Study of Renewable Energy Installation Quality

Renewable Energy Growth Program 2021 Study

Prepared in collaboration with:

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1. Executive Summary

Natural Power, working under contract with the Rhode Island Office of Energy Resources ("OER"), has completed the process of inspecting and evaluating the installation quality of projects installed through the Renewable Energy Growth ("REG") program. The REG program, a tariff-based program, supports renewable energy system development across Rhode Island.

Natural Power has completed inspections for 90 small scale solar, 19 medium scale solar, and 4 large scale solar photovoltaic systems. The small-scale solar projects represent most recent operational installations from National Grid provided data for the 2020 and 2021 REG tariff years[1]. The medium and large-scale solar projects represent most recent operational installations from National Grid provided data for the 2018, 2019 and 2020 REG tariff years. This report summarizes the results from these efforts. Inspections were performed according to a standardized inspection process and the use of Natural Power's PV quality evaluation and scoring tool developed specifically for the REG quality assurance program. The inspection tool focused heavily on the National Electric Code ("NEC") standards.

Key findings outlined in this report:

- Major grounding issues were identified in several small-scale inspections.
- Many small-scale inspections identified labeling issues related to rapid shutdown and disconnect directory requirements.
- The customer survey results showed the REG program participant knowledge is limited, and many survey respondents would like to have more information available.

Natural Power summarized recommendations based on the findings in the quality assurance program.

- Enhance the guidance document with greater details on grounding at the grid connection.
- Offer training for small-scale installers based on findings from study.
- Natural Power recommends creating an information center on the OER website for REG participants to find contact information, frequently asked questions, and additional resources. In this information center additional information on the consumer disclosure form could be provided to help improve participant knowledge.

[1] Three small-scale projects for one installer were requested from the 2019 REG tariff year.

2. Introduction

This report outlines the results from Natural Power's quality assurance study reviewing the quality of renewable energy installations funded by the Renewable Energy Growth ("REG") program in Rhode Island through the 2021 tariff year. The Rhode Island Office of Energy Resources ("OER") commissioned this study on behalf of the Rhode Island Distributed Generation Board ("DG Board"). These results are based upon inspections completed which includes inspections of 90 small scale solar, 19 medium scale solar, and 4 large scale solar photovoltaic systems.

2.1. About the Renewable Energy Growth Program

REG, a program administered by National Grid, supports the development of distributed generation projects in Rhode Island. Several technologies are eligible for the program, including solar, wind, hydropower, and anerobic digestion. Participants in the program are enabled to sell their generation output using the long-term tariffs at fixed price. The program updates the ceiling prices, megawatt allocation plan, and recommendations from the quality assurance program on an annual basis. A ten-member board, the DG Board, oversees the development and recommendations for the annual program plan.

A consultant is hired for the quality assurance program annually to ensure the safety, quality, performance, and conformance to the stated specifications. Licensed inspections for the installed systems are used to determine code compliance and verification of system components installed as compared to what was filed for the project interconnection application to National Grid. Final inspection reports are submitted to OER detailing findings from all inspections. Inspections are conducted for small scale projects (<25kW), medium scale projects (25kW-250kW), and large-scale projects (250kW+). To further enhance the quality assurance study, a customer feedback survey is conducted to understand perception of the program, satisfaction, and feedback. A draft report and final report and presentation are completed to convey results and recommendations to the DG Board.

3. Study Goals

This goal of this study is to determine the quality of renewable energy installations funded through the 2021 REG tariff year. Natural Power was commissioned to study the safety, quality, performance, and conformance of the installations. The study analyzed the quality of renewable energy installations for small, medium, and large-scale installations across different installers, basing inspection results on a 1 to 5 quality scale. Common and serious installation issues were identified and summarized by elements and severity ranging from incidental to critical. In addition to analyzing the installation issues, the responsiveness of installers to reconciling issues was reviewed. Additionally, a small-scale customer survey is conducted to further understand participant's satisfaction and perceptions of the program. From these results, recommendations were made to improve the program in subsequent years.

4. Study Methodology

4.1. Sampling Process

Natural Power prepared a sample of inspections across technologies and installers. Inspections were recommended for all installers, with an average sample of 1 to 5 inspections per installer. Table 4.1 outlines the summary of inspections and installers by technology.

Table 4.1: REG Quality Study Sample Selection

Inspections	Projected Number of Inspections	Projected Number of Installers	Actual Number of Inspections	Actual Number of Installers
Small Solar Inspections	90	34	90	32
Medium Solar Inspections	20	7	19	6
Large Solar Inspections	4	3	4	3

For the small-scale solar installations, Natural Power selected sites randomly, in proportion to the number of operational sites per installer. The sample targeted inspecting all installers with operational sites enrolled in the REG program for the most recent REG tariff years. Natural Power selected small scale solar projects based on the strategy outlined in Table 4.2. Alternate sites were included for instances where participants were unable to be contacted.

Table 4.2: Small Scale Sampling Summary for 2020-2021 REG Tariff Years

Small Scale Solar Installer Category	Total Operational Installations	Target Sample Size
Large Installer	Greater than 10	3-5
Medium Installer	10 or less	2-3
Small Installer	2 or less	1-2

4.2. Inspection Process

All on-site inspections of the renewable energy systems were completed by Natural Power subcontractors, Ridgeline Energy Analytics and Neo Virtus Engineering. During on-site inspections, licensed electricians collected all relevant data using a mobile device application developed by Natural Power specifically for the REG quality assurance program. Subcontractors scheduled and conducted all inspections with system owners. A standard operating procedure was followed with all communications throughout the inspection process to be cognizant of customers' perception of the program.

4.2.1. On Site Data Collection

To provide timely reporting and tracking of inspections, Natural Power developed a mobile application form specific for the REG quality assurance program, hereinafter called the ("Inspection Tool"). The Inspection Tool was developed to collect, analyze, and report inspections for the program. The specific inspection fields, based heavily on the 2017 edition of the National Electrical Code, ensured consistency of inspections and reporting. The Inspection Tool allowed for the inspection team to import system data, complete inspections on a mobile phone or tablet, and produce an inspection report. All inspection reports were reviewed by an engineering manager, and additionally by a Rhode Island licensed electrician and NABCEP Certified PV System Inspector. Additionally, a corrective action report was produced to reconcile issues noted during the inspection process. A summary of the Inspection Tool can be seen in Figure 4.1.

