pilot, which describes how these technologies are being made possible by enhanced grid information and the management of that information and some of the benefits that might be obtained.

6.2 Renewable Energy Systems

The Pilot's solar PV systems operate in a passive mode, meaning they are generating electricity whenever the sun and weather conditions permit. GridSolar is able to examine actual generation for the larger PV systems installed by ReVision Energy, since ReVision has enabled GridSolar to access the real-time digital generation data from these facilities. GridSolar has implemented a methodology to record real time data from seven PV Solar installations. This information is made available to CMP within the GridSolar Ops Center SMART interface in chart, table and downloadable format, Figure 6:



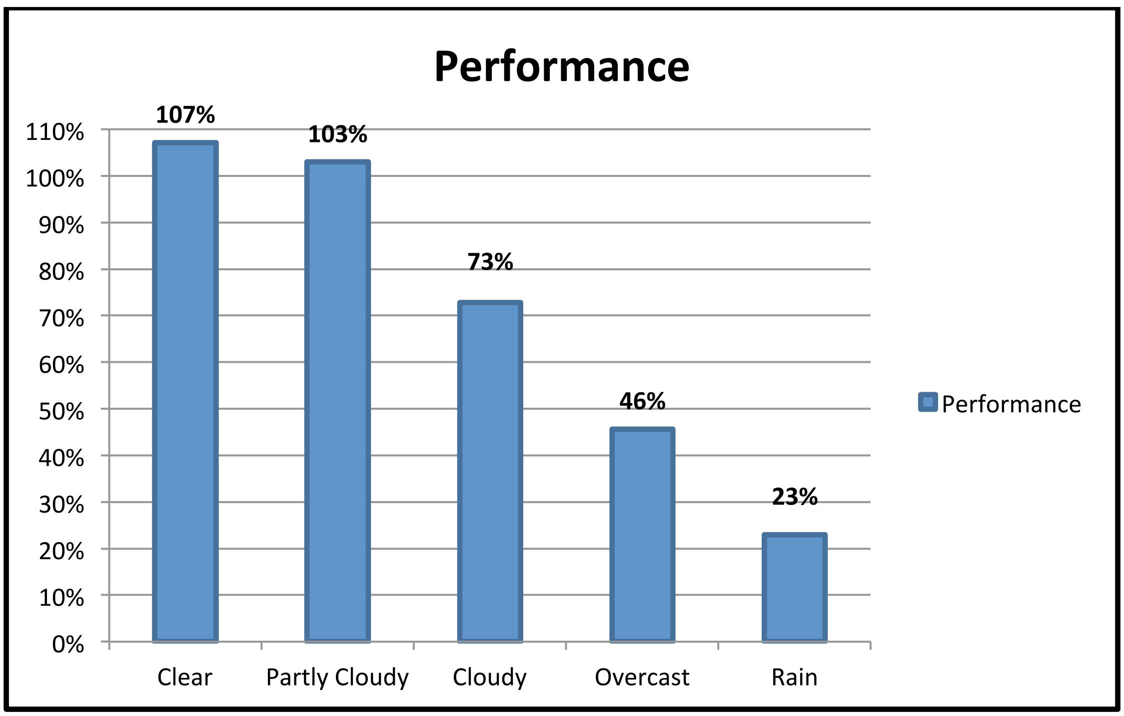
Data Date	Watts
Sep 23, 2015 9:07 AM	18,592
Sep 23, 2015 9:06 AM	18,467
Sep 23, 2015 9:05 AM	18,552
Sep 23, 2015 9:04 AM	18,246

Figure 6: Real time PV Solar Generation Interface

Using the methodology described above and additional output data from the solar PV systems, GridSolar has examined the performance of the solar PV units each hour over the months of July and August 2015 to determine how they are operating relative to the capacity ratings established by GridSolar in the NTA Contracts for each facility. Although this information does not pertain to specific performance during testing or dispatch events, we believe that this information is useful for the evaluation of the Pilot, so we present in this Final Report.

Chart 1 looks at the actual generation for the YMCA solar PV system each day in July and August 2015 for the hour 14:00 to 15:00, and compares that generation to the capacity rating of the facility, based on the weather conditions each of these 62 hours. The weather categories are those reported in Wiscasset, Maine by the U.S. Weather Service. The results show that on average, during clear weather conditions (conditions we would expect to occur on a peak load day), the YMCA installation is generating at 107% of its NTA capacity rating.[17] Not surprisingly, the performance rating goes down as the solar radiation diminishes, however, these conditions also affect peak load similarly, by lowering ambient temperatures, which then increases circuit carrying capacity and simultaneously reduces AC load.

Chart 1: Weather Related Performance for the YMCA PV Solar Installations



GridSolar next looked at this same metric for all of the ReVision Energy PV Solar installations. The results are shown in Chart 2. On clear days, these systems are generating at 100% of their combined

[17] The unit performed at 103% of its capacity rating during hours characterized by the Weather Service as "Partly Cloudy".

capacity ratings. This confirms the validity of using the PV Watts calculation methodology for determining capacity ratings for solar PV systems for purposes of providing grid reliability.[18]

Chart 2: Weather Related Performance for All Real Time PV Solar Installations

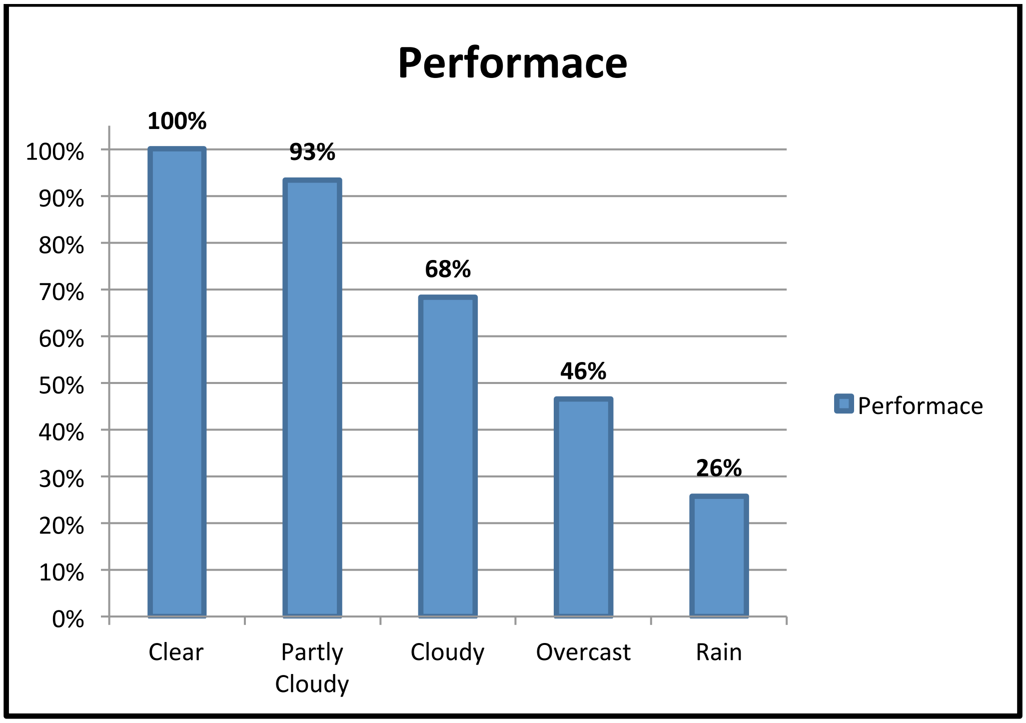
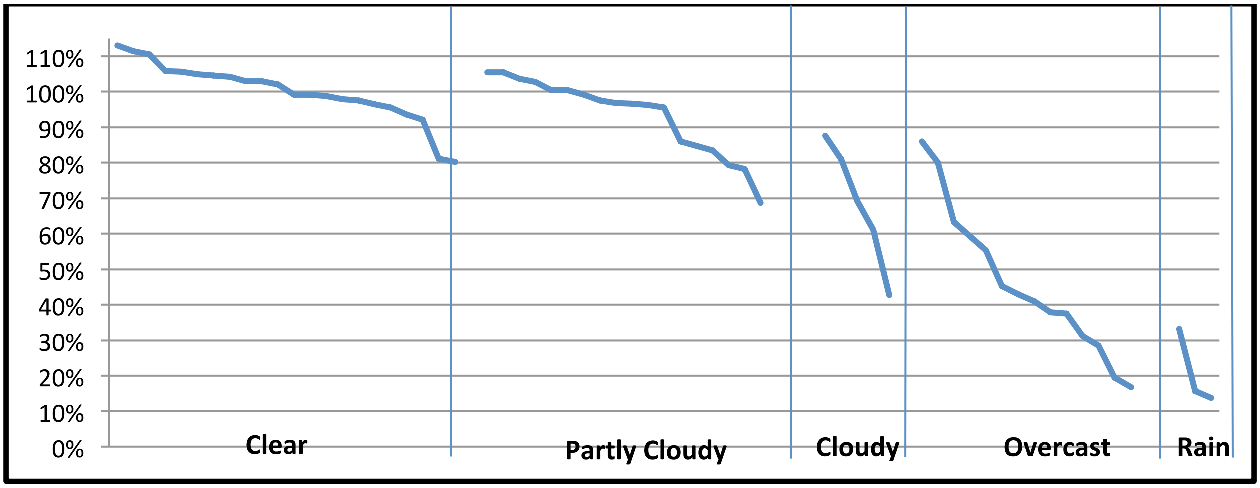


Chart 3 maps out the actual hourly generation for the ReVision solar PV units by weather condition. The data is sorted from highest to lowest generation for each weather condition. This chart shows that on those hours (14:00 – 15:00) each day in July and August 2015 that were identified as "Clear", the solar PV systems generated as much as 113% and as little as 80% of their GridSolar capacity ratings – the average is 100% as shown on Chart 2. This graph also shows that there is considerable overlap in terms of generation performance across weather categories, but that generally the weather is a good predictor of system performance. Even on "Partly Cloudy" days, the system is producing at or above its capacity rating for about 25% of the time – presumably those days when the weather is more clear than cloudy and CMP's system loads are high.

