Business & Technology Report

**June 2021**

# Guidebook for Rapid Solar Interconnection

NRECA

America's Electric Cooperatives

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# Guidebook for Rapid Solar Interconnection


Prepared By:

**National Rural Electric Cooperative Association Research**

**Jan Ahlen, Director – Energy Solutions, Business and Technology Strategies**
**David Pinney, Principal – Analytics Tools & Software, Business and Technology Strategies**

Contact:

**NRECA**

**David Pinney**
Principal – Analytics Tools & Software
Business and Technology Strategies
David.Pinney@nreca.coop

Business and Technology Strategies
www.cooperative.com/bts




NRECA
America's Electric Cooperatives

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# Introduction

NRECA represents more than 900 rural electric utilities responsible for keeping the lights on for more than 42 million people across 48 states. America's Electric Cooperatives serve 56 percent of the nation's landmass, 88 percent of all counties, and 12 percent of the nation's electric customers, while accounting for approximately 11 percent of all electric energy sold in the United States.

Electric cooperatives have seen strong growth in solar power over the past several years, as shown in Figure 1.

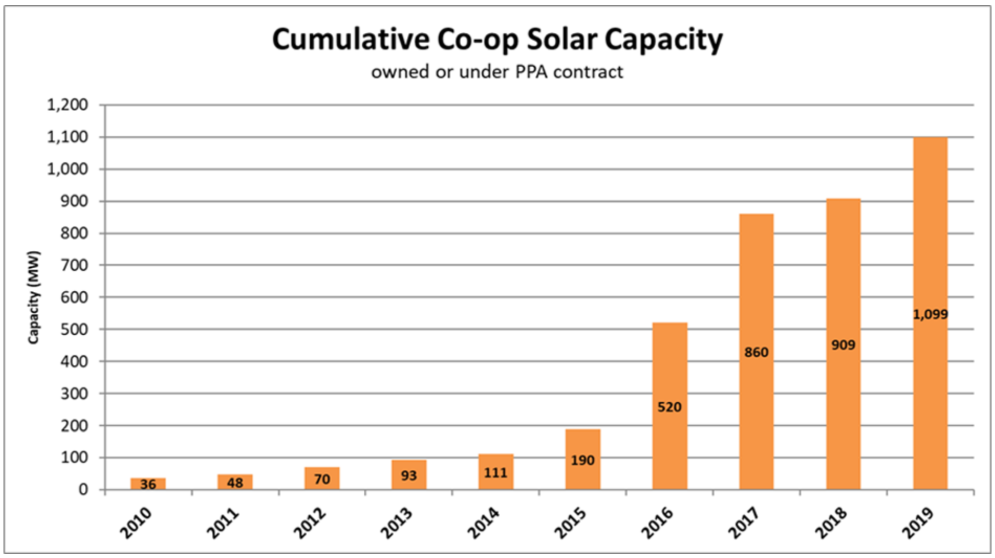


**Figure 1: Electric Cooperative Solar Growth**

In addition, of all renewable energy sources, solar is poised to have the fastest growth. While wind energy has seen the most growth over the past decade, solar is set to take over and expand greatly over the next several years (see Figure 2). In particular, behind-the-meter solar installations have grown significantly over the past several years, as consumer preferences continue to evolve and solar PV installation costs fall.

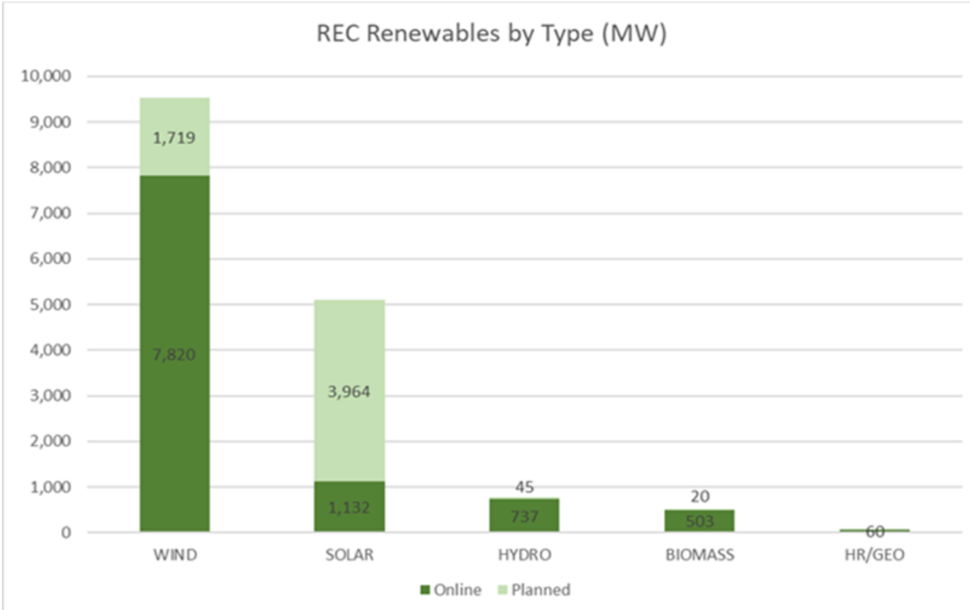


**Figure 2: Current and Future Renewable Energy Deployments by Type**

As not-for-profit consumer-owned utilities, electric cooperatives are responsive to their consumer-members' increased desire for solar power. However, many electric cooperatives have small staffs and are sometimes inundated with solar interconnection requests. The small staff size and increasing number of requests makes it difficult for some electric cooperatives to process the requests in a timely manner. Current interconnection practices are labor intensive and require a lot of time by electric cooperative staff to process the interconnection requests. In addition, existing solutions to automate and speed up interconnections are expensive and difficult to use.

The following guidebook provides electric cooperatives and other utilities with an approach to automate the solar interconnection process. The guidebook is a companion to the open-source software tool R3IT that is available on github.com/dpinney/r3it. This tool may be utilized by utilities to automate solar interconnections. As a result, solar interconnections can be made safely, reliably, and more affordably.

The guidebook also details how to communicate the solar program to consumers. Five electric cooperatives are highlighted as examples of electric cooperatives who have successfully implemented rapid and comprehensive interconnection programs.

# Acknowledgements

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Significant contributions for this report were made by the staff of Jo-Carroll Energy, Kauai Island Utility Cooperative, Rappahannock Electric Cooperative, Tri-County Electric Cooperative of Texas, and Northeast Oklahoma Electric Cooperative. We would like to thank these electric cooperatives for sharing their experiences and ideas.

# Key Technical Policies and Procedures

There are several key technical policies and procedures to consider between the time a customer submits an interconnection request until the interconnection request is authorized and the solar PV system is installed. This section provides an overview of the interconnection workflow steps, as well as a discussion of relevant technical engineering standards of particular importance to interconnecting solar PV systems.

