Karla M. Corpus
Senior Counsel
NY Regulatory

March 22, 2019

VIA ELECTRONIC DELIVERY

Honorable Kathleen H. Burgess
Secretary
New York State Public Service Commission
Three Empire State Plaza, 19th Floor
Albany, New York 12223-1350

RE: Case 14-M-0101 – Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision (REV)

NIAGARA MOHAWK POWER CORPORATION d/b/a NATIONAL GRID: FRUIT BELT NEIGHBORHOOD SOLAR REV DEMONSTRATION PROJECT – FINAL REPORT

Dear Secretary Burgess:

Niagara Mohawk Power Corporation d/b/a National Grid ("National Grid") hereby submits for filing its Final Report for the Fruit Belt Neighborhood Solar REV Demonstration Project, as required by the REV Demonstration Project Assessment Report filed by the New York State Department of Public Service Staff ("Staff") with the Commission on December 2, 2015 in Case 14-M-0101.

Please direct any questions regarding this filing to:

Anntonette Alberti
Manager, Complex Demo
National Grid
1125 Broadway
Albany, NY 12204
Tel.: 518-433-5213
Mobile: 518-369-2100
Email: anntonette.alberti@nationalgrid.com

Respectfully submitted,

/s/ Kara M. Corpus

Karla M. Corpus
Senior Counsel

Enc.

cc: Tammy Mitchell, DPS Staff, w/enclosure (via electronic mail)
Marco Padula, DPS Staff, w/enclosure (via electronic mail)
Denise Gerbsch, DPS Staff, w/enclosure (via electronic mail)
Michael Summa, DPS Staff, w/enclosure (via electronic mail)
Melanie Littlejohn, w/enclosure (via electronic mail)
Cathy Hughto-Delzer, w/enclosure (via electronic mail)
Anntonette Alberti, w/enclosure (via electronic mail)
Carlos Nouel, w/enclosure (via electronic mail)
Fouad Dagher, w/enclosure (via electronic mail)
Jonathan Nickerson, w/enclosure (via electronic mail)
Pamela I. Echenique, w/enclosure (via electronic mail)
Carol Teixeira, w/enclosure (via electronic mail)
Jason Eno, w/enclosure (via electronic mail)
Janet Audunson, w/enclosure (via electronic mail)

Fruit Belt Neighborhood Solar
REV Demonstration Project
Buffalo, New York

Final Report

March 22, 2019

nationalgrid

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nationalgrid

Executive Summary

Niagara Mohawk Power Corporation d/b/a National Grid ("National Grid" or the "Company") led a team of partners to complete the Fruit Belt Neighborhood Solar Reforming the Energy Vision ("REV") Demonstration Project ("Demonstration Project" or "Project." Solar Liberty Energy Systems ("Solar Liberty") provided turnkey solar installation services. Additional support was provided by the New York State Energy Research and Development Authority ("NYSERDA") and the Buffalo Niagara Medical Campus ("BNMC"), and the Fruit Belt Coalition, Inc.

The low-to-moderate ("LMI") customer segment has a very low penetration of solar photovoltaic ("PV") systems due to economic barriers. This Project consisted of installing 74 rooftop solar PV systems totaling 500 kW of generation capacity within a single LMI neighborhood. Systems were installed on residential houses (69), faith-based non-profit organization buildings (3) and community non-profit buildings (2) located within the Project area. All solar PV systems were connected "in front of the meter," meaning the power generated goes directly into the distribution grid, not the home or structure hosting the PV system. The value of the power generated each month is divided equally among residential and faith-based solar PV system hosts (72) and a set of customers selected through a lottery system (58). Monthly bill credits will be distributed for twenty-five years; the expected solar PV systems' lifespan.

This Project also explored local grid efficiency impacts from concentrated solar PV generation. Additionally, the Project facilitated residential energy efficiency ("EE") by helping residents enroll in NYSERDA's EmPower New York ("EmPower") program. NYSERDA subsequently completed EE upgrades for 42 residential account holders located within the Project area.