[18] GridSolar's solar PV system evaluation process discovered that the Fire Station installation of 9.18 kW DC was under-generating in comparison to its capacity rating. We asked ReVision Energy to investigate and provide a solution if available. Based on initial review the problem may be a shading issue at that location. If no solution is found (e.g., tree trimming), GridSolar will provide the location a new capacity rating based on actual performance.

Chart 3: Weather Related Performance



6.3 Distributed Generation, Energy Efficiency and Demand Response

6.3.1 Energy Efficiency

As noted in the NTA Inventory in Section 4.1, the primary energy efficiency NTA deployed in the Pilot Area is commercial LED lighting. GridSolar was somewhat surprised by how few businesses in the Pilot Area had switched to LED lighting prior to the start of the Boothbay Pilot, given the very substantial statewide efforts of the Efficiency Maine Trust to incentivize businesses to make the switch. In discussions with area businesses, we learned that one of the reasons why is the seasonal nature of many businesses in the Pilot Area, which limits annual operating hours and therefore the savings these businesses can realize from more efficient lighting. This situation created a significant latent demand that the Trust was able to capture in a relatively short period of time. Further, since the EMT projects generally would not have been able to financially justify conversion to LEDs due to the seasonality of their operations, it is likely that EMT's efficiency projects reached levels that are above and beyond what would be included in the MACE standard that underlies the CMP load forecast.

GridSolar has received a number of positive assessments from those businesses in Boothbay that installed energy efficient lighting through the Efficiency Maine Trust effort. Businesses have remarked about the quality of the light and the reduced heat gain (and thus reduced AC loads), and have been especially pleased by the resulting reduction in their electricity usage and monthly bills.

Neither the Efficiency Maine Trust nor GridSolar systematically tracks the status of customers that are included in the EMT NTA resource. That said, we are not aware of any instances in which a customer has switched from the LED lighting installed back to incandescent lighting. We are aware of a couple of small businesses that have closed, such as The Boothbay Playhouse. In effect, closures result in load reductions that are likely larger than those achieved through the efficiency measures. Further, Efficiency Maine Trust has informed us that the contracts it has with those participating in this program require that if a customer moves to a different physical location, the customer must leave the lighting retrofits at the existing location. Accordingly, we believe it is appropriate to use the full capacity rating value for the Efficiency NTA resource in evaluating load reductions during testing or dispatch events.

6.3.2 Demand Response

GridSolar did not receive any traditional demand response or dynamic pricing NTA resources in response to either of its two RFP solicitations. We discuss some of the reasons why this may have been the case in Sections 6.4 and 7.2.4

6.3.3 Distributed Generation

The 500 MW diesel back-up generator (BUG) resource is now fully operational. The unit passed all IEEE1547 interconnection equipment testing requirements on May 14, 2014. After an iterative series of tests and corrections, the remote operations and dispatch capabilities were confirmed and the generator was successfully dispatched in live testing for about 1 hour (1:07 – 2:10 PM EST) on July 1, 2014. Data was logged and as shown in Table 8 below and the upstream substation loads showed evidence of the 455 kW of load reduction (90% of nameplate):

Table 8: CMP Substation 209, Circuit D3 bus readings on July 1, 2014. Source CMP.

7/1/2014 16:00	BOOTHBAY HARBOR	CIRCUIT 209D3 MW	2.28
7/1/2014 15:00	BOOTHBAY HARBOR	CIRCUIT 209D3 MW	2.42
7/1/2014 14:09	BOOTHBAY HARBOR	CIRCUIT 209D3 MW	2.33
7/1/2014 14:00	BOOTHBAY HARBOR	CIRCUIT 209D3 MW	2
7/1/2014 13:39	BOOTHBAY HARBOR	CIRCUIT 209D3 MW	1.9
7/1/2014 13:07	BOOTHBAY HARBOR	CIRCUIT 209D3 MW	2.03
7/1/2014 13:00	BOOTHBAY HARBOR	CIRCUIT 209D3 MW	2.49
7/1/2014 12:00	BOOTHBAY HARBOR	CIRCUIT 209D3 MW	2.33

As expected, this test demonstrates direct distribution system load reductions at the substation upstream from the dispatched active NTA resources.

The BUG has now been operational for two summers. During this period, there have been occasional difficulties as all parties "discover" various default settings and operating characteristics of BUG units that were designed and which are primarily configured to provide service when the grid is down – not to operate in parallel. For example, in August 2015 GridSolar had to modify the software configuration for fuel level warnings and alarms. The unit was dispatched per GridSolar tests and CMP dispatch requests for about 18 hours over successive days the week of August 17th. This burned enough diesel fuel that the unit hit default alarm thresholds and automatically shut down at a fuel level of 25%. These thresholds were set at higher levels than expected. GridSolar has since worked with MiltonCAT to change these default settings.

The BUG SCADA system has also been upgraded to track CMP circuit voltages and frequency on the line feeding the Boothbay Industrial Park. Historically, the BUG experienced alarms that appeared to be related to circuit voltages and frequency outside of recommended limits, which in some cases prevented the BUG from operating. GridSolar was unable to explain these occurrences due to the lack of data available from CMP regarding conditions on its circuits. Now, actual historic data can be used to set an expectation and possibly explain future problems with these limits. This type of data is vital to the analysis of current and future NTA resources and operational procedures. GridSolar continues to develop the system in order to provide what it believes will be important insight and value to improve grid operations. In addition, GridSolar has added notifications that relay the status of the BUG NTA resource to the GridSolar Ops Center to ensure it is always ready to operate

Operation of the BUG has been much improved. Outside of the automatic fuel level shutdown – which occurred for about 30 minutes – the unit has performed very reliably, successfully meeting all 6 dispatch test events this past summer and all 5 test events during the week of August 17th, as discussed in the Attachments to this report.

6.4 New Smart Grid Technologies

One of the objectives of the Boothbay Pilot project was to evaluate whether smart-grid technologies, including real-time, automated interactive technologies to optimize the physical operation of energy-consuming appliances and devices could be incentivized and deployed as a component of an NTA solution to a grid reliability issue. No providers submitted bids to provide NTA resources using such technologies, however. Therefore GridSolar is unable to report on whether new smart grid technologies can perform NTA functions and, if so, at what cost.

GridSolar attributes the lack of proposals to three factors. First, while CMP has deployed advanced metering capabilities for all of its customers, its measurement, reporting and billing systems are not currently capable of utilizing this information. As a result, supply-side NTAs based on automated devices or manual controls (consumer choice using real time data) provide essentially no economic value to customers. Likewise, the broader set of benefits that a customer might realize from the use of new in-home smart grid technologies are also unavailable and cannot currently interact with the CMP AMI system, making the deployment of such technologies far less economically attractive.

Second, the Pilot project's limited 3-year duration, small 2 MW scale and the seasonal nature of much of the customer loads in the Boothbay region made the Pilot less attractive to entities that might otherwise have had an interest in testing the effectiveness of smart grid technologies. Indeed, it is hard to imagine the design of a Pilot that would have been provided such entities less inducement to participate.

Third, it is early in the consumer adoption cycle for many of these technologies. Promotion and trials of newer interactive smart grid appliances falls within the scope of activities to be conducted by the Smart Grid Coordinator for the State of Maine, pursuant to the Smart Grid Act. Since the Commission has not approved such an entity, it is unrealistic to expect that the benefits that were anticipated to flow from the entity's activities would be realized in the Boothbay Pilot.

A second area of smart grid technologies that were identified by the Commission in its Order included metering and communications concerning grid operations and status. Unlike the above technologies where a variety of factors created an unsuitable environment for their deployment, this area lies directly within the control of CMP. The advanced metering initiative undertaken by CMP provides CMP with real-time operating conditions and the status of its electric grid, including its distribution system. For many purposes and specifically for NTA deployment and dispatch to relieve localized reliability concerns, this information is very important and, arguably, essential for the most effective and efficient use of NTA resources. CMP has not provided GridSolar with access to this information, despite repeated requests. If CMP and Maine's other electric utilities are able to treat this information as essentially proprietary and not share it with those entities involved in the development of NTA solutions, the deployment of NTA resources and the management of those NTA resources – a significant potential benefit of the smart grid – will be lost.

6.5 NTA Solicitation

The Order directs GridSolar to include in the Final Report "A description of all processes used to solicit NTA resources and an accounting of the number of responses to solicitations for resources, the nature of the resource offered in the response, and the quantity of energy production offered by each respondent." GridSolar has previously filed with the Commission reports related to the process and results of two Request for Proposals used to solicit NTA resources, which are summarized in Section 3.1 of this report. These reports are included as attachments to this Final Report as Sections 8.1.1 and 8.1.2, respectively.