## Interconnection Workflow Steps

The following is a high-level overview of the steps needed to complete an interconnection request of a typical residential solar PV system that is less than or equal to 10 kW.

1. **Customer submits Interconnection Request and submits it to the utility.**
2. **Utility acknowledges receipt of Interconnection Request.**
3. **Utility evaluates the Request for Completeness**. Following this, the utility would notify the customer if it is complete or if the customer needs to provide any additional information.
4. **Utility evaluates the Interconnection Request** and approves the Request unless the Interconnection request cannot be made safely or reliably.
5. **The utility verifies that the solar PV can be interconnected safely and reliably**. Unless the utility can prove that it cannot connect the solar PV safely and reliably, the utility approves the application.
6. After installation, the **Customer returns the Certificate of Completion.**
7. **The utility notifies the customer in writing that interconnection is authorized.**

## Discussion of Relevant Standards

Several technical and regulatory standards pertain to interconnecting solar PV systems. Some standards are required while others are recommendations. The following are highlights of important standards. A full list of relevant standards appears in the Additional Resources section at the end of this report.

### *IEEE 1547*

The IEEE 1547 standard deals exclusively with the requirements for interconnecting distributed energy resources (DER) with electric power systems. In 2019, updates and revisions to the original 2003 standard were finalized and published in IEEE 1547-2018. More information on this new standard can be found in the Additional Resources section. In addition, Utilities can also use the *IEEE Guide for*

*Conducting Distribution Impact Studies for Distributed Resource Interconnection* for additional guidance.

***FERC Small Generator Interconnection Procedure (SGIP)***

FERC SGIP is a crucial standards framework for interconnecting solar PV. For instance, FERC SGIP suggests the specific time it should take to complete various steps in the interconnection workflow. More specific information about the timing, including links, can be found in the Additional Resources section.

***UL1741***

This standard ("Inverters, Converters, and Controllers for Use in Independent Power Systems") addresses the electrical interconnection design of various forms of generating equipment. Many manufacturers submit their equipment to a Nationally Recognized Testing Laboratory (NRTL) that verifies compliance with UL1741. This "listing" then is marked on the equipment and supporting documentation.

# Automation Software

As part of work supported by the Department of Energy, NRECA has developed a software application that automates the steps of the utility interconnection workflow. Besides collecting the paperwork involved with interconnection requests and managing the interconnection queue, the application also automates the engineering screenings required to ensure safe interconnection. A demonstration version of the application is available at https://demo.r3it.ghw.io/, and the software is available for installation as a free, open-source application at https://github.com/dpinney/r3it.

Small and medium-sized utilities, primarily rural electric cooperatives (co-ops) and municipals (munis), are beginning to see high volumes of small-scale solar interconnection requests (1 to 2 times per day). These requests are time-consuming and costly to field, and interconnection costs must be fairly recovered. The goal of this application is to reduce the time, cost and uncertainty involved in the interconnection process, while better serving the consumer. The current interconnection processes are manual and paper intensive. Furthermore, many small utilities do not have engineers on-staff and contract out the analysis on a per application basis. Manually driven paper-based processes and one-off engineering analysis, coupled with the communication overheads when coordinating multiple departments and the consumer, result in significant delays in the completion of interconnection applications.

Our software hopes to mitigate these time-intensive processes by providing a platform that facilitates:

- secure online application and document submission with encryption in transit and at rest;
- role-based access control for document access and approval;
- online authorization with agreement checkbox and electronic, typed signature;
- automatic tracking of the application through the interconnection process;
- email notifications that automatically inform everyone of the application status and action items;
- secure automatic payment collections through Stripe;
- automated the engineering analysis on the interconnection queue; and
- detailed reporting of the engineering analysis for the engineers.

The software process and the automated screens are informed by the FERC Small Generator Interconnection Procedures (SGIP) fast-track process and the Solar Utility Network Deployment Acceleration (SUNDA) project to create a general tool that would be useful to most utilities. The tool maintains a power-flow model and runs simulations using Gridlab-D to check for voltage, flicker, thermal, reverse power flow, tap change, and fault current violations. The models are updated automatically at the acceptance or withdrawal of an application.

Utilities have distinct application needs and unique state compliance requirements and, thus, the following aspects of R3IT are easily configurable via a single file: screen violation thresholds; the utility branding in the tool; the interconnection application processing work-flow; whether to require manual approval in addition to, or in lieu of, the automated engineering screenings; role assignment and role-based permissions; security (e.g. TLS certificates); correspondence email address; and debug logging locations. R3IT is also built with deployment flexibility in mind and, thus, can be deployed as a cloud-hosted tool or on-premises.

## Landing Page

The landing page of the tool provides options for a user to register an account or log in to an existing account. The background image, the utility logo, and the text on the landing page are all easily configurable. Coop members can register for accounts for the site and login securely.