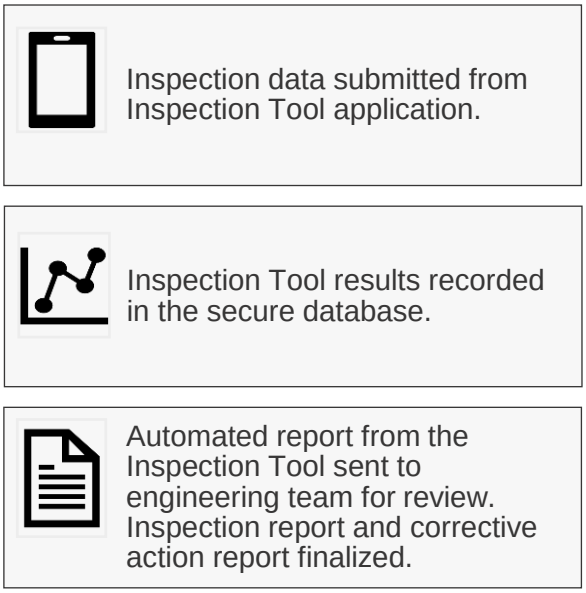


Figure 4.1: Summary of Inspection Tool

Based on identified violations during site inspections, the Inspection Tool generated a quality score. This quality was based on a 1 to 5 score that Natural Power used to quantify the quality of the systems. Table 4.3 summarizes the scoring system categorization, descriptions of the categorizations, and examples of violations seen based on the categorization.

Table 4.3: Inspection Tool Scoring System

Defect Category	Summary	Examples	Typical Score
No Issues	No identified issues.	No issues.	5
Incidental	Minimal issues not expected to impact safety or system operations.	Poor wire management, missing or incomplete labels.	4
Minor	Mid to long term risk of safety or system failure.	Bonding issues, insufficient clearance, undersized circuit protection, improperly supported conductors.	3
Major	Short term risk likely to affect system performance or safety, though not posing immediate hazard.	Missing grounding equipment, module damage, missing or undersized grounding electrode conductors, improperly secured modules, cross-mated DC connectors.	2
Critical	Immediate risk of system failure and/or safety hazards.	Exceedance of current limits on busbars or conductors, exceeding inverter voltage limits, and use of non-DC rated equipment in DC circuits.	1

A scoring algorithm was developed that calculates the score based on the issues observed. A PV system with incidental issues would generally score a four out of five using the Inspection Tool scoring scale. However, if there were many incidental issues the score may become three out of five, instead of a four out of five.

The Inspection Tool is heavily weighted on the 2017 National Electrical Code compliance and product installation instructions. The highly specific tool allows for consistency across inspections, and straightforward comparison and analysis of results.

4.3. Report Delivery and Installer Follow-Up

4.3.1. Inspection Reports

The Inspection Tool automatically stored and collected inspection data. Additionally, the application automatically sends a draft report to the engineering team after the inspection was submitted through the Inspection Tool. This automation allows for review and approval of inspections in a timely manner. After processing, the reports are delivered to installers if any violations were found. In addition, a corrective action response ("CAR") template is created to aid installers in reporting reconciliation of issues. All inspection reports are uploaded to a secure ShareFile site after review and processing for OER.

4.3.2. Procedures for Follow-Up with Installers

Natural Power used a REG quality assurance specific email for all follow-ups to ensure installers received information from a specific sender for all inspection details. Template emails were used for initial contact and for follow up emails with installers. After initial contact of the installer was made, Natural Power followed up on a weekly basis if corrective action was not made. Natural Power tracked the installer response rate between the initial delivery of the inspection reports and CAR's and the date of response with suitable corrective action made, or response noting corrective action will be made.

4.4. Data Aggregation and Analysis

Natural Power reviewed the aggregate data for frequency in installation issues and deficiencies. Natural Power used the Inspection Tool quality score as a metric in determining the quality of installations. In addition, Natural Power observed the frequency of component issues by PV component. A summary of statistics Natural Power analyzed are shown in Table 4.4.

Table 4.4: Summary of Metrics Analyzed

Metric	Unit
Average Inspection Tool score	1-5
Weighted average Inspection Tool score	1-5
Average Inspection Tool score per installer	1-5
Frequency of system deficiencies	Total occurrences
Average time for initial outreach to completed corrective action items	Days

5. Study Findings

Natural Power has completed 113 inspections including 90 inspections of small-scale installations, 19 inspections of medium-scale installations, and 4 inspections of large-scale installations.

5.1. Small Solar PV System Findings

From September to November 2021, Natural Power completed inspections of 90 small-scale solar PV installations falling in the 2020 and 2021 tariff years[2].

5.1.1. Overall Small-Scale Solar Installation Quality Scores

Table 5.1 summarizes the small-scale inspection count per quality score. Natural Power calculated the average quality score for the small-scale PV installations. The average unweighted score across inspections is 3.57.

Table 5.1: Small-Scale Quality Score Summary

Score	Category Description	Installations with Quality Score
1	Critical and/or major deficiencies	14
2	Major deficiencies	12
3	Multiple minor deficiencies	11
4	Incidental/minor issues	15
5	No deficiencies or incidental deficiencies	38

Source: Natural Power Inspection Data

Figure 5.1 shows the proportion of quality scores for the small-scale installations inspected. 58.9% of installations have a quality score of 4 and 5 with no issues to minor issues, 12.2% of installations have a quality score of 3 with several minor deficiencies, and 28.9% of installations have a quality score of 1 and 2 with major to critical deficiencies.

[2] Three small-scale projects for one installer were requested from the 2019 REG tariff year.