6.6 Direct and Ancillary Economic Benefits

The Boothbay Pilot is a small-scale Pilot project that has resulted in the deployment of 1.8 MW of NTA resources in the region. While there were jobs created during the installation of these resources, the most significant job impacts based on total cost would have been related to equipment manufacture, very little of which is performed in Maine. GridSolar does not have the cost breakdowns for each of the NTA resources deployed (that would be the proprietary information of each provider) and is unable to determine the dollar amount of in-region or in state spending associated with each installation effort. Similarly, GridSolar does not have any information related to the number of direct or indirect jobs that were created as a result of the Pilot project.

The Order calls for the reporting of "direct and ancillary benefits of the Pilot Project, including investment in NTA resources and associated job creation" as a component of the final report. Since the Pilot project will result in reducing the amount of money CMP spends to ensure grid reliability by more than $12 million over the 10-year planning horizon, GridSolar would expect the Pilot to create less direct economic activity and fewer direct jobs than the far more expensive transmission solution.

Any assessment of direct and ancillary benefits, however, should not end here. The $12 million reduction in CMP spending translates into $12 million in savings to CMP's ratepayers, monies that now enter the Maine economy in a different fashion. The now lower electricity rates CMP's ratepayers face will contribute towards reducing costs for Maine businesses, thereby increasing their competitiveness and business opportunities, and will put more money in the pockets of Maine consumers. As an economic proposition, the Boothbay Pilot project is (within CMP's service territory) equivalent to a tax reduction that results from government's finding a more efficient means of realizing the same measurable outcomes. Accordingly, any analysis of the economic consequences of the Boothbay Pilot must utilize the same general equilibrium models used to analyze the effects of fiscal policy on the economy, e.g., the REMI-model. GridSolar does not have access to those types of methodological tools.

6.7 Areas of Potential Additional Savings and Benefits

Most of the NTA resources, and specifically the energy efficiency, solar PV and Ice Bear resources, provide benefits to their host customers that are separate from and in addition to the grid reliability benefits that are the purpose of the project. The primary ancillary benefit is lower energy costs, either as a result of reducing energy use (efficiency/conservation), producing low marginal cost energy (solar PV) or shifting energy use from periods of high prices and low efficiency to periods of low prices and high efficiency (Ice Bears).

In addition, under certain operating regimes, there may be additional benefits that can be realized by battery storage systems (charging and discharging against spot energy prices, ancillary services). Currently, however, Convergent is not utilizing the battery storage unit in this regard, even during the non-summer months when its contract permits more flexibility.[19]

Finally, GridSolar initially expected that existing back-up and emergency generation (e.g. fire stations, hospitals, banks) could be reconfigured to permit participation as an NTA resource, and/or that a customer that wished to have improved reliability and resiliency to meet critical electrical loads during periods of grid outage might be incentivized to do so given an additional revenue stream realized as an NTA resource. Unfortunately, the combination of the timeframe required to bring NTA resources on-line combined with the small-scale and limited customer facilities in the Boothbay Region effectively discouraged such participation. GridSolar expects that the next project will see dual use BUG NTAs.

6.8 Storage, Peak Reduction

The Pilot included two types of storage NTA resources used to reduce peak loads. These were battery storage and ice banking. The ice banking NTA resources include both active and passive Ice Bear units. The passive units are always scheduled "on" to provide improved and less expensive AC services to their host customers. The active Ice Bear units are only operated in a demand response mode when called upon.

6.8.1 Battery Storage

As noted in GridSolar's previous status reports, the 500 kW Battery Storage NTA resource provided by Convergent has been tested and has been operational since April 1, 2015. GridSolar and Convergent have continued to work together to implement the best operating procedures and technology necessary

[19] GridSolar has discussed this with Convergent. The company has indicated that its primary focus for the resource is ensuring that it meets its obligations to GridSolar. Convergent is continuing to evaluate additional services it can provide and revenue streams it can earn.

to provide the most value to the Pilot. Convergent has provided a virtual private network (VPN), which has successfully allowed GridSolar to access a secure web interface for direct dispatch control of the unit. While the VPN was not a part of the contract scope, GridSolar had also hoped to use this network to access the full SCADA system to allow for real time data and monitoring as well as advanced operational control. The protocols used on this particular network have made it difficult to provide the continuous communication the SCADA system requires. Both parties are continuing to investigate a feasible solution so that a SCADA system may be fully implemented.

Going forward, GridSolar intends to modify the technical requirements for future larger-scale active NTA resources at the RFP stage. This will improve compatibility between the GridSolar and NTA resource systems and limit the resources and time required to implement operational protocols.

6.8.2 Ice Bears

Ice Energy achieved commercial operation of its last scheduled units at Hannaford Supermarket on March 30, 2015. These units replaced units removed from another location. With this installation, Ice Energy fully met their contracted capacity requirements. The total inventory of Ice Bear units is now at 252.8 kW (peak-load shifting plus demand response).

The passive Ice Bear NTA resources have provided on-peak load relief since their installation, including approximately 40 MWh during the 2015 summer months. Ice Energy has performed repairs and maintenance as necessary in order to keep the fleet fully operational. For example, the Animal Hospital units experienced some difficulties that required a new compressor and new motherboard, making the units unavailable for about a month. The Hannaford unit experienced a leak and software problems making it unavailable for about a month. Despite these issues, throughout the 2015 summer, the Ice Bear fleet has performed at an overall rate of 98% availability. Because the Ice Bear units are a fleet rather than single units like the Battery and BUG, they provide a good indication of what could be expected in a larger NTA development where batteries or BUGs are also deployed as a fleet. In addition the 98% availability provides a good starting point to evaluate the reserve margin that might be required in future applications.

GridSolar notes that one end-user with an Ice Bear unit, The Boothbay Playhouse, has recently gone out of business. The Ice Bear unit remains in place at the Playhouse. However, since the facility is not occupied, we expect that it is operating at a much reduced level if at all. In an interesting quirk, because the Playhouse is not occupied its air conditioning load is also significantly reduced, so in effect, the peak shifting consequence of the Ice Bear unit is being realized in the load profile of the facility. Accordingly, we are still crediting Ice Energy for this capacity.[20]

In addition, GridSolar can report that customers are generally very pleased with the Ice Bear units. Customers have told us that the units are providing the cooling sought, and in fact a number of

[20] This raises an issue of whether GridSolar should be provided the contractual flexibility to negotiate a reassignment of units or facilities in these types of instances to maximize the value the NTA resources can bring to the Pilot Project and other projects in the future.

customers have indicated that their interior space is better conditioned with the Ice Bear units than without. As a result, GridSolar is accommodating scheduling the Ice Bear operations to meet customer needs where these needs do not conflict with units' primary grid reliability purpose. For example, one Ice Bear customer requested an adjustment in its Ice Bear operating schedule so that its two units are staggered, providing a longer cooling period. In all instances, however, GridSolar retains full operational control of the schedules and has made it very clear to customers that where we believe the units may be required to provide load relief, Grid Solar will modify the schedules in its sole judgment. In that case, the customers non-peak cooling needs will be served by their original AC units.

6.9 Consumer Education

The Boothbay Pilot has provided participating consumers in the Boothbay region with timely energy consumption and control options. Efforts by the Efficiency Maine Trust to promote energy efficient commercial lighting options has had the effect of making consumers aware of this option and overcome some of the more significant barriers to adoption, including the seasonality of many regional businesses. In addition, those consumers that are hosting Ice Bear energy storage units are much more aware of the energy usage of their HVAC systems and how AC needs can be better monitored and controlled.

The Boothbay Pilot did not receive any proposals from third-parties to reduce peak usage in the region by providing consumers timely energy consumption information combined with dynamic price signals to induce specific behaviors. Further, the Pilot did not receive any proposals to use radio or some other form of broad-scale remote control of consumer appliances. The Pilot was simply of too small a scale and the utility billing systems insufficiently developed at the time the Pilot was undertaken to support the type of efforts that would be required to structure and evaluate any NTA based on the provision to consumers of timely energy consumption information and control options.

6.10 Removal of Barriers

The Boothbay Pilot was successful in overcoming certain barriers to the broad adoption of various NTA technologies and equipment, including energy efficient commercial lighting, energy storage and small to medium scale rooftop solar PV systems. In addition, the information obtained through testing and monitoring the performances of back-up generation and battery storage connected to and operated in parallel with the electric grid should allay any concerns about the abilities of each technology to provide grid reliability benefits.

One area where the Pilot had a direct effect in reducing (but not eliminating) an important barrier to the deployment of distributed generation resources was in the interconnection of such resources to the grid. One heretofore critical standard for such interconnection is that the generating resource cannot result in reverse power-flow on the grid. To ensure that no reverse power flows occur, the utility tests the maximum output of the generator against minimum load conditions on the circuit to which the generator is interconnected, on the assumption that this is the worst case scenario. However, since certain actively managed NTA resources (such as engine-generators and battery storage systems) are dispatched only during conditions of maximum loads on the circuit, the circuit can handle a much higher generation output without creating a condition of reverse power-flow. Were the more general standard to apply, many distributed generation resources could never be deployed on distribution circuits.