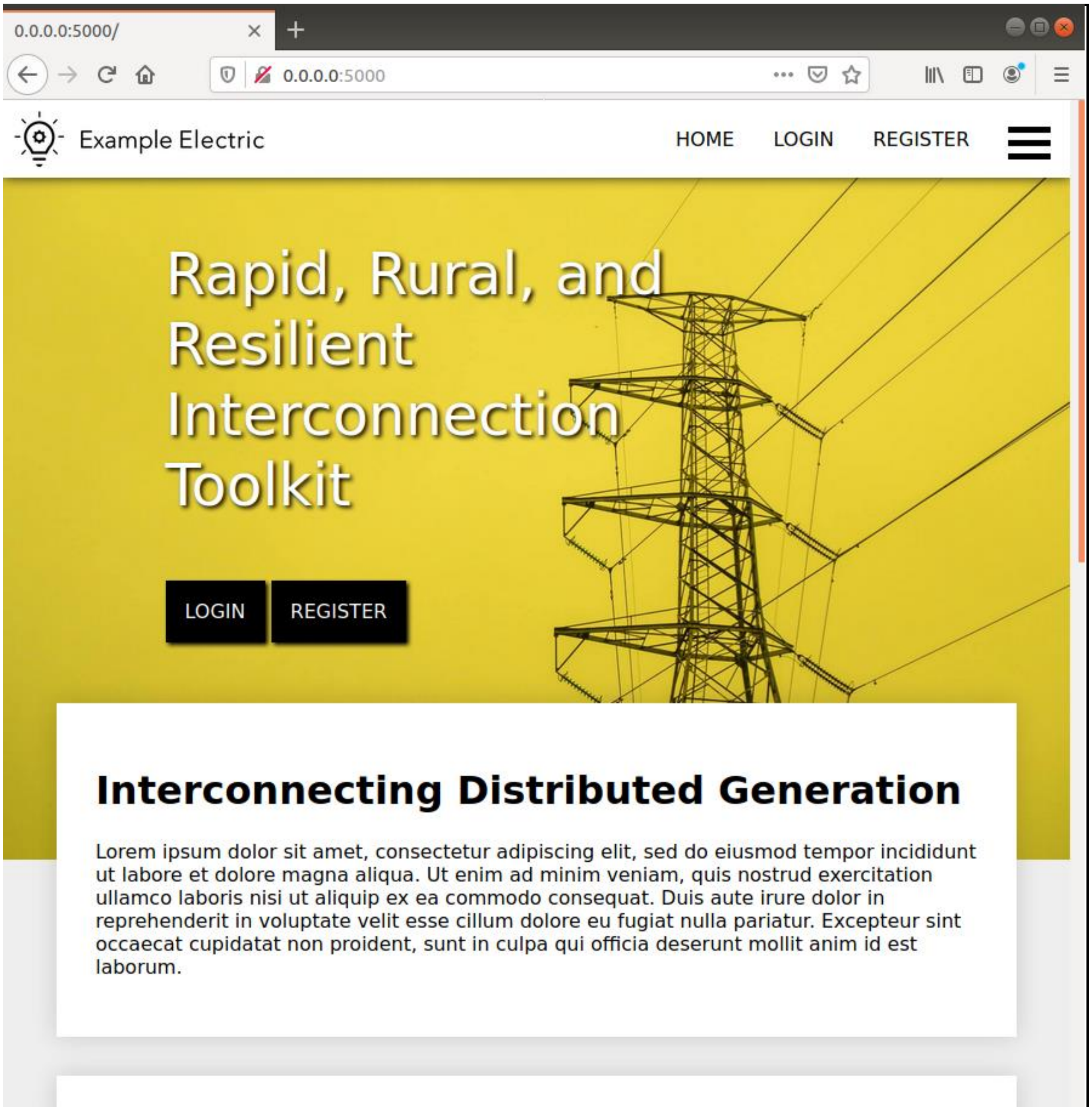


**Figure 3: Landing Page Showing Login and Register Options**

## Application Dashboard

Upon logging in, users are taken to the application dashboard. From the dashboard, users can see the available net metering capacity at their utility, apply for a new interconnection, see any applications that require their action and see all previously submitted applications.

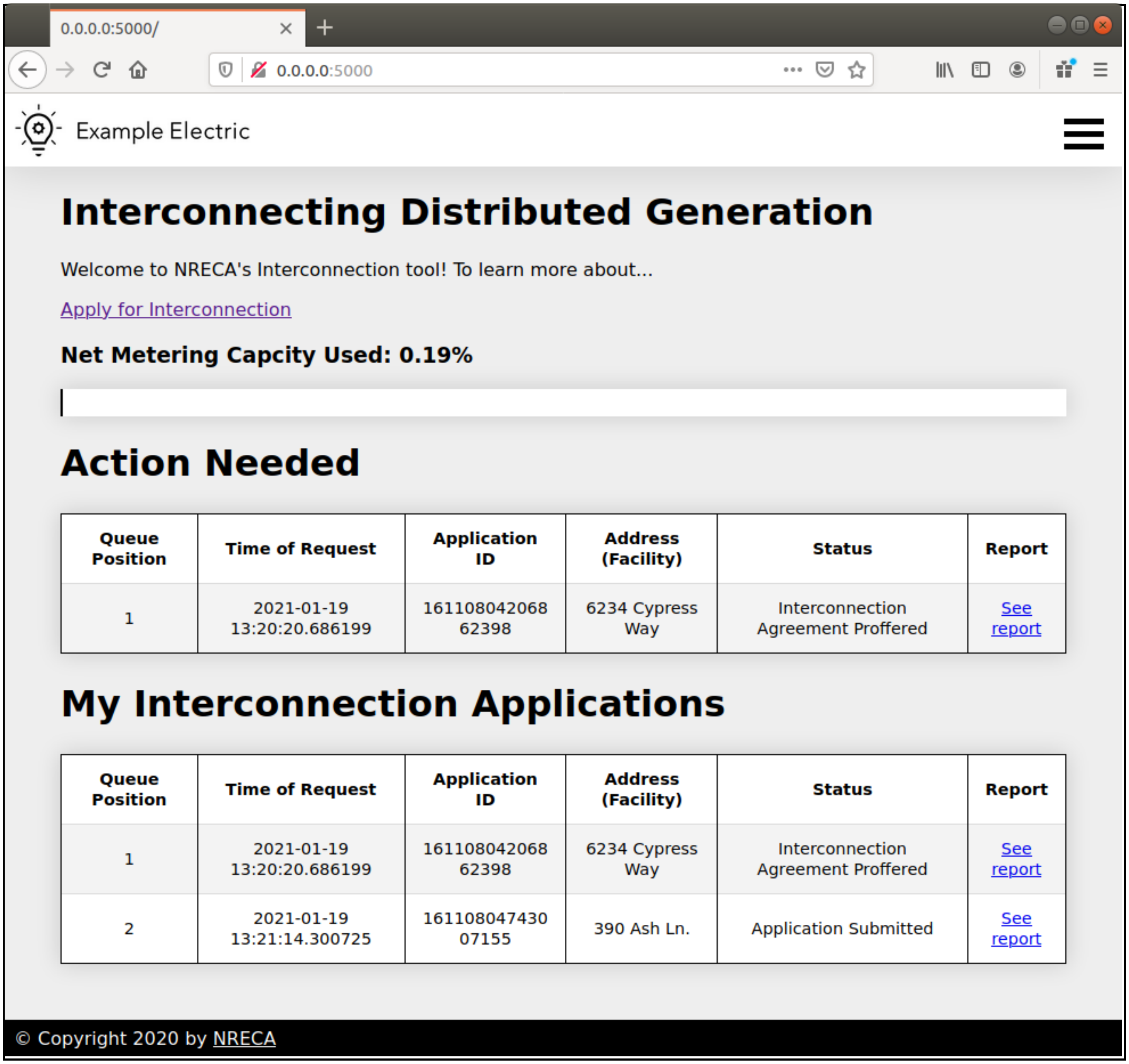


**Figure 4: Application Dashboard**

## New Interconnection Application

Users can click on the 'Apply for Interconnection' button in the user dashboard to submit a new application. See Figure 5. The application asks for information about the consumer, the installer, and the installation itself, as well as for an electronic signature.