Source: Natural Power Inspection Data

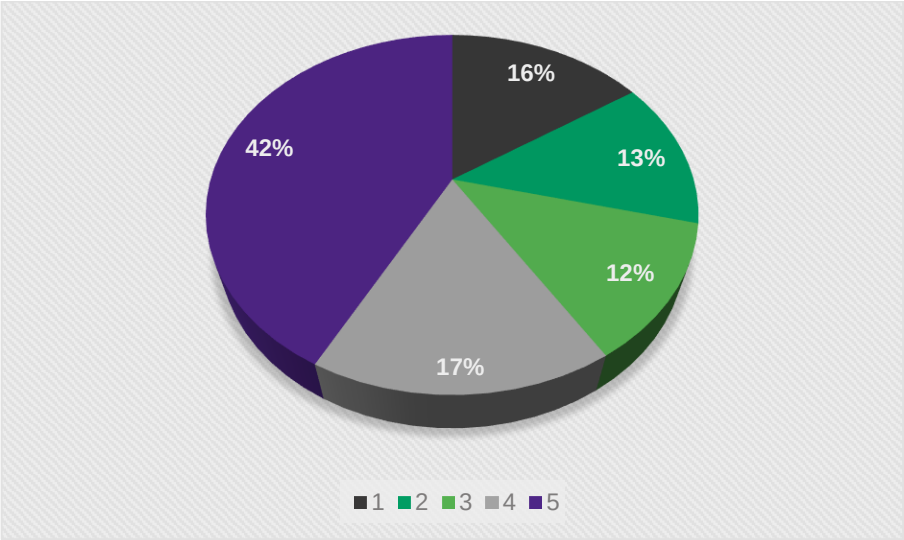


Figure 5.1: Proportion of Small-Scale Quality Scores

Natural Power also calculated the weighted quality score for the small-scale installations, as the unweighted average does not account for the proportion of installations per installer. This approach creates a larger emphasis on high volume installers. The weighted average quality score of 3.71 is 4% greater than the unweighted average, suggesting higher volume installers generally have fewer deficiencies in installations. The use of a weighted average presents a more representative analysis of the program, as the sample is disproportionate to the overall program installations.

Natural Power compared the tariff 2020 and tariff 2021 results as shown in Table 5.2.

Table 5.2: Comparison of Tariff 2020 and Tariff 2021 REG tariff years[3]

REG Tariff Year	Unweighted Average Score	Weighted Average Score	Number of Cases Inspected
2020	3.76	4.06	71
2021	3.19	2.81	16

Source: Natural Power Inspection Data

The sample for the 2021 tariff year is relatively small and may not be accurate for the REG 2021 tariff year.

5.1.2. Quality Score for Low Volume Installers

Natural Power further studied the installation quality by installer, specifically by low volume installers with 10 or fewer installations in the 2020 and 2021 REG tariff years. Overall, 50% of low-volume installers had a quality score of 4 and above with incidental issues observed, 18% of installations had a score of 3 to 3.25 with minor issues noted, 14% had a score of 2 to 2.5 presenting major deficiencies, and 32% of low-volume installers had a score of 1 presenting critical issues. Table 5.3 outlines the average scores for low-volume installers.

[3] Three small-scale projects for one installer were requested from the 2019 REG tariff year.

Table 5.3: Low-Volume Installer Average Quality Scores

Installer	Average Score
101	1.0
102	1.0
103	1.0
104	1.0
105	2.0
106	2.0
107	2.5
108	3.0
109	3.0
110	3.0
111	3.3
112	4.0
113	4.0
114	4.0
115	4.0
116	4.3
117	4.5
118	4.5
119	4.7
120	5.0
121	5.0
122	5.0

Source: Natural Power Inspection Data

5.1.3. Most Common Installation Issues

Natural Power tracked the occurrences of issues by major component in the PV installation. Table 5.4 shows the major components of PV installations and the occurrences of issues observed based on the components. Issues were often noted on the supply-side connection.

Table 5.4: Summary of Issues Observed by Major PV Components

PV Component	Incidental	Minor	Major	Critical	Total Occurrences
Array	0	1	2	0	3
Inverter	5	2	0	1	8
AC Combiner	3	4	1	0	8
AC Disconnect	2	2	1	0	5
Supply-Side Connection	95	70	17	16	198

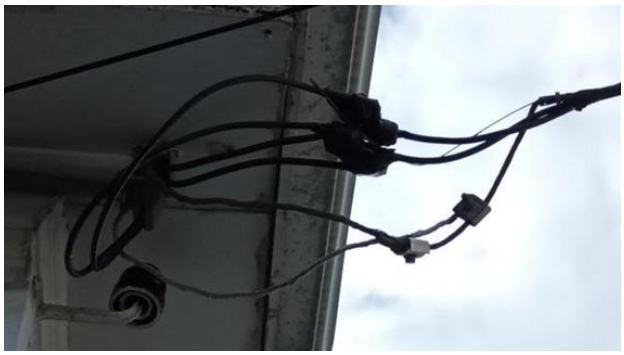
Source: Natural Power Inspection Data

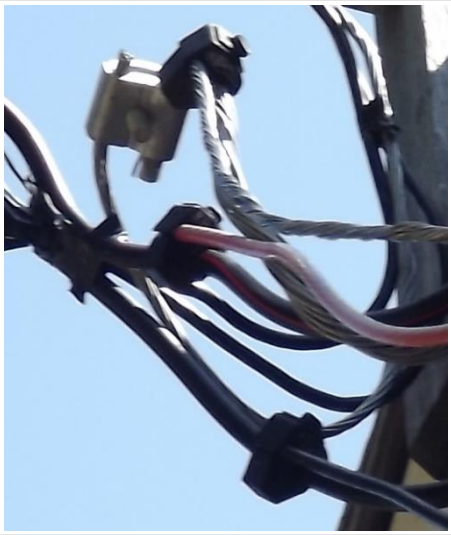
Table 5.5 outlines several deficiencies commonly observed during inspections. Although the array showed very few deficiencies, several small-scale arrays were not safely accessible during this study. There were a very large number