This issue surfaced with respect first to the interconnection of the 500 kW Back-up generator on CMP's circuit serving the Boothbay Industrial Park, and then again with the 500 kW Battery Storage unit on the same circuit. This particular circuit provided one the best locations for these resources, since it serves industrial loads and since the area was zoned for industrial activities. During certain times of the year, however, loads on this circuit might be less than the 1 MW of combined nameplate ratings of the two NTA resources, and were those two units to be dispatched at maximum output, it could lead to reverse power-flows that reach upstream towards the Boothbay substation.

After a more careful and thoughtful review of load conditions on the circuit, and the operational parameters of the NTA resources, the parties agreed that there was a zero chance that the dispatch of these resources at maximum output would exceed loads on the circuit during times of peak load conditions in the Boothbay Region, when these resources would be called upon to perform. By recognizing this operational characteristic and modifying CMP general interconnection standard, the Pilot was able to overcome a barrier to the adoption of a very important class of NTA resources.[21] In the current configuration this does place a burden on the utility not to call for a test of more resources than the circuit can handle without creating a reverse power potential. In future applications, the GridSolar algorithm could be modified to test the available circuit headroom before interconnecting.

6.11 Discussion of Control Center Operations

6.11.1 SCADA Network Status

The SCADA Network is a secure and dedicated wide area network that transmits the communication between the GridSolar server and the active resources.

The SCADA network is currently fully developed. The network design consists of a secure communications connection between the GridSolar server in Portland and each active NTA resource that is under contract.

6.11.2 Command Interface Development Status

The Command Interface is a secure and password protected point of interaction that provides users with the ability to control the load available from active NTA resources in the Boothbay Pilot.

The interface is fully operational. The interface design provides the ability to request load from the Boothbay Pilot NTA resources and document activity for review and audit purposes.

[21] We understand that interconnection standards also need to be modified in a similar manner with respect to certain distributed solar PV systems. Since these systems only generate electricity during the daytime hours, applying a standard that looks at minimum circuit loads at any time, and specifically during nighttime hours, is excessively restrictive and would represent a significant barrier to the deployment of distributed solar PV systems.

Testing of the interface design and functionality has been completed with the assistance of CMP. Beta testing was completed in April 2014; security improvements were completed in 2014 (Hartbleed Worm patch) in April 2014; acceptance testing was completed in May 2014; simulation testing was completed in June 2014; the interface went live in July 2014.

GridSolar and CMP tested the GridSolar NTA communications and dispatch system on July 22, 2014, July 29, 2014 and August 25, 2014. Additional testing was done on multiple occasions during the summer of 2015. Results of these tests are reported in 4.2 and 4.3, respectively.

6.11.3 Operations Center Equipment and Scalability

The GridSolar Operations Center and the platform linking GridSolar, CMP and the NTA resources, include the following features:

- Hardware: Server, router and firewall with advanced threat protection, intrusion protection and point-to-point VPN; uninterruptible power supply.
- Software and Databases:
    - Detailed databases and storage systems for all aspects of the GridSolar Operations Center system and operations;
    - Full data redundancy, replication and backup systems;
    - Remote Desktop Application with high level authentication remote access allowing for control of all GridSolar services and procedures from any location with a cellular or Wi-Fi connection;
    - SCADA – Full supervisory, data acquisition and controls for the BUG system;
    - SMART Utility Application Interface - PHP Model-View-Controller framework with authentication and role-based access control, including:
        - Command Center
            - Based on the available NTA resources a certain amount of kW is available for use over a certain period of time. The Utility can request load relief based on those parameters and the application will designate the NTA resources as necessary;
            - Active command status can be monitored real time; and
            - All past commands can be reviewed and analyzed.
        - Resources
            - Inventory – resource type, capacity, location, available duration, circuit, contract terms, generation/load relief and total & monthly kWh generated per resource;
            - Schedule – displays when resources are scheduled for the time period being reviewed; and
            - Rules – define specific resource parameters that define operation and process
    - Notification System
        - Dispatch Alerts – email & test notifications to stakeholders when active resources will be dispatched.
        - Command Alerts – email & text notifications to GridSolar operators when

commands are submitted for load relief.

- File Repository
  - Fully functional, remote accessible, compliance-minded records retention system as a central location for all GridSolar official documents, contracts and compliance logs.
  - A central repository available to GridSolar team members as a shared drive for file management and calibration.
- Service Line -- Online routing of phone calls to any member of the team so that someone is always available. GridSolar team members receive text & email notifications when a call is missed & when a voicemail is received.

- Network
  - A private local area network protected by high performance firewalls. These firewalls offer protection against today's wide range of threats targeting applications, data, and users. It enables GridSolar to establish secure communications and data privacy between multiple networks and hosts using IPSec and SSL VPN protocols.

By using this combination of assets, GridSolar has built a portable and scalable system. This will allow GridSolar to clone existing software and implementations, enabling quick expansion of NTA Inventories and the available regions and participating T&D Utilities. As GridSolar grows, the physical hardware can be expanded without impact on the underlying software. New or multiple networks can be added to the existing infrastructure, allowing the system to communicate with each different asset in different regions for different utilities.

7 Lessons Learned and Recommendations

7.1 The Pilot Has Demonstrated that NTAs Can Meet Reliability Criteria

With the completion of the 500 kW battery storage unit on April 1, 2015, the Boothbay Smart Grid Reliability Pilot Project reached full strength of 1,677 kW of NTA resources on the Boothbay Peninsula. The Pilot includes two types of NTAs, active and passive, broken down into five "buckets" – efficiency, photovoltaic solar, demand response and peak shifting, back up generation and battery storage. The projects are in about twenty locations spread throughout the project area.

As detailed in this report, testing during the 2015 peak load season repeatedly demonstrated that each of these NTAs categories work effectively, and can be operated (passive NTAs) or dispatched (active NTAs) to directly reduce loads on the electric distribution grid serving the project area in order to keep the system within approved reliability criteria. A review of the performance history and lessons learned for each category follows below, but first we note key overall conclusions:

- GridSolar now has a total NTA resource portfolio of 1,804.68 kW of nameplate capacity in the Boothbay project area with an effective capacity rating of 1,676.84 kW.[22]
- The Passive NTA resources are performing as expected, with the performance of the solar PV systems tracking very closely to projections.
- In testing, GridSolar's Operations Center repeatedly demonstrated an ability to dispatch a wide variety of active NTA resources in response to CMP requests for load relief within 5 minutes. The communications interface between CMP and GridSolar has worked as designed and has demonstrated that GridSolar, a third-party entity, can respond to utility requests for load relief in a timely and effective manner.
- The costs of the Boothbay Pilot Project are running within budgets in the various Commission orders establishing the Project, and represent a very substantial savings over the transmission alternative.
- GridSolar is able to monitor the performance of all NTA resources (except the Efficiency Maine Trust efficiency resource) and to reduce payments under the NTA Agreements when resources have been unavailable to deliver the capacity called for in those Agreements. Through September 2015, there have been 19 such instances for a total amount of $26,324.09. This represents a 2.1% reduction in capacity for the year, and indicates that 97.9% of the entire NTA resource fleet was available for dispatch throughout the 2015 Peak Season.

[22] The initial capacity rating was 1,678.71 kW, as shown in Table 1. The difference reflects an ongoing derating of solar PV, consistent with industry standards.

7.2 Results by NTA Resource Category

7.2.1 Efficiency

The Boothbay Pilot has demonstrated that, even in a non-industrial, non-metropolitan region like the Boothbay Peninsula, there is a strong latent demand for certain types of energy efficiency technologies that can be obtained for a relatively low price. The Boothbay Pilot has also provided useful information about how energy efficiency can contribute as an NTA to provide grid reliability. The following are specific items that should be considered in future efforts:

- The use of energy efficiency technologies as an NTA raises a question that was not addressed in the Boothbay Pilot. Because utility load forecasts used in reliability needs assessments incorporate future investments in energy efficiency by EMT under its legislative mandate to achieve Maximum Achievable Cost Effective (MACE) efficiency, the question is whether purchases of efficiency NTA resources will represent double counting of the same resource. This matter is best considered in the context of a future implementation of an NTA solution, where the Trust can provide the calculations used determine MACE for a given circuit and identify opportunities for additional efficiency NTA that are not already built in to load forecasts.

- A competitive RFP process to obtain energy efficiency is not the best strategy for future NTAs. Rather, energy efficiency from residential and most commercial customers should generally be obtained through a contract with Efficiency Maine Trust on a no-bid basis. EMT already conducts RFPs for its efficiency programs. There is no need to duplicate this process. Moreover, a no-bid option would allow the Trust to integrate NTA activity into its broader mission and extensive list of existing programs and resources, and to deliver efficiency NTAs that exceed MACE in a timely and cost-effective manner. If efficiency resources are bid in response to an RFP, they should be vetted to prevent double counting under MACE and to allow for equitable integration with EMT incentive programs.

- The scope of energy efficiency technologies participating in the Boothbay Pilot has been limited to commercial lighting and a few AC upgrades to air source heat pumps. More innovative approaches such as price-induced demand responsiveness, automated smart grid appliances, increased consumer awareness, and information feedback loops were not bid into the Boothbay Pilot, so we were not able to learn anything about their potential to provide load relief and grid reliability in a cost-effective manner. Initial demonstration of these technologies is likely to require a specific carve-out in any subsequent NTA solution and more active participation in securing these types of technologies by the Smart Grid Coordinator and the Trust.