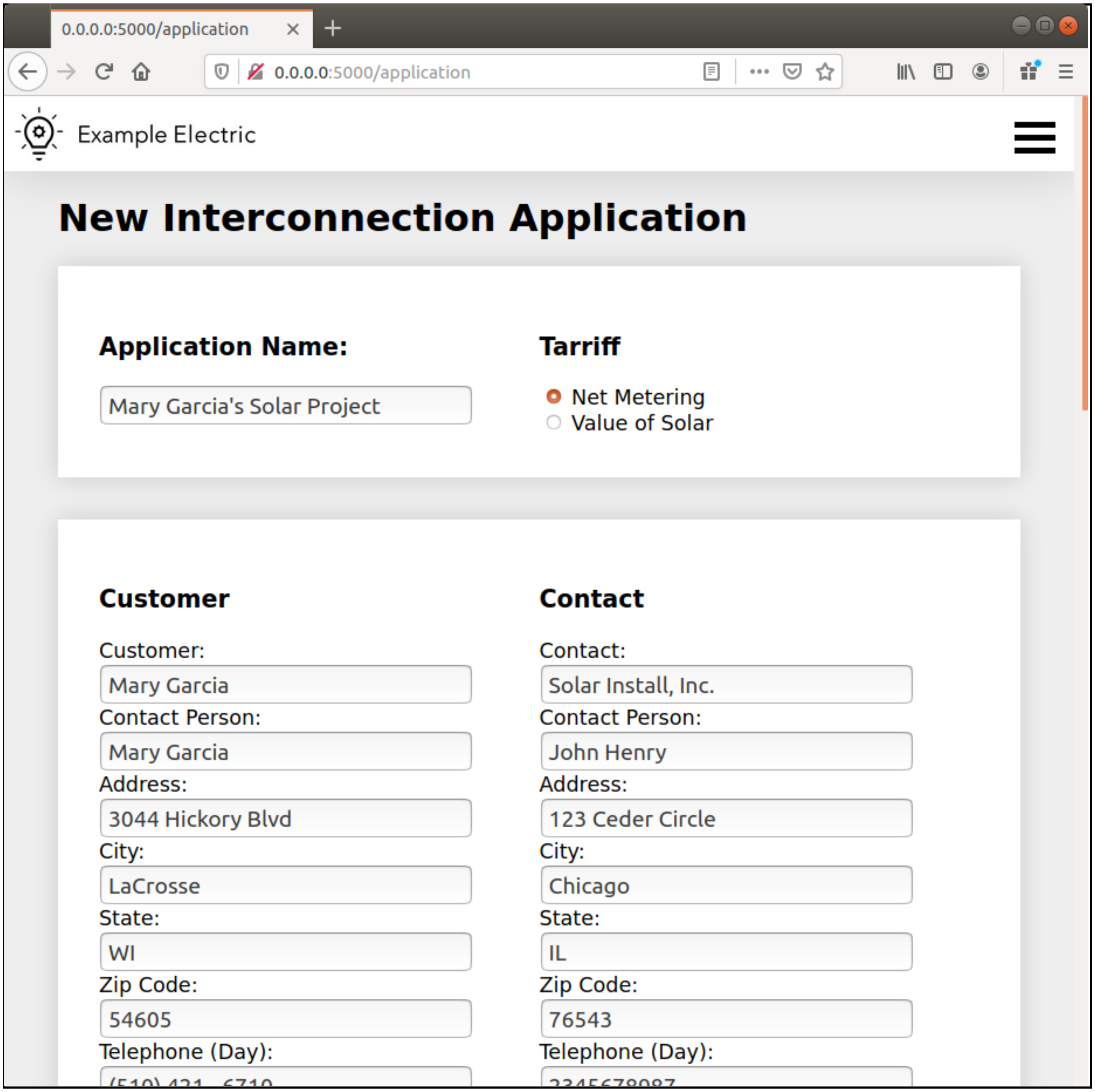


**Figure 5: User Dashboard Screen for Submitting an Application**

## User Report View

By clicking on the ‘report’ button for any application in the user dashboard, users can get more detailed information about that application, as well as upload any required documents, see the results of the automated screens, and withdraw their application.

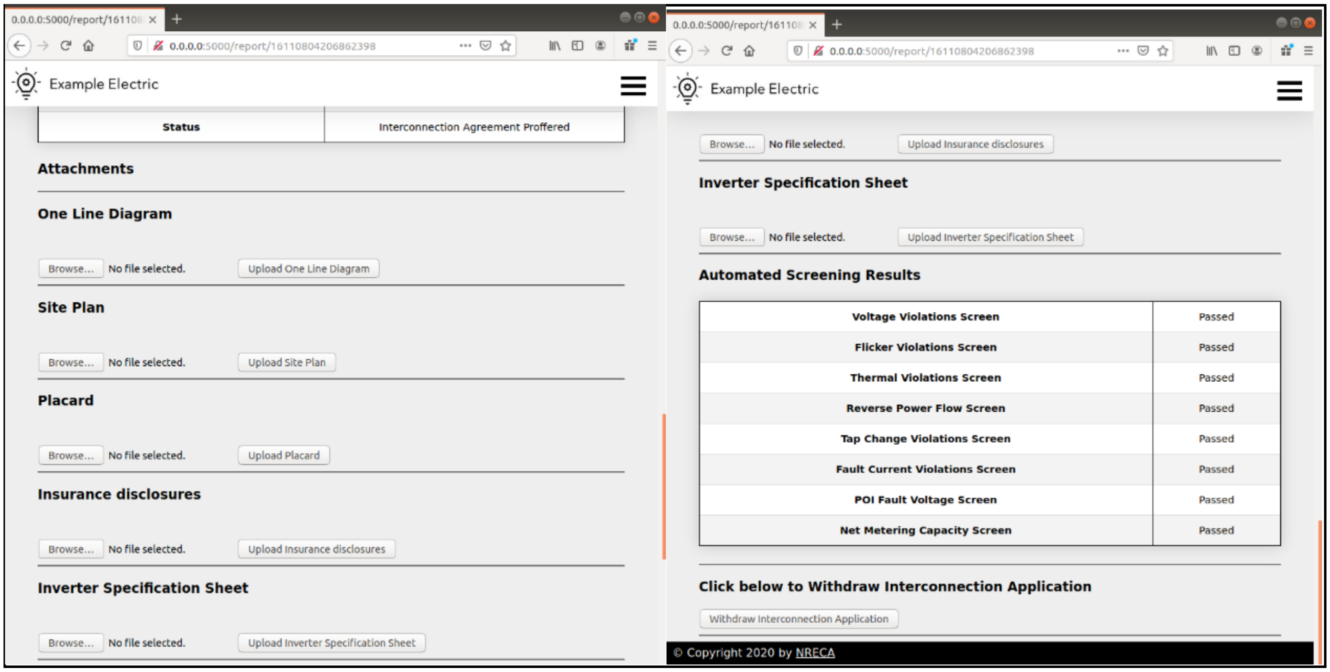


**Figure 6: User Dashboard Screen with Detailed Information about an Application**

## Engineer Dashboard

R3IT utilizes role-based access control, thus upon logging in, the role of the users is evaluated and if certain users are specified as engineers in the tool configuration, they are taken to the engineer view of the application dashboard. See Figure 7. The engineer view is similar to the consumer view except that a consumer account with no special role can only see applications that pertain to their user account, whereas the engineer can see all applications in the queue. The engineer can also see a one-line diagram of the overall system on which the analysis is performed.