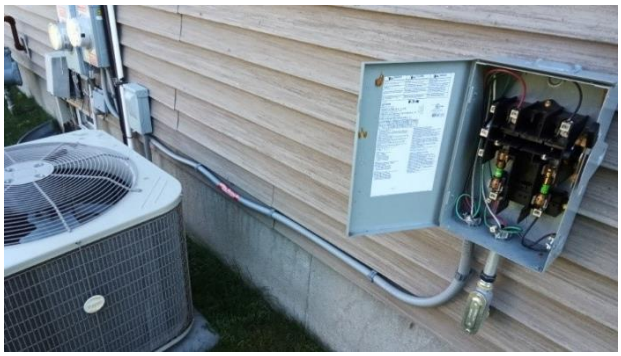
of deficiencies identified at the supply-side connection. This is likely because the method required by the program is unique and unconventional with a non-REG supply-side connection. The supply side connection is the point of interconnection and refers to the utility side of the main breaker. The three most common supply-side connection findings are:

1. The new PV service connection was not grounded in accordance with NEC requirements. This includes wiring the PV system disconnect like a second “tenant” on the house, connecting the PV grounding system to the main house grounding electrode system, and bringing the house grounding electrode system up to the current code requirements.
2. In most cases, the PV system disconnect did not have the proper directory labeling. Because this particular connection is on the utility side of the existing main breaker, a directory is required to indicate the additional disconnect that needs to be turned off in the event of an emergency. In addition, several PV disconnects were missing the rapid shutdown labeling required by the NEC. This labeling informs firefighters that the system is equipped with rapid shutdown and identifies the rapid shutdown switch.
3. Many of the connectors used to tap into the existing electrical service conductors were not listed for outdoor use. The two most-common types observed were insulation-piercing connectors and insulated set-screw type connectors intended for use inside an enclosure.

Table 5.5: Summary of Small Scale Common Inspection Issues

Pictures of Issues	Description of Issues
	Many large trees around the project present underperformance issues to the PV system.
	The service drop support is broken away from point of attachment. Conductors not supported and creating tension on terminations.

Pictures of Issues	Description of Issues
	Service disconnect directory for the existing service disconnect and PV system service disconnect required per NEC 230.2(E), 690.4(D), 705.10, and 706.11. This disconnect would be a second “service” disconnect, required to be turned off to safely de-energize all electricity in the house.
	NEC 230.9(A) requires not less than 3ft of clearance for windows that are designed to be opened.
	Indoor-rated insulation-piercing connectors used on service connection.
	No grounding electrode system was established for the PV service, and it was not bonded to the house grounding block or external ground rod. There is no bond visible separate ground rod for the PV.

Pictures of Issues	Description of Issues
	The connections to utility at the weather head are not rated for outdoor use.
	The neutral is not bonded in the PV service disconnect and supply-side conductors are undersized for application.
	The length of liquidtight flexible metal conduit (LFMC) exceeds the 6’ limit per 230.43(15) Wiring Methods for 1000 Volts, Nominal, or Less.

Source: Natural Power Site Inspections

5.2. Medium Solar PV System Findings

From September to November 2021, Natural Power completed 19 inspections of medium-scale solar PV installations that fell in the 2019 tariff year.

5.2.1. Overall Medium-Scale Solar Installation Quality Scores

Table 5.6 outlines the results, summarizing the inspection count per quality score for medium-scale installations. Natural Power calculated the average quality score for the medium-scale PV installations. The average unweighted score across inspections is 3.26.

Table 5.6: Medium-Scale Quality Score Summary

Score	Category Description	Installations with Quality Score
1	Critical and/or major deficiencies	6
2	Major deficiencies	1
3	Multiple minor deficiencies	2
4	Incidental/minor issues	2
5	No deficiencies or incidental deficiencies	8

Source: Natural Power Inspection Data

5.2.2. Quality Score by Installer

Natural Power further studied the installation quality by installer. Overall, 50% of installers had a quality score of 3 and above with incidental to minor issues observed, and 50% had major to critical installation issues noted. Table 5.7 summarizes the average quality score by installer.

Table 5.7: Installer Average Quality Scores

Installer	Average Score
201	1.0
202	1.0
203	1.8
204	3.0
205	4.8
206	5.0

Source: Natural Power Inspection Data

5.2.3. Most Common Installation Issues

Natural Power tracked the occurrences of issues by major component in the PV installation. Table 5.8 shows the major components of PV installations and the occurrences of issues observed based on the components. Major issues identified on the medium scale systems included cross-mated DC connectors, undersized DC string fuses (risk of nuisance tripping), and grounding issues.

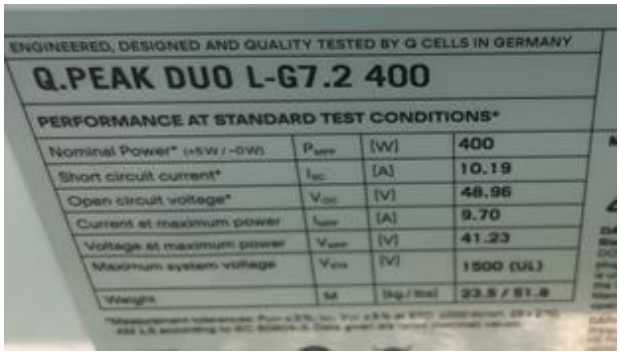
Table 5.8: Summary of Issues Observed by Major PV Components

PV Component	Incidental	Minor	Major	Critical	Total Occurrences
Array	3	13	6	0	22
Inverter	4	2	1	0	7
Supply-Side Connection	14	5	3	2	24

Source: Natural Power Inspection Data

Table 5.9 summarizes common deficiencies found in the medium-scale projects inspected.

Table 5.9: Summary of Meduim Scale Common Inspection Issues

Pictures of Issues	Description of Issues
	Cross-mated DC connectors: NEC and UL standards require mating of identical brands or product family unless evaluated for cross-mating. No such test exists between different brands.
 	Undersized string fuses for module short-circuit current (Isc). Module Isc is 10.19A 10.19 x 156% = 15.9A (NEC 690.9) 20A fuses required. 15A observed.

5.3. Large Solar PV System Findings

From September to October 2021, Natural Power completed 4 large scale solar PV inspections falling in the 2018, 2019 and 2020 tariff years.

5.3.1. Overall Large-Scale Solar Installation Quality Scores

Table 5.10 outlines the results, summarizing the inspection count per quality score for the large-scale installations. Natural Power calculated the average quality score for the large-scale PV installations. The average unweighted score across inspections is 3.