7.2.2 Solar PV

The Boothbay Pilot has demonstrated that solar PV NTAs can be installed in a cost-effective manner, that its output can be measured and verified in an accurate and inexpensive manner and that it provides reliable capacity that contributes to ensuring a reliable electric grid. Based on the results of the

Boothbay Pilot, GridSolar offers the following observations about solar PV as an NTA resource:

- The costs of solar PV systems have continued to fall since GridSolar issued RFP I (2012) and RFP II (2013). With the extension of the federal tax credits and regional RPS requirements, we expect solar PV to be a very attractive NTA resource over the next five years. It may get even better with the pending implementation of federally mandated Clean Power Plans in the New England states.

- As a general rule, solar PV systems are designed to maximize annual kWh production, since that provides the highest returns on investment. As an NTA resource, however, the value of a solar PV system is measured by the amount of capacity it can deliver to the grid (either as an injection to the grid or a reduction to load served) during those hours of the year when the grid is most stressed. For the Boothbay project, GridSolar determined that these hours were the 2-4 pm period during the months of July and August. While we expect that this period will be similarly critical in most if not all NTA solutions for different regions, it should to be verified in each instance, and capacity values of solar PV systems adjusted accordingly.

- The formula for determining capacity factors of each specific PV array – which averaged 65 to 75% of the array's DC nameplate rating – has proven accurate and consistent, based on real time generation data for the seven largest installed projects.

- The nature of the Boothbay Pilot and the lack of certain smart grid and SCADA capacities at the grid level in the Boothbay region did not allow GridSolar the opportunity to make full use of the capabilities of smart inverters now built into many solar PV systems (or in other NTA resources) to provide supplemental grid reliability. As Mr. Evans has noted in his work (attached hereto as Appendix 8.6), if appropriately specified in terms of capabilities and location on the electric distribution grid, solar PV can provide benefits, such as reactive power, well beyond the measured capacity benefits used in this Pilot effort.

7.2.3 Storage

The Boothbay Pilot utilized two forms of storage technologies – ice banking in the form of the Ice Bear units deployed at a number of commercial establishments in the Pilot Area, and a 500 kW battery storage unit that is directly connected to a distribution circuit. Both types of resources represent proven technologies and have demonstrated an ability to provide grid reliability services in multiple tests under the Boothbay Pilot.

As we noted earlier, the Ice Bear units provided a valued service to their host facilities in the form of lower overall electricity costs and improved air conditioning quality. These values were not reflected in the prices bid for this NTA resource. But we may see somewhat lower prices bid in the future, as the manufacturers and distributors of the equipment can now draw upon the results of deployment in the Boothbay Pilot to demonstrate the non-NTA value of these units. In addition, GridSolar is aware that Ice Energy (the manufacturer of the Ice Bear units) has greatly increased its manufacturing capacity as a result of the deployment of thousands of these units under utility sponsored programs in California and other states. We expect that this increased scale will result in lower unit costs and therefore lower bid prices in future RFPs for NTA resources in Maine.

The battery storage unit was the most expensive of the NTA resources procured, and the last one to come on-line. While costly, it is also the most versatile and within its overall discharge and recharge parameters, provides the most flexibility and the most rapid response time. GridSolar expects that battery storage will generally remain among the most expensive NTA resources unless major technological breakthroughs can be achieved. Nevertheless, there are a few factors that GridSolar believes might improve the cost-effectiveness of this NTA resource. These include:

- The per unit cost of battery storage has fallen significantly over the past few years and is expected to continue to fall.
- The Boothbay Pilot is bearing the full cost of the battery storage unit installed. In future NTA solutions GridSolar believes that battery storage systems will be able to draw upon additional revenue streams without reducing the value they provide as NTA resources. These revenues include on-peak and off-peak cycling to take advantage of energy price differentials, response to winter price spikes in real-time energy prices, voltage control and power quality improvements. If the developer of battery storage systems is able to capture these and perhaps other revenue sources, battery NTA bids will drop. This will require compromises between the battery storage availability as an NTA resource and its use in generating revenues in other energy markets. We believe these compromises are possible, especially during the non-summer months.
- The one battery storage unit deployed in the Boothbay Pilot is a stand-alone unit that is directly connected to a CMP distribution circuit. An alternative type of battery storage system is under development by Tesla, Sonnenbatterie, and others is designed to be located behind the customer's meter and provide a variety of services to the customer, including supporting off-grid operations. This type of system may offer important grid reliability benefits under the right interconnection and operating regimes. It is a technology that GridSolar believes should be given further consideration in the next implementation of an NTA solution.

7.2.4 Demand Response

Aside from a few of the Ice Bear units, GridSolar was not successful in attracting demand response resources (DR) to participate in the Boothbay Pilot. In part, this reflected the customer base in the Boothbay region; in part, it reflected the uncertainty about how the Pilot was going to operate and specifically its replicability, and therefore the economic return to potential participants that might otherwise bid in such resources.

Another concern is the relationship between the use of such resources as NTAs versus their use as capacity resources in, for example, ISO-NE's Forward Capacity Market. This may become problematic under the new Performance Incentive Program structure adopted by ISO-NE. The issue is whether such resources can serve two masters: (a) ISO-NE, which pays for those resources to be available on demand to address regional (or zonal) reliability issues and (b) GridSolar, which pays for those resources to be available on demand to address specific transmission or distribution reliability issues.

Conceptually, GridSolar does not believe that a conflict necessarily exists. For example, if GridSolar has dispatched a DR resource to reduce loads in Boothbay, that dispatch would have exactly the same load reduction for ISO-NE should ISO-NE call upon it after it has been dispatched by GridSolar. In fact, the resource is serving two purposes and arguably should be paid in both cases, since in the former, it is deferring transmission investments and in the latter generation investments. The problem is that under ISO-NE's measurement and verification system that DR resource may be recorded as having a zero baseline and therefore as not having provided capacity. And the reverse is true for GridSolar were that DR resource first called upon by ISO-NE to deliver capacity benefits under an ISO-NE capacity program.

The above issue could be fixed by rule. Where a potential conflict might arise, however, is when DR resources are only able to provide capacity for limited periods. In such cases, one or the other program might call upon the resource thereby using up its capacity so that less or none is available for the other program, should it require the resource at a different time. Without coordination between the ISO-NE and GridSolar measurement and verification procedures, each DR resource could be forced to choose which service to provide – generation or transmission deferral, and this might limit the attractiveness of NTA programs to DR providers such as EnerNOC.

The only DR resources to participate in the Pilot were a few Ice Bear units whose operation was programmed to respond on demand rather than as a passive energy storage unit like the majority of the Ice Bear units. As a result, GridSolar does not believe that the Pilot was a sufficient test of the ability of a broader class of DR resources to serve as NTA resources. That said, GridSolar does not believe that there is any impediment to a DR resource operating as an NTA resource, assuming that the coordination issues between ISO-NE's Forward Capacity Market and the NTA solution can be worked out.

7.2.5 Back-up and Standby Generators (BUGS)

At the start, GridSolar identified three conditions in which BUGs might be expected to play important roles as NTA resources – (a) new generators deployed as stand-alone units for the single purpose of providing grid reliability services to GridSolar and the utility; (b) existing BUGS currently providing back-up and standby service to host customers that would be reconfigured to also operate as grid-connected units such that they could provide grid reliability as an NTA resource and also operate in an island mode to provide back-up service to the host during outages; and (c) new BUGs to be deployed for host customers that would like to have back-up generation available per item b, but who are not able to justify the full expense of BUG units for this sole purpose.

In many respects, the Boothbay region was not well suited to test whether BUGs could play an important role as NTA resources. The economic base of the region is simply not broad enough to support the full range of industrial, commercial and institutional development that is found across most metropolitan regions in New England. This limited the opportunities to engage potential host customers in discussions regarding the third type of BUG described above. Further, while GridSolar did identify three target entities with existing back-up generation, the specific circumstances surrounding each made it infeasible to reconfigure those units to allow for grid parallel operations.[23]

As a result, GridSolar developed and then turned over to a third-party, a stand-alone BUG, whose sole purpose was to provide grid reliability when dispatched by GridSolar. As a result, the Boothbay Pilot is carrying the full cost of this NTA resource. In addition, since the term of the Pilot Project was set at three years, a short-term leasing arrangement (as opposed to ownership) was the only option that made financial sense.

The performance of the BUG has been good, as expected. The unit is designed to turn on, synch with the grid and deliver its full capacity rating in 10 seconds. When there were no glitches, the unit performed in exactly this manner. The glitches that did arise are what GridSolar would classify as equipment flaws that would normally be revealed and corrected during commissioning, and are generally issues that would be addressed and not recur on subsequent installations. GridSolar has not identified a single issue with the operations of the BUG that would lead us to recommend reduced reliance on this NTA resource in future NTA solutions. On the contrary, the relatively inexpensive cost of these units and their superior performance characteristics suggest that they may represent a larger share of the NTA portfolio in future NTA solutions.

Additionally, as noted in Section 3.1.3, although fueled by diesel or propane, when deployed as NTAs BUGs will likely result in substantial reductions in GHG emissions based simply on a comparison to the construction phase of new transmission alone (BUG engines are the same as the engines used in most heavy construction equipment). During NTA operations, when the BUG is operating it is displacing a grid based generator. Since the BUG will operate during peak loading hours, its GHG emissions will generally be less than those of the generator. In addition the generator will need to carry far greater line losses than the BUG before it reaches the point of consumption.

7.3 Results for GridSolar Operations Center

The Boothbay Pilot has demonstrated that the GridSolar Operations Center can successfully and timely provide the full range of contracted NTA services to meet grid reliability requirements. Below, we describe the Pilot results for the Command Interface with CMP, NTA operations, measurement and verification, and NTA payments.