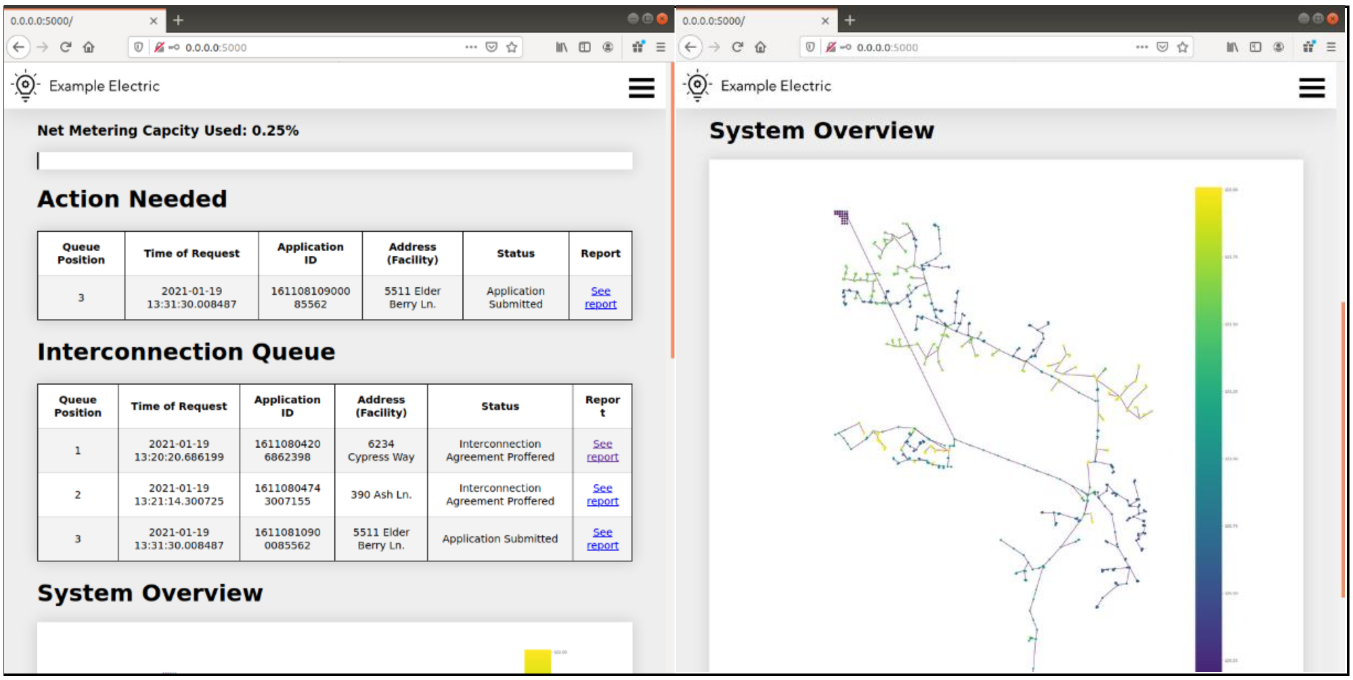


**Figure 7: Engineer View of Application Dashboard**

## Engineer Report View

The accounts with engineer roles also have a different report view. See Figure 8. In addition to all of the information provided to the consumers, the engineer can also see detailed tables with the outputs of the engineering screens and options to manually update the application status.