Table 5.10: Large-Scale Quality Score Summary

Score	Category Description	Installations with Quality Score
1	Critical and/or major deficiencies	1
2	Major deficiencies	1
3	Multiple minor deficiencies	0
4	Incidental/minor issues	1
5	No deficiencies or incidental deficiencies	1

Source: Natural Power Inspection Data

5.3.2. Quality Score by Installer

Natural Power further studied the installation quality by installer for the large-scale projects. A summary of inspection scores by installer is found in Table 5.11.

Table 5.11: Installer Average Quality Scores

Installer	Average Score
301	1.0
302	3.5
303	4.0

Source: Natural Power Inspection Data

5.3.3. Most Common Installation Issues

Natural Power tracked the occurrences of issues by major component in the PV installation. Table 5.12 shows the major components of PV installations and the occurrences of issues observed based on the components. Issues were often noted in the array. Major issues included cross-mated DC connectors and thermal damage identified on busbars inside DC combiners.

Table 5.12: Summary of Issues Observed by Major PV Components

PV Component	Incidental	Minor	Major	Critical	Total Occurrences
Array	0	3	2	0	5
DC Combiner	0	0	1	0	1
AC Combiner	2	0	0	0	2
Junction Box	0	1	1	0	2
Optimizer	0	0	1	0	1
Supply-Side Connection	2	0	0	0	2

Source: Natural Power Inspection Data

Table 5.13 summarizes common deficiencies found in the large-scale projects inspected.

Table 5.13: Summary of Large Scale Common Inspection Issues

Pictures of Issues	Description of Issues
	Cross-mated DC connectors: NEC and UL standards require mating of identical brands or product family unless evaluated for cross-mating. No such test exists between different brands.
	Example of thermal damage to busbar inside DC combiner.

5.4. Installer Responsiveness to Quality Installation Issues[4]

Natural Power tracked installer responsiveness from initial outreach to receipt of response from the installer. There were 18 installer responses that provided corrective action, 12 of which provided satisfactory corrective action or partial corrective action. 13 responses were received notifying Natural Power that corrective action would be made, but there were delays due to the end of year activities. Overall, 58% of responses from installers provided corrective action. On average it took approximately 16 days from initial outreach for receipt of installer response. Figure 5.2 outlines installer response by email reminder. 29% of responses were accounted for after initial contact, 10% account for responses after second email, and 61% account for response after the third email.

Source: Natural Power installer responsiveness data

Figure 5.2: Installer Response by Email

Figure 5.3 summarizes installer response by the initial score received from the inspection. Thirty five percent of responses received a score of 5 on the initial inspection report, 16% received a score of 4, 6% has a score of 3, 13% received a score of 4, and 19% received a score of 1. Overall, the average inspection score with installer response was 3.45.

Source: Natural Power installer responsiveness data

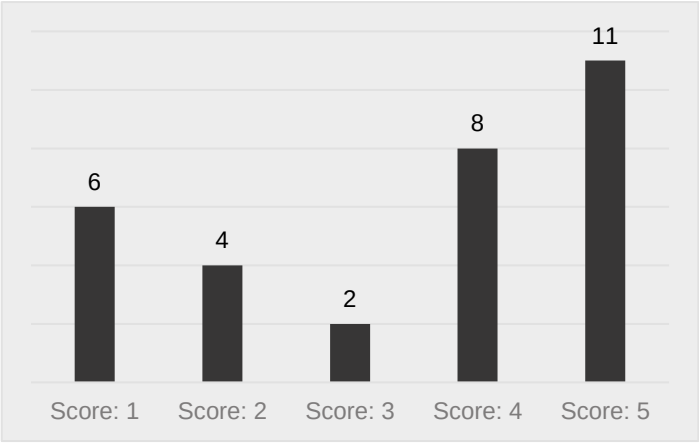


Figure 5.3: Installer Response by Score

[4] Due to the timing of the 2021 quality assurance study, several installers made Natural Power aware they were experiencing delays in corrective action due to end of year activities.

5.5. Customer Survey

In parallel with the inspection process, Natural Power surveyed small scale REG program participants with operational sites from the 2020 and 2021 REG tariff years on August 23rd, 2021. A reminder email was sent on September 6th, 2021, to those who had not completed the survey. Of the REG program participants, 93.7% were from the 2020 REG tariff year and 6.2% were from the 2021 REG tariff year. The survey included 645 participants, with 63.4% of participants opening the invitation, 29.6% invitations unopened, 5.6% bounced invitations, and 1.4% opted out of the survey. Of the opened invitations, 18.1% completed the survey.

The survey asked questions related to program prior knowledge, perception of system quality, satisfaction with installers and National Grid, feedback on the quality assurance inspection process, cost, and customer support.

5.5.1. Customer Feedback on Installer

Several questions surveyed the respondent's satisfaction with their system installer. Questions targeted installer performance of installations and customer service. The survey participants were asked to rate the performance from "very satisfied" to "not satisfied at all" for the following questions:

- How would you rate your satisfaction with your installer's performance when installing your system?
- How would you rate your satisfaction with your installer's customer service (e.g., responsiveness to questions and concerns, clarity, and timeliness of communication)?

Figure 5.4 outlines participant satisfaction with the installer's installation performance. The responses show general satisfaction for installation performance from installers.