[23] The first entity was the Maine State Aquarium. This facility had three small back-up generators; however, the internal electrical system had multiple busses that greatly increased the costs associated with parallel operations of the units. The second entity was St. Andrews Hospital. While its back-up generator was a potential NTA resource, the operational status of the hospital was in question and its potential closure under consideration. Third, several BUGs were located at Bigelow Lab's new facility. These were in many respects ideal back-up units; however, the federal funding arrangements underlying the design, construction and operations of the Lab made it impossible to permit the sharing of common interconnection facilities.

7.3.1 The GridSolar- CMP Command Interface

Through an iterative process with CMP, the custom Command Interface was successfully deployed at minimal cost and overhead. The Command Interface, visible to both GridSolar and CMP, displays a real-time inventory of all active NTA resources available to be dispatched for each circuit, as well as production from the larger passive NTA resources (Solar, Section 6.2). A command function allows CMP to log requests for delivery of NTA resource capacity in response to stress on the circuit. Once a command is logged by CMP, GridSolar responds by dispatching active NTA resources. The system alerts CMP as resources as activated and monitors performance of the NTA resources until such time as CMP logs a command notifying GridSolar that the NTA resources are no longer needed.

CMP provided extensive input into the system architecture and procedures. Based on that input, GridSolar implemented real-time data reporting and charting, continuously updated the NTA Resource dispatch algorithms, sped up response time on the Command Interface, and developed a training manual and added Video tutorials to walk CMP Operators through the process.

> *"I think you've made the website as intuitive and simple as you can and the instructions are pretty clear in the version I have. I'll whip through the manual again and verify, but I think what we need to do is put together an operators' tutorial that they can refer to on shift."*
>
> *– CMP Supervisor*

To date, GridSolar has responded to CMP's requests from the Command Interface within an average of 3 minutes, with the exception of one instance where a software error occurred during the transition from beta testing to operation mode. The Ops Center maintains a continuous channel of communication with CMP Operators, enabling calls to confirm and communicate action for a particular command. The system also supplies constant digital communication to confirm operator actions.

7.3.2 SCADA, NTA Operations, Measurement and Verification

The SCADA systems connecting the GridSolar Operations Center with each active NTA resource operated successfully, enabling transmission of real-time information about each resource, two-way communications and operational commands, and M&V data logging and reporting. No communications failures were reported for active NTA resources; a few of the passive units (Solar, Ice Bears) had sporadic data logging and/or communications (cell phone reception) problems. None affected performance of the resources. Alternate data collection methods were employed until the affected passive NTA providers were able to fix their equipment and communications issues.

All NTA operation data were continually processed and tracked within the GridSolar Operations Center. The SCADA system stored BUG data directly to the database. Other data were delivered to GridSolar from various sources in various formats to then be translated and stored in a common format centrally located in the Command Interface. The volume of data has become more advanced as the Pilot has progressed and as the importance of various data sets was recognized. This information is available to help improve NTA operations, fine tune NTA performance criteria, and develop additional uses and value from NTA operations. (*See, e.g., Boothbay NTAs – Advanced Findings and Potential Grid EdgeTM Services (DRAFT),* Peter Evans, President New Power Technologies (October 2015) at Appendix 8.5.)

GridSolar also utilized the M&V criteria to both confirm NTA operations and to verify and calculate payments. GridSolar processed invoices through the Operations Center. Direct payments were initiated separately by GridSolar on behalf of NTA Resources. The process was an overall success but did require several updates to keep up with the CMP systems and CMP contact turnover. No negative feedback was received from NTA Resources.

GridSolar Operations Center has continued to maintain and update the Command Interface and SCADA systems with operating system upgrades; security updates and implementations; virus and malware protection; preventative and performance improvement measures; and resolution of bugs as identified. GridSolar occasionally consulted with our IT Consultant for maintenance and enhancement projects maintaining superior performance of our systems.

7.4 Cost Comparison and Economic Benefits

GridSolar currently projects that the NTA-Transmission hybrid Boothbay Pilot will provide approximately $18.7 million of savings to CMP's ratepayers over the 10-year extended life of the project (through 2025), net of the costs of the hybrid components.

To compute the annual revenue requirement for the Pilot, GridSolar used actual expenses for operations and NTA payments through 2015 and estimated costs and payments for the period 2016 through 2025. Each of the NTA resources is expected to be available at its respective nameplate rating over the entire period, except for the solar PV systems, which are assumed to see reductions in capacity due to degradation at the rate of 0.5% per year. The estimate of GridSolar's administrative costs assume that beginning in 2017 an NTA Solution for the broader Mid-Coast Region is implemented. As a result, we have assigned 20% of GridSolar's estimated ongoing operating costs to the Boothbay Pilot; the remainder would be assigned to the Mid-Coast NTA Solution.

The GridSolar revenue requirement is then compared against the estimated revenue requirements of an $18 million transmission solution less the transmission component of the hybrid NTA solution, which is estimated to be $2 million. We have assumed an overall carrying cost factor for CMP transmission investments of 7, which we apply for each year during the period 2014 – 2015, inclusive.[24] The data and graphs displaying the results are shown in Figure 7.

The cost comparison analysis demonstrates how cost effective the NTA hybrid solution is compared to the transmission only solution, even with the expensive Battery Storage component representing over 25% of the capacity requirement. This comparison addresses only 2 MW of critical load, which was the expected load over the ten-year study period based on the CMP Needs Assessment for this region. The transmission solution can accommodate significant additional load growth at essentially no additional

[24] We believe this is a conservative figure, and that the actual figure CMP used in the MPRP case was closer to 6.

cost; however, over the ten year period under the NTA hybrid solution, there are substantial ratepayer savings – approximately $18.7 million – that can be used to offset the costs of additional NTA resources should load growth in the Boothbay Region exceed the projections over the initial ten years and continue to grow beyond.[25] This additional $18.7 million can be expected to support higher amounts of NTA resources on a dollar per kW basis, as the prices of certain NTA resources such as Solar PV fall over time and the overall NTA resource mix shifts away from higher priced Battery Storage or new battery technologies bring these costs in line with other resources.

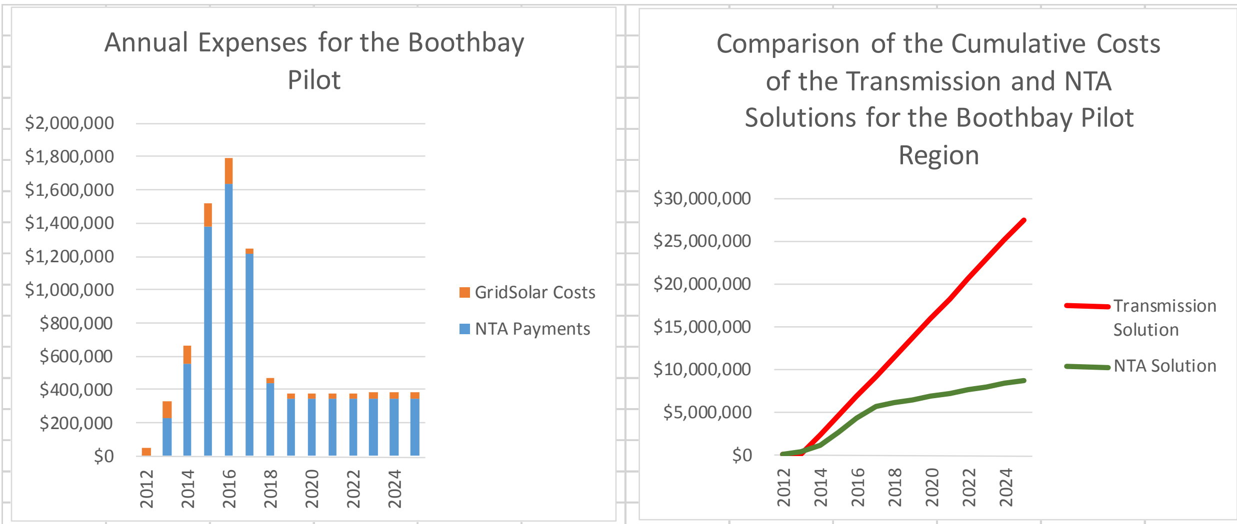


Figure 7: Cost of GridSolar's NTA Solution compared to new transmission to meet 10-year reliability needs in the Boothbay Region of the CMP electric grid.

GridSolar also evaluated the NTA Resource solution in a "worst case" scenario under which the Commission authorizes the GridSolar model as proposed for three years (through 2017) and then subsequently abandons this approach and constructs the transmission solution. Under this scenario the Commission would spend $5.6 million on contracts with the NTA resources plus GridSolar's O&M costs, but would postpone the transmission investment for four years or longer, since the 600 kW of passive NTA resources (efficiency and solar PV) at a minimum would remain operational. The four years of transmission avoidance would save ratepayers an estimated $9.1 million compared to the transmission solution carrying costs. If the 600 kW of passive NTA Resources buys an additional three years of transmission avoidance, the savings increase to $16.0 million.

Thus, even under the worst-case scenario (or if electric loads in the region started to exceed reliability criteria), CMP ratepayers save money by using NTAs to defer the much larger transmission investment. If additional NTAs were needed to meet peak load growth, however, it would be far more cost effective to issue another RFP to add incremental efficiency, solar PV and BUG NTA resources, which have the lowest levelized costs per kW.