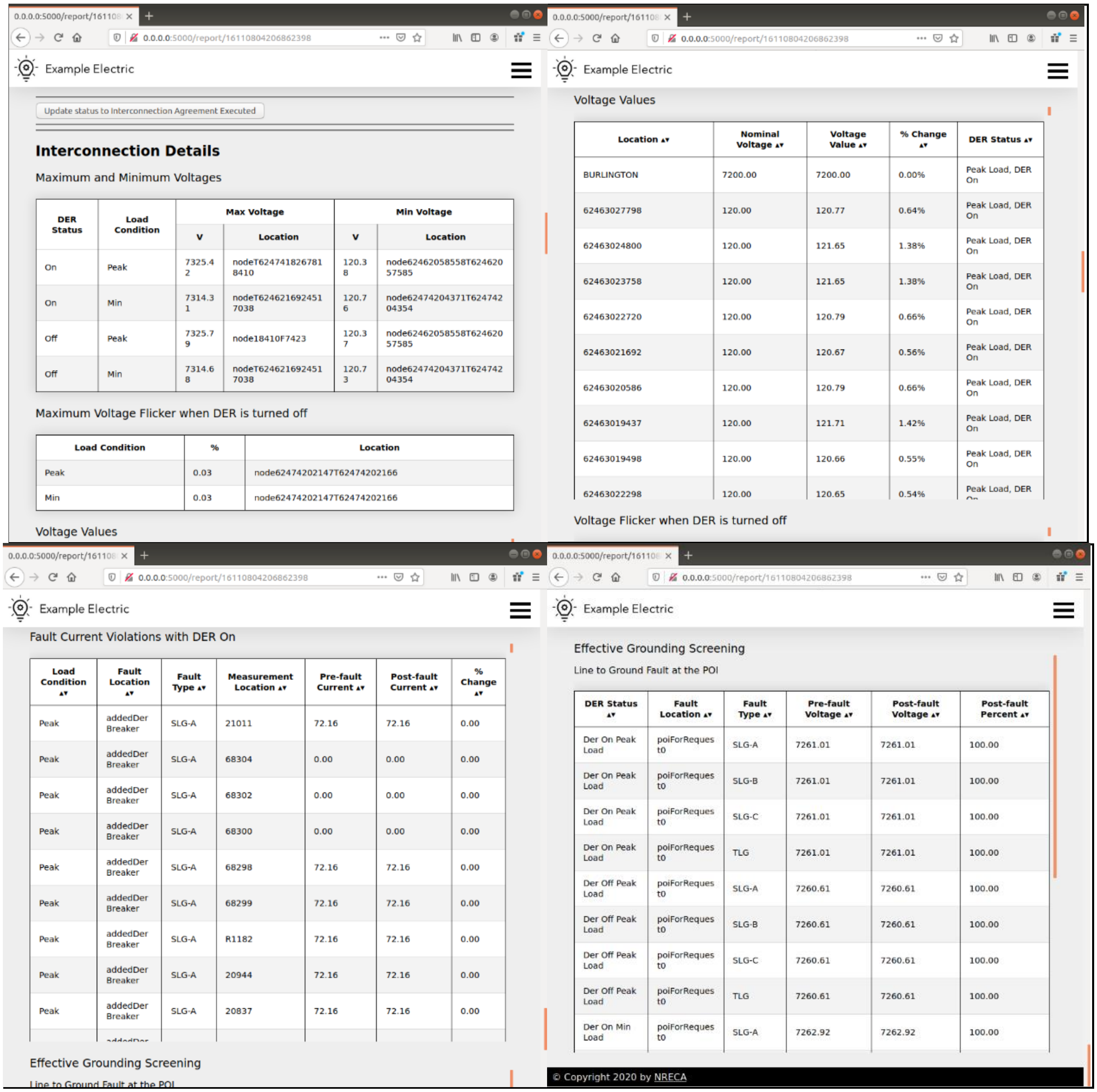


**Figure 8: Report Details withing the Engineer View**

# Communication Strategies for Consumers

There are various strategies that utilities can utilize to communicate and market solar offerings to their customers. However, it is important to note that there is no one-size-fits-all strategy for every utility. Each utility should decide for itself which communications options fit the unique circumstances of the consumers they serve. Demographics, access to reliable internet, and other factors are important to take into account.

While there is no perfect communications strategy for every utility, there are several overarching key steps and best practices that are applicable across the board. The following are steps that should be considered in creating and executing a communications plan that focuses on behind-the-meter solar installations.

## 1. Have a Goal in Mind

The first step in any communications strategy is to develop a goal for the program. What are you trying to achieve and what is the purpose? It is helpful for the goal to be SMART:

- **S**pecific,
- **M**easurable,
- **A**chievable,
- **R**elevant, and
- **T**ime Bound.

For instance, instead of having the goal be "market the solar program to the membership," make sure the goal fits the SMART framework:

- **Specific**: "Membership" – Members most likely to adopt solar PV based on market analysis.
- **Measurable**: The effectiveness of the communications program will be measured by the growth of residential solar installations and downloads of relevant documents on the utility website.
- **Achievable**: The goal should be realistic and attainable.
- **Relevant**: The goal should be results-based and fit into the utility's strategic plan.
- **Time Bound**: The goal should be achieved by a certain date.

Our original goal of "market the solar program to the membership" could then be changed to "through various communications and marketing strategies, increase the growth rate of solar adoption among consumers most likely to adopt solar by 50% by the end of 2021."

Once a SMART goal has been established, we can move to the next step.

## 2. Gather Data and Information

The first step in any communications strategy is to understand your target audience.

*Identify Key Audiences*

A communications plan should include a set of key audiences, both internal and external. Internal audiences include employees and board members. External audiences include a potential consumer Advisory Group, co-op members, legislative officials, and the media. Each of these groups is important. It is vital that internal audiences have an understanding of the program and are able to communicate it to utility consumers. Within the electric cooperative segment, electric cooperative staff are known in the community and interact regularly with community members on a day-to-day basis. An understanding of the program is vital in case a co-op employee has an ad-hoc conversation at the grocery store.

*Gauge Member Interest*

Before rolling out a new program or service, it is important to know the market. Market intelligence is vital when developing a communications plan. Market analysis can come in various forms. Surveying consumers is important, but a larger segmentation analysis may be more helpful in many situations.

Surveying utility consumers can glean a lot of valuable information. Topics to survey members could include:

- Level of interest in solar energy,
- Motivation for participation (saving money, environmental, "cool" factor, etc.), and
- Level of trust in the co-op as a trusted resource on solar energy.

The findings of the survey should inform who to target in the marketing strategy and how to target them.

For utilities looking to conduct more granular analysis, a consumer segmentation analysis may be appropriate. Electric cooperatives who have utilized consumer segmentation show that investment in tools and techniques to deepen understanding of consumer needs and preferences can pay off in increased levels of engagement, including higher participation in co-op offerings. Utilities have access to a lot of consumer data. Combining this data with consumer surveys could provide intelligence that, with the right design, can be used to understand and then connect consumers to the utility in new and dynamic ways.

**Cobb EMC Demonstrates Effective Consumer Segmentation**

An example of effective consumer segmentation comes from Cobb EMC, an electric cooperative serving more than 200,000 members in a fast-growing area outside of Atlanta. Cobb EMC had been utilizing traditional communications and marketing techniques – including newsletters, media placements, and bill stuffers – to connect with members and promote products and services. But, the outreach was not producing results, as evidenced by a disappointing 18 percent open rate on emails.

Cobb EMC used segmentation techniques to build a detailed understanding of its members. The cooperative combined household demographic data with information from its own consumer surveys, and ACSI and J.D. Powers consumer satisfaction responses. Using consumer segments, Cobb EMC divided its members into 13 distinct "personas." Each persona represents a distinct grouping of consumers based on factors such as household size and makeup, income, spending preferences, media habits, and attitudes about energy and the environment. Cobb EMC uses the segmentation information to design products and services of the greatest value and relevance to its membership. Cobb EMC turned the information into an actionable database for targeted member communications. Cobb now can direct information about a new service such as its EV rate, to the segments of its membership that will be most receptive. As a result, email open rates in 2019 have risen to as high as 78 percent.

## 3. Develop Communications Timeline

The communications timeline should include when to disseminate materials to employees, board members, consumers, and other stakeholders. A timeline is important, so that the communications plan meets the established deadline.

- Board members and employees should be prepared to have conversations with consumers in the community and provide those consumers with information they want and need about the program. The timeline should include a deadline for producing those materials.

- Consumers should receive information at least three times using an array of channels. The timeline should include when consumers should receive the message through different methods (ex: bill insert, Facebook post, website, etc.).

- External stakeholders (media, public officials, civic organizations) should be engaged in a different way. Public officials should be engaged individually. Local community events, such as state fairs, are an excellent avenue to get the message out.

## 4. Create Materials

Communications and marketing messages and materials should be developed in line with project objectives and in collaboration with key stakeholders (Board of Directors, managers, consumer advisory group, etc).

- **Develop Key Messages**

  Key messages in the marketing material should be developed with the help of the consumer survey and/or consumer segmentation analysis. Depending on the granularity of the results, messages may be different depending on the consumer segment. For instance, consumers who identify as "green" may receive messages surrounding the environmental sustainability of solar PV, while an older demographic on a fixed income may be more persuaded by the stable monthly cost of solar PV.