Source: Rhode Island OER REG Quality Survey 2021 SurveyMonkey Results as of October 2021

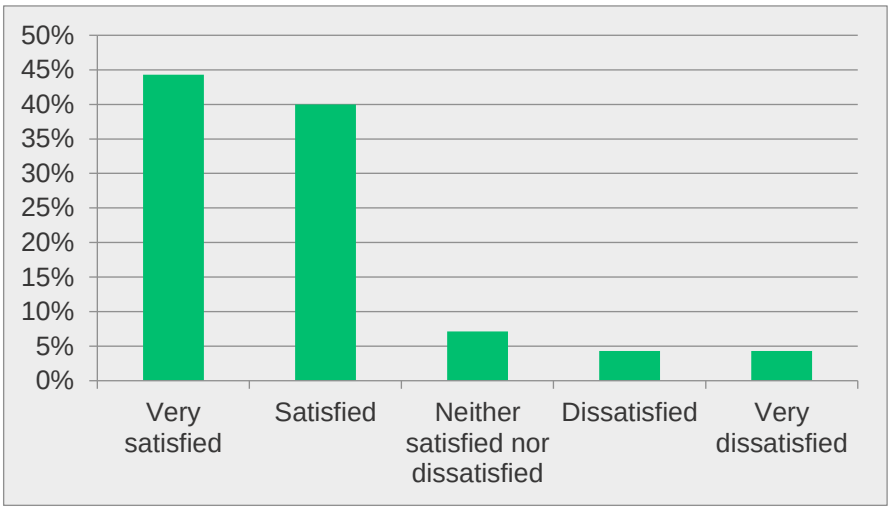


Figure 5.4: Satisfaction with Installer's Installation Performance

Figure 5.5 outline the satisfaction with installer customer service. In total, 79% of participants were satisfied, 12% were indifferent, and 9% were dissatisfied with their installer's installation performance and customer service. Overall, the results show participants had favorable satisfaction of their installers in the 2021 quality assurance survey.

Source: Rhode Island OER REG Quality Survey 2021 SurveyMonkey Results as of October 2021

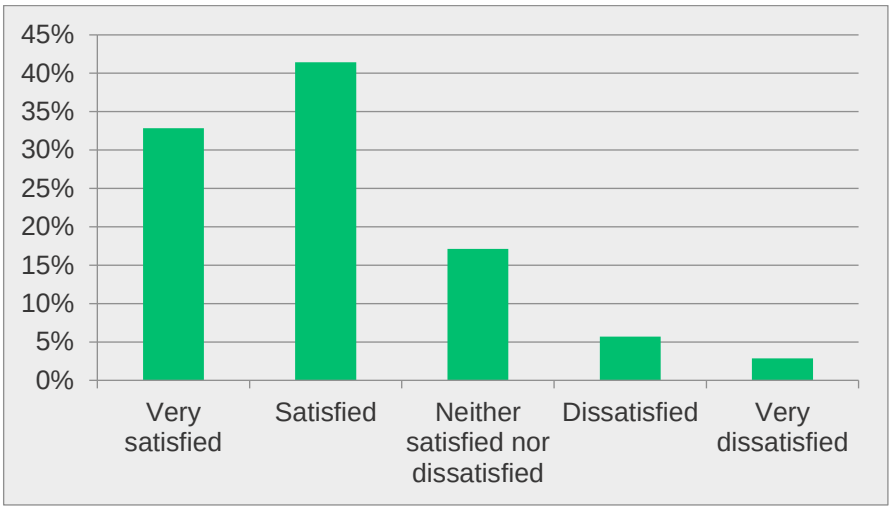


Figure 5.5: Satisfaction with Installer's Customer Service

5.5.2. Performance and Benefit Expectations

Survey participants were asked questions related to the performance and payment expectations. The respondents were asked to rate their systems production and REG payments from "much lower" to "much higher" than their expectations for the following questions:

- How does the system's production/energy output compare with what you expected?
- How different are the Renewable Energy Growth payments compared to what you anticipated?

Figure 5.6 summarizes the participant satisfaction with the production of their system. 60.6% of participants found their production to be as expected or higher, and 39.4% found production to be lower than expected.

Source: Rhode Island OER REG Quality Survey 2021 SurveyMonkey Results as of October 2021

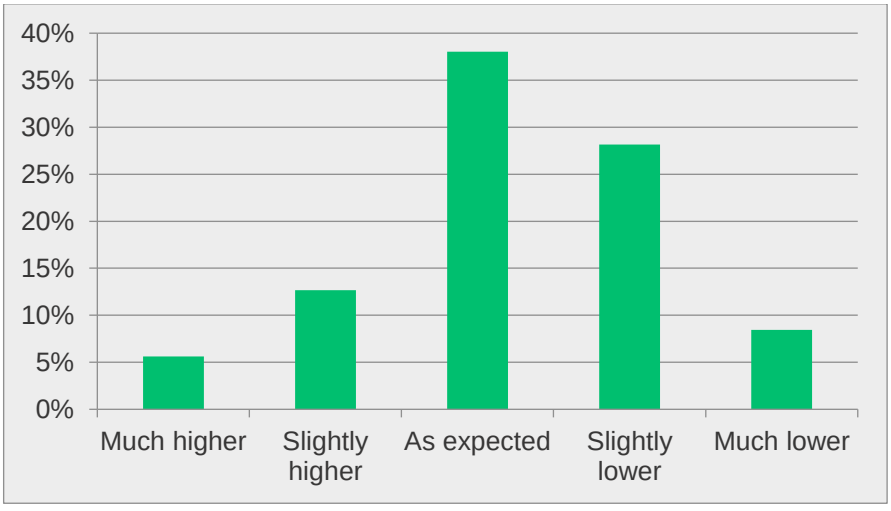


Figure 5.6: System Production Satisfaction

Figure 5.7 summarizes the participants perception of the REG payments. 52.2% of participants found the payments to be as expected or higher than expected, and 47.8% of participants found the payments lower than their expectations. While production slightly exceeded or met the expectations of the participants, the payments were split between meeting or being higher than expectations and being lower than expectations.