[25] CMP's most recent projections indicate flat or declining load. Given the number of passive NTAs implemented as part of the Pilot, GridSolar anticipates that load in this pocket would likely follow this declining path.

7.5 Recommendations

7.5.1 The Boothbay Project: The Commission should direct GridSolar to exercise NTA Contract options to extend the Pilot to 10 years.

The Pilot was initially approved as a 3-year demonstration project, with an option to extend to 10 years. The RFP allowed providers to bid one price for years 1-3 of operations and a second price for years 4-10. Each NTA contract provides for GridSolar, at the Commission's direction, to exercise an option to secure NTA resources bid for the Year 4-10 extension period. Given the success of the project and ratepayer savings to date, GridSolar recommends that the Commission extend the Pilot to 10 years.[26]

One issue with exercising this option is that each NTA resource has a different start date, or "vintage". The NTA resources in the Pilot were acquired by GridSolar pursuant to two RFPs issued on September 27, 2012 and May 30, 2013. In each RFP, some NTA resources were developed, approved by the Commission, and achieved commercial operations faster than others. Accordingly, the contract dates for the NTA resources differ. A complete inventory of all of the NTA resources by contract date is provided in Table 9. This table shows the start and end dates under the existing contracts, the capacity ratings, the contract prices ($/kW/month) during the first 3 years, and the optional price ($/kW/month), where applicable, for years 4 – 10, should the Commission chose to exercise the option to continue the Pilot for the full 10-year project period.

Table 9: Inventory of all NTA resources in the Boothbay Pilot as of December 2015

Seller	Site	Bucket	Start Date	End Date	Initial Capacity Rating (kW)	1-3 Capacity Price $/kW/Month	4-10 Capacity Price $/kW/Month
Efficiency Maine Trust	Commercial	Efficiency	7/1/13	6/30/16	66.32	$15.32	NA
Efficiency Maine Trust	Small Business	Efficiency	7/1/13	6/30/16	166.46	$27.08	NA
Flagship Inn, LLC	Flagship Inn	Solar PV	7/1/13	6/30/16	8.94	$66.85	NA
Flagship Inn, LLC	Flagship Inn 2	Solar PV	7/1/13	6/30/16	10.93	$65.85	NA
Heliotropic Technologies, PA	Private Home 3	Solar PV	7/1/13	6/30/16	2.48	$50.40	NA
Brown Bro's Inc.	Brown's Wharf Inn	Solar PV	7/29/13	7/28/16	18.78	$20.00	$22.00
Heliotropic Technologies, PA	Joy to the Wind	Solar PV	7/29/13	7/28/16	1.68	$50.40	NA
Heliotropic Technologies, PA	Logan House	Solar PV	8/27/13	8/26/16	3.34	$50.40	NA
Brown Bro's Inc.	Brown's Wharf Inn 2	Solar PV	9/1/13	8/31/16	3.53	$50.00	$22.00
Heliotropic Technologies, PA	Private Home 4	Solar PV	11/18/13	11/17/16	0.81	$50.40	NA
Lafayette Boothbay Harbor, Inc.	Boothbay Harbor Inn	Solar PV	1/1/14	12/31/16	30.09	$50.00	NA
Lafayette Boothbay, Inc.	Tugboat Inn	Solar PV	1/1/14	12/31/16	14.90	$50.00	NA
ReVision Energy, LLC	BRRDD Recycling	Solar PV	2/1/14	1/31/17	16.36	$50.00	NA
ReVision Energy, LLC	BRRDD Storage	Solar PV	2/1/14	1/31/17	10.02	$50.00	NA
ReVision Energy, LLC	Fire Station I	Solar PV	2/1/14	1/31/17	14.08	$50.00	NA
ReVision Energy, LLC	Fire Station II	Solar PV	2/1/14	1/31/17	6.20	$50.00	NA
ReVision Energy, LLC	Town Garage	Solar PV	2/1/14	1/31/17	29.02	$50.00	NA
Heliotropic Technologies, PA	Private Home 5	Solar PV	3/10/14	3/9/17	3.28	$50.40	NA
Ice Energy Holings, Inc	Meadow Shopping Mall	Demand Response	4/4/14	4/3/17	25.20	$110.00	$27.00
Ice Energy Holings, Inc	Bigelow Labs	Peak Load Shifting	4/4/14	4/3/17	15.90	$110.00	$27.00
Ice Energy Holings, Inc	Car Wash	Peak Load Shifting	4/4/14	4/3/17	14.45	$110.00	$27.00
Ice Energy Holings, Inc	Chamber of Commerce	Peak Load Shifting	4/4/14	4/3/17	6.62	$110.00	$27.00
Ice Energy Holings, Inc	DMR	Peak Load Shifting	4/4/14	4/3/17	19.87	$110.00	$27.00

[26] Similarly, the Needs Assessments and the Transmission and NTA solutions developed by CMP for the Mid-Coast Region assume that the NTAs in the Boothbay Pilot will remain operational and available to be used both in Boothbay and also to support reliability needs in the much larger Mid-Coast portion of the CMP electric grid.

Ice Energy Holings, Inc	Meadow Shopping Mall	Peak Load Shifting	4/4/14	4/3/17	42.65	$110.00	$27.00
Ice Energy Holings, Inc	Spruce Point Inn	Peak Load Shifting	4/4/14	4/3/17	46.90	$110.00	$27.00
Ice Energy Holings, Inc	T&D Sunoco	Peak Load Shifting	4/4/14	4/3/17	13.79	$110.00	$27.00
Ice Energy Holings, Inc	Town of Boothbay	Peak Load Shifting	4/4/14	4/3/17	8.16	$110.00	$27.00
Oyster Creek Electric	Brown's Wharf Inn	Efficiency	6/1/14	5/31/17	23.64	$40.00	$10.00
Ice Energy Holings, Inc	Boothbay Harbor Inn	Demand Response	6/9/14	6/8/17	4.00	$110.00	$27.00
Ice Energy Holings, Inc	Biovation	Peak Load Shifting	6/9/14	6/8/17	13.25	$110.00	$27.00
Ice Energy Holings, Inc	Boothbay Animal Hospital	Peak Load Shifting	6/9/14	6/8/17	13.25	$110.00	$27.00
Ice Energy Holings, Inc	Boothbay Harbor Inn	Peak Load Shifting	6/9/14	6/8/17	8.24	$110.00	$27.00
Ice Energy Holings, Inc	Boothbay Playhouse	Peak Load Shifting	6/9/14	6/8/17	6.62	$110.00	$27.00
Ice Energy Holings, Inc	Hannaford Supermarkets	Peak Load Shifting	5/30/15	6/8/17	6.62	$110.00	$27.00
Ice Energy Holings, Inc	Tugboat Inn	Peak Load Shifting	6/9/14	6/8/17	7.29	$110.00	$27.00
Heliotropic Technologies, PA	Private Home 2	Solar PV	6/23/14	6/22/17	3.03	$50.40	NA
Heliotropic Technologies, PA	Blue Heron	Solar PV	6/28/14	6/27/17	2.50	$50.40	NA
MWM, LLC	Industrial Park Dr	Backup Generator	7/1/14	6/30/17	455.00	$17.42	$17.42
ReVision Energy, LLC	YMCA	Solar PV	7/1/14	6/30/17	31.24	$40.00	NA
Oyster Creek Electric	Private Home 1	Solar PV	8/1/14	7/31/17	3.30	$50.00	NA
Convergent Energy + Power	Industrial Park Dr	Energy Storage	4/1/15	3/31/18	500.00	$168.70	$26.30

Table 10 shows the status of each of the NTA resources for each calendar quarter through 2025. We have categorized the status as either – (a) under contract, (b) under option or (b) no contract or option but expected to continue operations and be available. White cells indicate when an NTA resource is no longer expected to be available.