- **Develop Materials**

  There are various options for delivering a marketing message. The options should be considered against the likelihood that the target audience will receive the message. In other words, utilities should try to meet their audience where they are. Examples of materials and platforms include:

  - Mail
  - Social media
  - Brochures
  - FAQ sheet
  - Dedicated webpage on utility website
  - Yard signs
  - Town halls (in-person or virtual)
  - Annual Meeting

## 5. Execute Plan

The execution phase is when the utility launches the communications and marketing program by integrating the previous steps. During this phase, materials should be produced and messages distributed to the primary audience. Communication should be sustained beyond the initial communications launched and the utility should engage with the media.

- Internal project launch (board, employees)
  - Board presentation
  - Employee presentation
  - Member services training
  - Marketing materials such as brochures, pocket cards, etc.

- Consumer communications/marketing
  - Project announcement (6-9 months)

    *First wave of communication to consumer members announcing the project*

    - Create community solar webpage
    - Disseminate FAQs
    - Introduce project branding
  - Targeted outreach (3-6 months)

    *Robust dissemination of information via newsletters, social channels and – most important – through in-person outreach at meetings and events*

    - Dissemination through co-op channels, including social media
    - Dissemination through community meetings and events
    - Paid advertising
    - Sponsorship advertising (sponsor the local weather – on sunny days)
  - Publicity: Press release announcing the program

## 6. Evaluate Plan

Following the execution of the communications plan, it is important to evaluate the results and compare them to the original goal. The evaluation can help inform future communications campaigns.

During the evaluation phase, the utility may want to consider a post-project survey about the satisfaction with the program. Also, it is helpful to create a log of all phone and email inquiries regarding the program. Externally, it is good to track media coverage. Finally, it is important to compile relevant data regarding the success of the program.

# Utility Success Stories

Many electric cooperatives are experiencing significant numbers of solar interconnection requests. As solar PV modules and installations become cheaper, it is likely that an increasing number of electric cooperative consumer-members will want to install solar PV systems. Each electric cooperative is unique in terms of their consumer-member demographics, system characteristics, internal processes, tariffs, personnel, and compliance restrictions. As such, each electric cooperative should decide for themselves which solar interconnection processes are suitable for their unique circumstance. However, when developing a solar strategy, it is often helpful to learn about the experiences of other electric cooperatives. The following are examples of electric cooperatives who have implemented strategies to process large numbers of solar interconnection requests.

## ➢ Kaua'i Island Utility Cooperative (KIUC)

Kaua'i Island Utility Cooperative (KIUC) is an electric cooperative serving the island of Kaua'i in Hawaii. The cooperative has been experiencing significant numbers of solar interconnection requests from its consumer-members. The popularity of solar PV on the island is due to a number of factors, including high power prices and declining costs of solar PV. KIUC has been a leader in solar deployments, for both on-site solar installations by consumers and utility-scale systems. KIUC has a goal of supplying 70 percent of the island's electricity with renewable energy by 2030.

Kaua'i Island Utility Cooperative
Your Touchstone Energy® Cooperative

The number of interconnection requests fluctuates depending on the month, but KIUC averages between 10 and 20 interconnection requests per week, with an overall average of 10 requests per week. KIUC has a standard process for solar PV systems less than 10 kW and a 'fast track' process for systems between 10 kW and 2 MW. The total turnaround time for a standard request is 1 week or less, and the turnaround time for the 'fast track' process is about 2 weeks. In addition, the majority of solar interconnection requests include a battery storage system. They utilize the same process for solar-only requests as solar + battery requests. There is currently no automated process for approving interconnection requests. Instead, co-op staff aggregate the requests in a spreadsheet and then hand it off to an engineer who then performs the analysis and decides whether to approve the request, reject it, or ask for more information. Given that the co-op has a long history of handling interconnection requests, the co-op has streamlined the process and worked to reduce approval times.

KIUC's experience of rapid growth of solar PV provides an excellent example of how to handle the impact of significant solar PV penetration. The lessons learned from the KIUC experience can help guide other cooperatives as solar development becomes an increasingly significant contributor to the power supply portfolio.

## ➢ Jo-Carroll and Dairyland Power Cooperative

Jo-Carroll Energy is a distribution cooperative located in Illinois. It is a member of Dairyland Power Cooperative, a generation & transmission cooperative headquartered in Wisconsin. Due to consumer demand, Jo-Carroll owns a community solar system and has a significant amount of behind-the-meter solar PV systems at residential and commercial locations. They are also piloting residential battery storage systems that are owned and controlled by the co-op.

During the past year, they have received a lot of interconnection requests. Currently, the co-op is averaging around 10 interconnection requests per week. While there is a lot of interest in solar PV amongst its consumer-members, the majority of Jo-Carroll's interconnection requests come from developers instead of consumer-members.

Jo-Carroll will shortly begin utilizing the R3IT software tool to improve the interconnection process. It is assessing which features of the software tool are most helpful to integrate into their current interconnection process. Currently, Jo-Carroll does not have any automated review of applications and relies on manual engineering reviews. A critical step in their interconnection process is delegation of permissions from members to the solar installers.

The majority of the review process includes document analysis and engineering review. The R3IT software tool will be able to significantly cut down the application approval time. However, manual review of certain parts of the application is unavoidable, so the co-op is working to best incorporate the R3IT platform into the interconnection review process while maintaining some manual control. Some aspects of the assessment of the application are subjective. It is difficult, for example, for a software tool to correctly analyse a one-line diagram that was drawn by a solar installer.

Jo-Carroll currently has one interconnection queue for the entire co-op membership. CEO Mike Casper notes that, in the future, they would "like to simplify the process for the consumer-member by offering a-la-carte options, such as small DG (< 20 kW), community solar, as well as larger scale systems." This would ultimately make the process easier for the applicant, as well as help Jo-Carroll staff process the requests faster.

During Jo-Carroll's piloting of the software tool, they found that main applications for R3IT from their perspective include automating payments, collecting signatures, and sending email reminders. Interconnection applications require applicants to submit a fee which are collected through a payment processor. They are currently using the service, Stripe, and are also considering PayPal as a second option. Integrating this payment service into their online platform that includes R3IT software would improve and streamline the process.

Jo-Carroll takes consumer-member privacy seriously. All consumer-member documents required for interconnection applications are handled in a secure manner. The online portal system utilizes encryption in transit and at rest. It also includes role-based access control for document access and approval.

Finally, the online portal utilizes electronic signatures to verify the application. While they are currently simply requiring applicants to type their full name and submit the application, they are considering DocuSign integration to improve the process further.