Source: Rhode Island OER REG Quality Survey 2021 SurveyMonkey Results as of October 2021

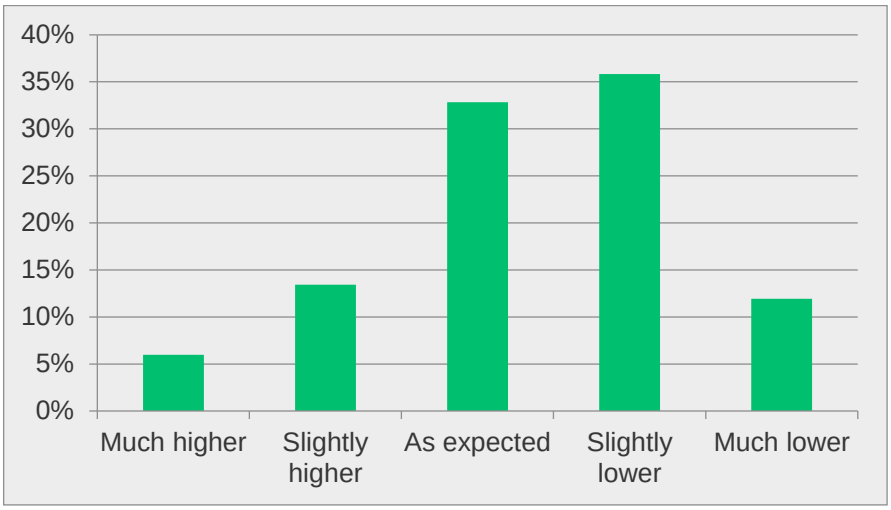


Figure 5.7: REG Payment Perception

Survey respondents were asked the following question related to the percentage of their monthly bill that is covered by payments:

- Approximately what percentage of your electric bill over the course of an entire year is covered by your Renewable Energy Growth bill credits and payments?

Figure 5.8 shows the results from survey respondents on the percentage the REG bill credits and payments cover the electricity bill. Overall, 58.2% of respondents found credits cover 51% and above of their electricity bill, 41.8% of respondents cover 50% or less of their electricity bill.

Source: Rhode Island OER REG Quality Survey 2021 SurveyMonkey Results as of October 2021

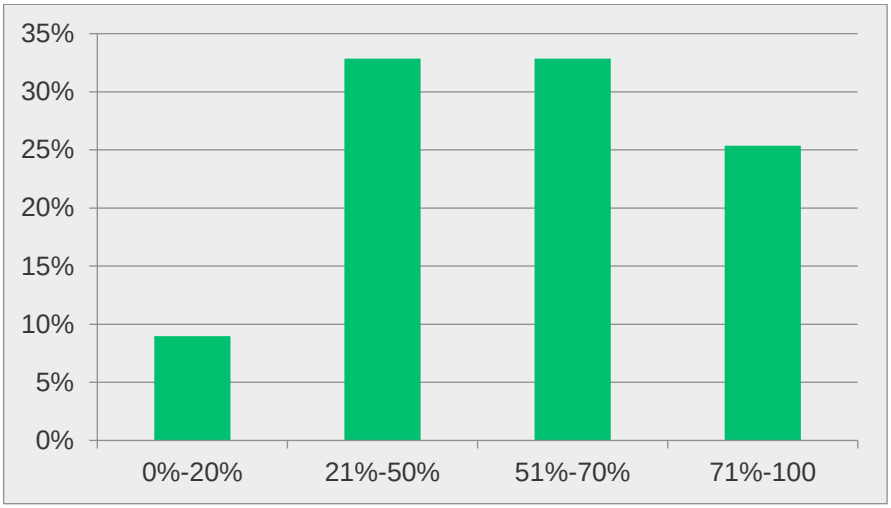


Figure 5.8: Electricity Bill Coverage Over the Course of a Year

5.5.3. Quality Concerns

Respondents were asked if their system was operating as expected, of the respondents 11% answered no. Natural Power subsequently asked the following question:

- What part(s) of your system is not operating as expected? (Select all that apply)

Figure 5.9 outlines the survey respondents quality concerns by PV system component. Several free response answers were given noting quality concerns with the output of the system not meeting expectations, or the respondents are unaware of if their system is operating as expected.

Source: Rhode Island OER REG Quality Survey 2021 SurveyMonkey Results as of October 2021

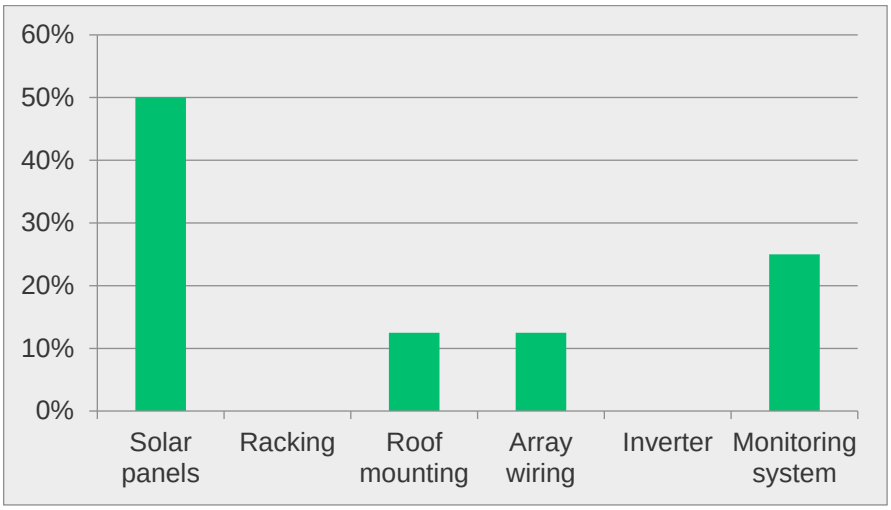


Figure 5.9: Quality Concerns from Survey Respondents

5.5.4. Roof Age

Natural Power found that 60.6% of survey respondents were not made aware of the possibility of moving the system to facilitate roof replacement at some point in the next 20 years, and 39.4% were made aware of roof replacement over the lifetime of the system. Solar PV systems have a lifetime of 20 to 25 years. The lifespan of asphalt shingles is 15 to 20 years, the lifespan of architectural shingles is 20-30 years, and the lifespan of premium shingles is between 25 to 40 years[5]. The installation of a PV system on a roof in the middle or end of its lifespan poses warranty and safety concerns of roof leakage, collapse, or costly removal of the system and reinstallation for roof replacement.

Survey respondents were asked the following question about the age of their roof system:

- If your renewable energy installation is installed on your roof, what was the age of your roof at the time of installation?

Figure 5.10 shows a summary of the roof age of the survey respondents. 32.4% of installations were installed on roofs that are 8 years or older. As the average expectancy of asphalt shingles is 20 years, PV systems are recommended to be installed on roofs no older than approximately 5-8 years old. PV systems often do not include the removal and reinstallation for roof replacement.