Table 10: NTA Contract Terms

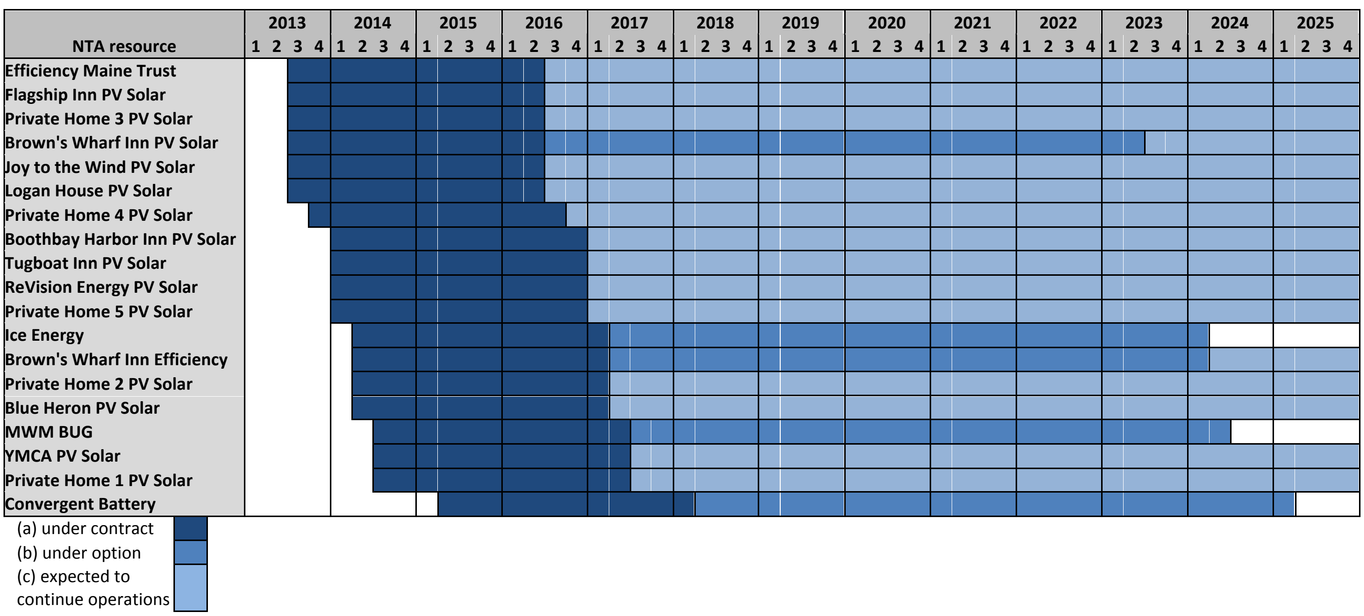


Table 11 presents a summary of the NTA resources by status for each summer period from 2013 through 2025. This summary assumes that all of the NTA resources remain in place, and that all options are exercised by GridSolar under the respective NTA Agreements. In all cases except solar PV, the capacities shown are identical to the initial capacities, since the NTA resources do not experience any degradation in performance. For the solar PV NTA resources, we have applied a degradation factor of 0.5% per year, consistent with industry standards.

Table 11: NTA Resource Status - Summer 2013 through Summer 2025

NTA resource Status	Summer 2013	Summer 2014	Summer 2015	Summer 2016	Summer 2017	Summer 2018	Summer 2019	Summer 2020	Summer 2021	Summer 2022	Summer 2023	Summer 2024	Summer 2025
Under Contract	282.5	1,171.9	1,677.4	1,394.6	500.0	-	-	-	-	-	-	-	-
Under Option	-	-	-	22.0	729.7	1,229.6	1,229.5	1,229.4	1,229.2	1,229.1	1,207.8	500	500
Expected to be in place	-	-	-	259.7	445.6	444.7	443.7	442.8	441.9	440.9	461.2	460.2	459.2
Total	**282.5**	**1,171.9**	**1,677.4**	**1,676.4**	**1,675.3**	**1,674.2**	**1,673.2**	**1,672.1**	**1,671.1**	**1,670.1**	**1,669.0**	**960.2**	**959.2**

Table 12 shows the dates at which GridSolar must exercise its option to extend the NTA Agreement for an additional 7 years for those NTA resources where the option is applicable. The contracts provide that the option may be extended in each instance in GridSolar's sole discretion (upon direction by the Commission), providing GridSolar is not otherwise in default. The NTA resource provider must use its "best efforts" to provide capacity during the option period. As shown in Table 5, the first date for the exercise of an option has recently passed. We have contacted Ice Energy about this matter, and are working with them to amend the NTA Agreement to permit a more extended time, pending approval by the Commission. Ice Energy has indicated that this is not a problem.

Table 12: Dates by Which Options Must be Exercised

NTA resource	Capacity	Option Date
Ice Energy	252.81	10/4/2015
MWM BUG	455.00	6/30/2016
Convergent Battery	500.00	6/30/2016
Brown's Wharf Inn PV Solar	22.31	7/28/2016
Brown's Wharf Inn Efficiency	23.64	5/31/2017

As part of any decision to extend the Pilot, GridSolar also recommends that the Commission authorize GridSolar to issue RFPs to procure new or replacement NTA resources commensurate with identified load growth and reliability needs in the project area over time, and to then seek Commission approval to enter into contracts with winning bidders consistent with current practice. This strategy reflects the Commission's previous finding that one of the values of NTAs is the ability to meet reliability needs in a more timely, dynamic, and cost effective fashion compared to lump sum transmission investments. CMP, *Request for Approval of Non-Transmission Alternative (NTA) Pilot Projects for the Mid-coast and Portland Areas*, No. 2011-138, Recommended Decision at 4 (July 10, 2014).

7.5.2 Recommendations for Future NTA Deployment and Operations

The Boothbay Pilot has demonstrated that a wide range of NTA Resources are available in Maine that can meet grid reliability requirements. These NTAs can be replicated and scaled in larger areas of the CMP and Emera electric grids, and can be dynamically implemented to provide reliability when, where and as needed. Inclusive of operating and administrative costs, NTAs may often be far less expensive to ratepayers than new transmission. Moreover, use of NTAs will accelerate the deployment of energy efficiency and renewable energy resources in the state without need for subsidies, and will also help reduce energy usage and emissions, lower energy costs, and improve consumer choice and access to smart grid technologies.

Likewise, the GridSolar Operations Center has demonstrated that NTAs can be independently operated to meet grid reliability criteria, and have the potential to provide additional grid services at lower cost and with fewer environmental impacts than traditional methods. Further, as noted in Section 6.11.3, the GridSolar Operations center is highly portable and scalable, and was designed to be cloned in a manner that will allow easy expansion and integration of future NTA projects.

Based on the performance and success of the NTA Resources participating in the Boothbay Pilot, and the systems and infrastructure developed to date, GridSolar recommends that the Commission proceed with deployment of larger scale NTA Pilot projects in the Camden-Rockland and Portland Loop areas pursuant to Docket 2011-138. In addition, the Commission should incorporate the results of the Boothbay Pilot into its consideration of the need for a Smart Grid Coordinator, as well as the viability of non-transmission solutions in all future proceedings under 35-A M.R.S.A. §§ 3132 & 3132-A.

As Maine advances NTA resources, it should incorporate the lessons learned in Boothbay, and in particular the following:

As with all electrical generation facilities, active NTA resources will never be 100% reliable. The majority of the problems experienced during the Pilot are commissioning issues and therefore should not recur. Some, however are operational. Accordingly, any expansion of this Pilot into the broader Mid Coast region or elsewhere in Maine should include a small reserve margin (which is the norm for generation). The relative size of this reserve margin as a percent of the total NTA deployment should drop as total deployment increases. This is because many of the typical operational problems associated with the active NTA resources can be addressed and resolved within a one-to-two-hour window.

- In conventional generating plants that operate continuously (or frequently), most or the “bugs” in the design or implementation are discovered and corrected in the first months of operation. Aside from testing, however, the GridSolar Active NTA resources are seldom dispatched (and sometimes almost never) as they are only needed to meet actual peak load conditions. In future deployments of Active NTA resources, GridSolar believes that it is advisable to subject these facilities to much more intensive testing initially, as well as more frequent operational testing. This would need to be part of any bid-specification issued for Active NTA resources in future situations.

- GridSolar is still unable to compare the status of its Active NTA resources to CMP’s real time demand curve because, despite repeated requests, CMP has not provided it with real-time access to load flows on critical circuits. GridSolar recommends that the Commission direct CMP to provide this type of information. Without this information CMP is in effect asking GridSolar to operate in the blind. No one responsible in any way for grid reliability should ever be so constrained, especially when no good justification exists.
- Certain passive NTA resources (including peak load shifting) may be located at businesses or

other facilities that cease operations. GridSolar recommends that the Commission authorize it to amend NTA Agreements where this has occurred to enable the owner of such resources to redeploy them to new locations so as to provide maximum grid reliability benefits. The portability of NTA solutions will help avoid the sunk cost problem that utilities often experience with transmission investments. Currently, in both cases – the transmission solution and the NTA solution, the investment at a closed facility is a sunk cost, and the utility is burdened with the loss of revenue from the lost customer. However, if GridSolar is permitted to relocate peak shaving equipment or other NTA resources, then the cost of this component of the reliability solution is no longer a sunk cost, which is a further benefit to the GridSolar solution.

7.5.3 Recommendations To Capture Additional NTA Functionalities and Benefits

As is discussed in Appendix 8.6, Peter Evans of New Power Technologies has used data from the Boothbay Pilot to evaluate whether certain NTA resources can contribute to lower cost solutions to voltage reliability problems as well as thermal reliability criteria. The work Mr. Evans has done with the limited amount of data available is thought provoking and a potential road map to gain some of the benefits the legislature anticipated that Maine ratepayers might realize from a smarter electric grid. 35-A M.R.S.A. § 3143(3). GridSolar believes that this is a matter that should be examined more closely by the Commission and various parties in this and other related proceedings.

8 Appendixes - Table Of Contents

8.1 Requests for Proposals for Non-Transmission Resources

8.1.1 RFP I – December 13, 2012

8.1.2 RFP II – August 21, 2013

8.2 Testing and Audit Results

8.2.1 July 1, 2014

8.2.2 July 22, 2014

8.2.3 July 29, 2014

8.2.4 August 25, 2015

8.2.5 July 10, 2015

8.2.6 August 17, 2015

8.2.7 August 18, 2015

8.2.8 August 19, 2015

8.2.9 August 20, 2015

8.2.10 August 21, 2015

8.3 Measurement and Verification Plan – Version 2

8.4 NTA Operations Manual – Version 1.4

8.5 *Boothbay NTAs – Advanced Findings and Potential Grid Edge™ Services (DRAFT),* Peter Evans, President New Power Technologies (October 2015)

8.6 Digital Inventory - Boothbay Smart Grid Pilot Project (attached as separate excel file)