## ➢ Rappahannock Electric Cooperative

Rappahannock Electric Cooperative (REC) is an electric distribution cooperative headquartered in Virginia. REC is one of the nation's largest electric cooperatives, serving 170,000 meters in 22 counties in Virginia. REC's power suppliers are Old Dominion Electric Cooperative (ODEC) and Southeastern Power Administration (SEPA). The large service territory includes both suburban and rural parts of Virginia. The co-op has a community solar offering for its consumer members and is experiencing increased demand for behind-the-meter solar PV systems. REC currently has over 1,000 net metering members and receives about 2 interconnection requests per day. In addition, they are starting to receive interconnection requests for battery storage systems. REC strives to position itself as a Trusted Energy Advisor for its consumer-members, and part of that includes interconnected solar PV systems. In order to reduce interconnection turnaround times, they are testing new methods and looking for "anything to make paperwork easier to handle," says REC's Peter Muhoro, Vice President of Strategy and Technology.

REC uses the Customer Information System (CIS), SmartHub from the National Information Solutions Cooperative (NISC), as an online service to their consumer-members. Consumer-members can log into their account and check their energy usage. Eventually, REC intends to integrate the process for applying for interconnections into this portal. This would improve service because consumer-members would only need one login. In addition, this would improve the relationship between the co-op and the consumer-member, since the co-op would be dealing directly with the consumer-member instead of the developer. Finally, REC is exploring whether to include a solar PV calculator on their website in order to help consumer-members make informed decisions and mitigate any confusion on payback periods from the net metering program.

The state of Virginia regulates the interconnection process, including timelines, and sets net metering rules for electric utilities. Because state laws change fairly frequently, REC is required to send informational packets on the laws to each net metered consumer-member. This can be time consuming and costly, so REC is exploring how to integrate the process into SmartHub.

Currently, REC's turnaround time for solar interconnection requests is impressively fast, but changes can be made to improve and speed up the process further. The overarching goal is to make it a better experience for the consumer-member. For example, they are exploring how to make the paperwork easier. However, state guidelines are very strict, so they cannot change the application form.

## ➢ Tri-County Electric Cooperative

Tri-County Electric Cooperative (TCEC) is an electric distribution cooperative in North Texas that serves over 120,000 meters over 16 counties and 9,420 miles of distribution lines. They receive 7 to 10 solar interconnection requests per week and have seen up to 20 requests on occasion. The number of requests has also increased since the February 2021 winter storm. The co-op has a dedicated webpage to solar which provides useful information to educate potential consumer-member solar adopters, including a cost calculator and an easily understood manual to help in the interconnection process.

TCEC uses a laserfish forms workflow that is integrated with the Customer Information System (CIS). The majority of applications are filed by the solar vendor. Consumer-members are now included in all correspondence to minimize any communications errors.

TCEC is exploring whether to incorporate a portal view after viewing the R3IT tutorial. They are comfortable with their existing process, but like the idea of having the applicant be able to see their application and edit it if they wish. Good feedback on R3IT was given by TCEC. For instance, the idea of reducing the number of logins between the applicant and the solar vendor was suggested.

## ➢ Northeast Oklahoma Electric Cooperative

Northeast Oklahoma Electric Cooperative (NOEC) serves 38,000 meters over 5,000 miles of distribution lines in northeast Oklahoma. NOEC has received 113 total applications for solar PV interconnection with 14 currently in the queue. They receive around 1 application per week, but NOEC staff has noticed that those numbers have increased. Applications can not exceed 125 percent of peak load for each consumer-member and cannon exceed 300 kW.

NOEC is currently analyzing improvements to its solar interconnection process. NOEC currently receives interconnection requests through phone calls into the office. The co-op then sends the applicant relevant information and requirements. Once the application is completed and sent back to NOEC, the co-op conducts an on-site inspection. While this approach is sufficient as interconnection requests are relatively low, an increase may necessitate a more efficient approach. Similar to other co-ops, NOEC wants to ensure that the co-op consumer-member is included in communications between the solar vendor and the co-op. NOEC is currently exploring the R3IT program and will be testing it internally to streamline solar PV interconnection requests

# Appendix

**Certification Codes and Standards**

IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems (including use of IEEE 1547.1 testing protocols to establish conformity).

UL 1741 Inverters, Converters, and Controllers for Use in Independent Power Systems IEEE Standard 929-2000, IEEE Recommended Practice for Utility Interface of Photovoltaic (PV) Systems

NFPA 70 (2002), National Electrical Code

IEEE Standard C37.90.1-1989 (R1994), IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems

IEEE Standard C37.90.2 (1995), IEEE Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers

IEEE Standard C37.108-1989 (R2002), IEEE Guide for the Protection of Network Transformers

IEEE Standard C57.12.44-2000, IEEE Standard Requirements for Secondary Network Protectors

IEEE Standard C62.41.2-2002, IEEE Recommended Practice on Characterization of Surges in Low Voltage (1000V and Less) AC Power Circuits

IEEE Standard C62.45-1992 (R2002), IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits

ANSI C84.1-1995 Electric Power Systems and Equipment – Voltage Ratings (60 Hertz)

IEEE Standard 100-2000, IEEE Standard Dictionary of Electrical and Electronic Terms

NEMA MG 1-1998, Motors and Small Resources, Revision 3

IEEE Standard 519-1992, IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

NEMA MG 1-2003 (Rev 2004), Motors and Generators, Revision 1

# Additional Resources

## SUNDA Project

Materials from the Solar Utility Network Deployment Acceleration (SUNDA) project, which ran from September 2013 through April 2018, focus on helping to lower the barriers to entry for co-ops interested in owning solar PV.

These materials are based upon work supported by the Department of Energy National Energy Technology Laboratory. The project team with the help of the participating co-ops developed a number of tools and resources that help cooperatives get up-to-speed on solar. More information can be found at: https://www.cooperative.com/programs-services/bts/sunda-solar/Pages/default.aspx

## Distributed Generation Toolkit

NRECA created this DG toolkit to help electric co-ops address the legal, economic and technical issues raised by consumer-owned generation. These materials provide models and guidance that each co-op can adapt to its unique needs after consultation with management, legal counsel and system engineers. More information can be found at: https://www.cooperative.com/programs-services/bts/Pages/Distributed-Generation-Toolkit.aspx

## NRECA Guide to IEEE 1547-2018 Standard for DER Interconnections

IEEE standard 1547-2003 governing distributed energy resources (DER) interconnections was written focusing on ensuring that DER did not interfere with the normal operation of the distribution system's regulation and protection systems. Now that growth in DER is having a significant impact on systems, IEEE 1547-2018 was developed to ensure Bulk Power System (BPS) dynamic and transient stability.

This Guide helps explain the changes and new features in the 1547-2018 standard and associated effects on cooperatives. More information can be found at: https://www.cooperative.com/topics/transmission-distribution/Pages/NRECA-Guide-to-IEEE-1547-2018-Standard-for-DER-Interconnections.aspx

For additional questions on the IEEE 1547-2018, please contact Robert.Harris@NRECA.coop.