[5] Lane, Catherine. "How Long Do Roofs Last? 5 Roof Types and Their Lifespans." Roofing Calculator, 9 June 2021, roofingcalculator.com/news/how-long-do-roofs-last.

Source: Rhode Island OER REG Quality Survey 2021 SurveyMonkey Results as of October 2021

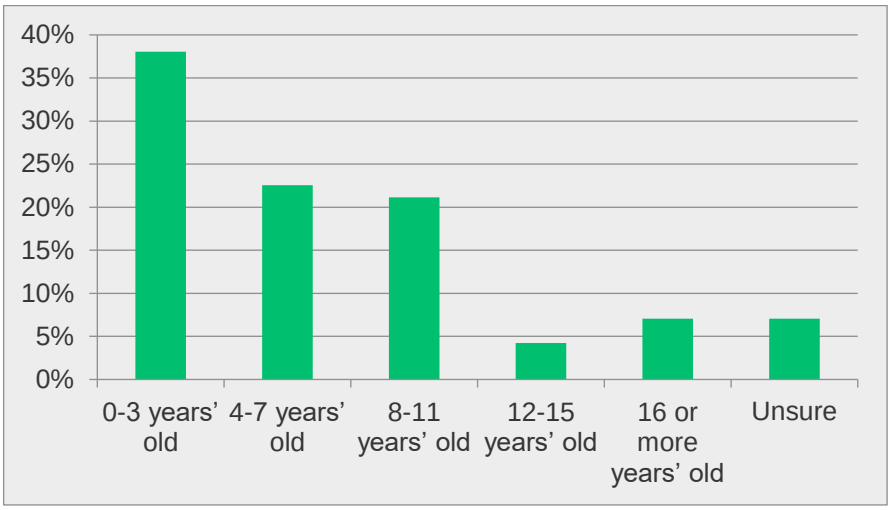


Figure 5.10: Survey Respondents Roof Age

5.5.5. Consumer Disclosure Form

Natural Power surveyed respondents' knowledge of the consumer disclosure form and found that 24.3% signed the form, 1.4% did not sign the form, 1.4% were provided the form and did not sign the form, and 73.9% were unsure of the if they had signed the form. Overall, a large portion of the survey respondents were unsure of if they signed this form, suggesting there is not enough knowledge related to this form. Additionally, OER surveyed stakeholders for recommendations to the consumer disclosure form. The survey found specific fields were recommended to be updated to create better transparency with consumers and installers.

6. Conclusions and Recommendations

Natural Power noted trends in the results of the survey, and from inspections as of October 2021. Several recommendations have been noted in the following sections from high priority to low priority based on the timeline these recommendations should be completed. High priority recommendations are recommended to be completed as soon as possible, and medium priority recommendations are recommended to be completed within six-months to a year. Figure 6.1 outlines the priorities and the timeline the recommendations should take place.

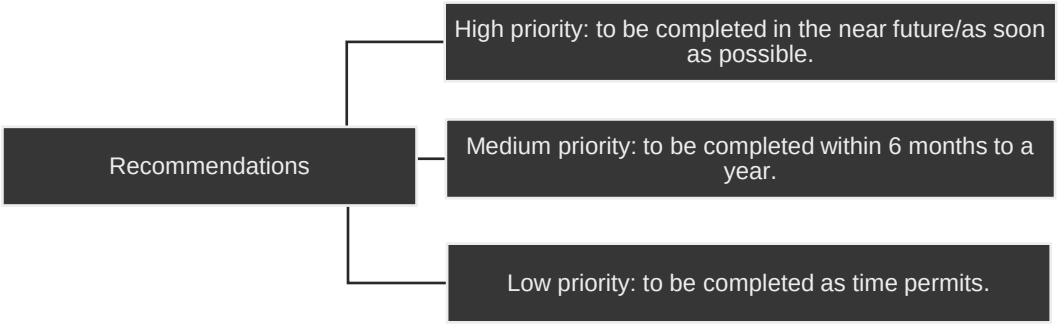


Figure 6.1: Recommendation Priorities and Timeline

6.1. High-Priority Recommendations

6.1.1. Installer Training

From the results of the inspections, Natural Power has noted several low-volume installers in the small-scale sample have lower quality scores as compared to the large volume installers. Natural Power recommends providing additional technical guidance and/or training session for these installers to raise awareness of this unique type of interconnection. As noted in prior studies, the grid connection for this program is very unconventional for a residential application and installers have minimal guidance with the electrical code requirements. Natural Power recommends creating a one-to-two-page guidance document outlining the grounding requirements specific to this program's grid connection for small scale installations. In addition, Natural Power recommends creating a 1-hour training session for installers, summarizing the study's findings, and outlining best-practices for small-scale installations.

6.2. Medium-Priority Recommendations

6.2.1. Continued Quality Assurance Studies

Based on study findings, Natural Power recommends the continuation of quality assurance studies for REG-funded renewable energy installations to further improve quality.

6.2.2. Small Scale and Storage Inspections

In future quality assurance studies, Natural Power recommends inspecting small scall solar and storage installations to ensure the safety, quality, and conformance of installations. A small sample of 6-8 installations is recommended to be inspected to collect enough data to understand typical deficiencies and areas in need of improvement.

6.2.3. Enhance Program Knowledge

As the consumer disclosure form creates transparency of REG payments and performance, further improvements to REG participant knowledge of this form would help to improve the expectations of payments and performance.

The Quality Assurance Survey found 47% of participants would like to be provided a contact list of who to contact when issues occur, 28% of participants would like to have a frequently asked questions forum or report to help solve common issues, 12% of respondents would like to have an online community to talk to other REG participants, 11% are content with the status of the REG program, and 2% provided additional responses requesting info on storage and pricing. In addition, several free response answers noted the participants were unsure and unable to contact anyone to obtain information or have questions answered. Based on these responses, Natural Power recommends creating an information center for REG participants to find contact information, frequently asked questions, and additional resources on the OER website. In this information center additional information on the consumer disclosure form could be provided to help improve participant knowledge.

In addition, the “Array Production %” field in the consumer disclosure form is recommended to be changed to “Array efficiency % (TSRF)”. This inclusion will aid in understanding the shading and orientation of individual arrays, and the impact it may have on production.

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