This Demonstration Project tested two hypotheses. The first hypothesis postulated that providing solar bill credits to LMI neighborhood residents, as well as partnering with NYSERDA to deliver EE programs to further drive energy bill savings, would have a positive impact on bill payment behavior and enable customers to better manage their arrears. Arrearage data analysis showed the way this Project was structured did not prove or disprove this hypothesis. While this Project did not result in reduction of arrearages, it facilitated new ideas for how the Company might use bill credits to pay down arrearages in future programs.

The second hypotheses postulated that concentrating distributed solar PV resources with reactive power support in an area served by a common substation (versus scattered deployment of conventional solar PV) would deliver measurable grid efficiency benefits. The Project proved this hypothesis to be true, and also identified optimal power factor settings for the micro-inverters installed in the solar PV systems.

The Project determined that primary cost efficiency and scalability drivers include the existence, and successful engagement of local neighborhood groups operating within the a proposed Project area, such as block clubs, issue-based groups, and faith-based organizations.. Customer engagement cost efficiencies were further achieved by hiring local community organizations to conduct some outreach efforts, as organization members knew many of the residents.

This Project team attempted to recruit two Project area residents, utilize them to for Project installation, then graduate them to becoming full-time workers for the installation company. However, there was minimal interest from those residing in this particular neighborhood.

Overall LMI customer perception of renewables and energy efficiency was gauged through conversations during public meetings, neighborhood canvassing, and customer dialogue following Solar PV system installation. These efforts revealed a general interest in renewable energy, but a hesitance to become enrolled in this Project because of a fear of hidden costs. These dialogues also revealed only a partial familiarity with the concept of energy efficiency; it was more often considered in practical terms, such as ‘brighter lights’ and ‘less cold air in the basement’.

The Project has demonstrated how to make renewable energy accessible to an LMI community. It has also enhanced the customer-utility relationship for the solar PV host customers, and for the neighborhood as a whole, as evidenced by ongoing positive remarks Fruit Belt Coalition leadership offered at public meetings.

1.0 Synopsis of REV Project

1.1 Project Background

LMI customer segments in communities across New York State face economic barriers to using solar PV, including lack of capital/credit to purchase such systems and inability to use available incentives, such as tax credits, to offset installation costs. National Grid developed a REV demonstration Project to explore whether LMI customer interest in PV systems exists if the utility provided the system. Additionally, National Grid wanted to learn what, if any, grid efficiency benefits and costs result from concentrating solar PV in front of the meter on a neighborhood feeder.

1.2 Project Description

This Project consisted of installing utility-owned residential solar PV systems ranging in size from 3.1kW to 18.5kW, and non-profit organization solar PV systems ranging in size from 15.9 to 28.0 kW per system, totaling 500 kW (or 0.5 MW) of solar PV generation capacity within a single LMI neighborhood. This approach provided data used to explore the grid efficiency impacts resulting from concentrated solar PV generation on a single feeder. An additional Project component consisted of providing energy efficiency upgrades to residences located within the Project study area. This Project also explored the social aspects of building positive relationships within the Fruit Belt community as part of the effort to increase energy awareness and Project participation.

The following hypotheses were tested by this Project:

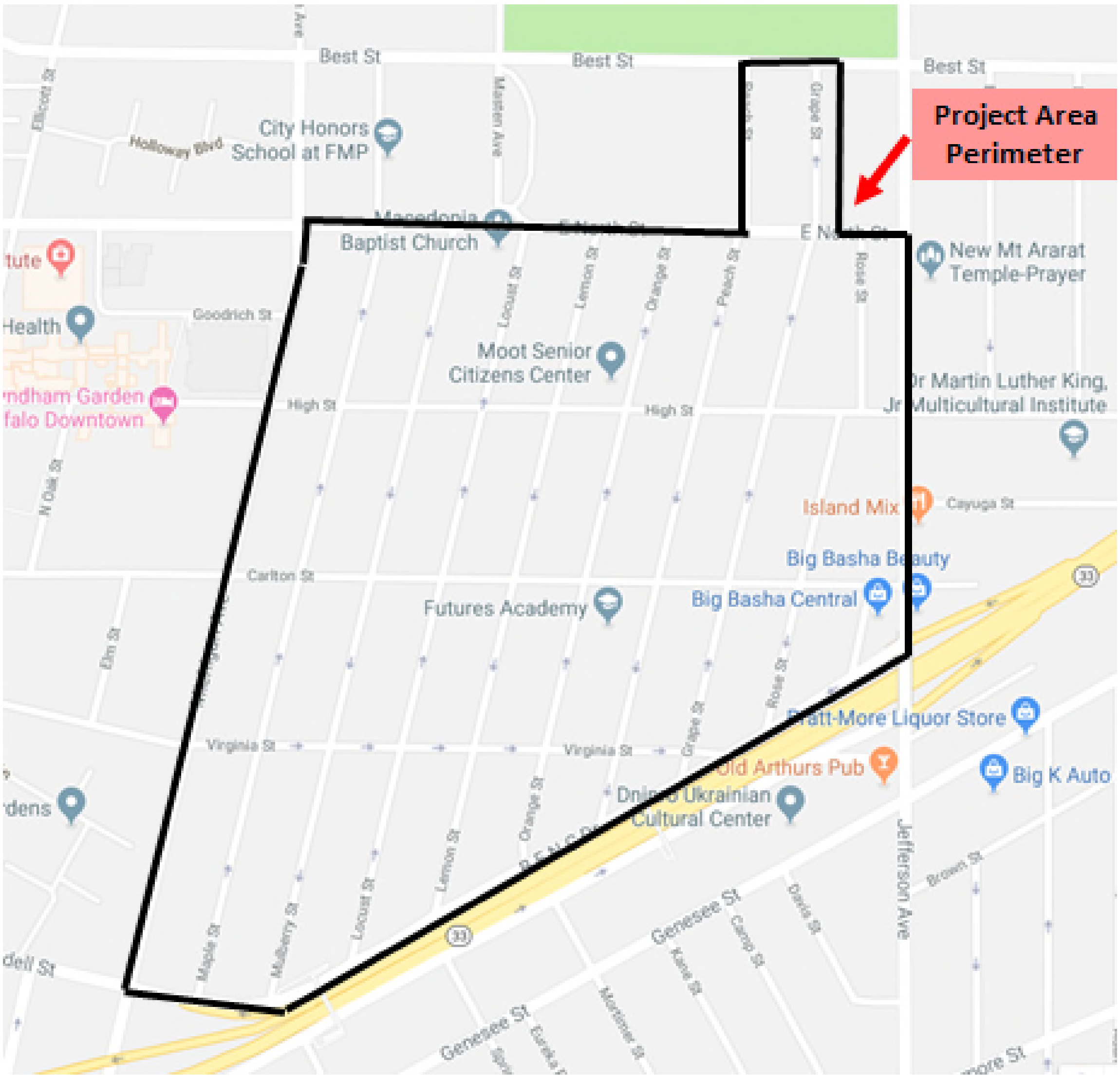
1. Providing solar bill credits to participants in an LMI neighborhood, as well as offering energy efficiency to further drive energy bill savings, will have a positive impact on bill payment behavior and enable customers to better manage their arrears.

2. Concentrating distributed solar PV resources with reactive power support within a boundary served by a common substation versus scattered deployment of conventional solar will deliver measurable grid efficiency benefits.

The solar PV systems are utility-owned and are connected “in front of the meter”, meaning the power flows into the local electric grid, rather than into the house or building on which the equipment is mounted. The financial benefit of the power generated from the solar PV systems is shared among solar PV host customers and an additional set of customers, chosen by lottery, who were unable to host a solar PV system, either due to the orientation of their roofs or because they are a tenant rather than an owner of the residence.

The Project also explored drivers for cost efficiency and scalability for a utility-owned model, the corresponding economic and job creation impact, and the overall LMI customer perception of renewables, energy efficiency, and the customer-utility relationship.

Figure 1-1: Fruit Belt Neighborhood Solar REV Demonstration Project Area



Base Map Source:
https://www.google.com/search?q=292+high+street&rlz=1C1GCEV_enUS830US830&oq=292+High+S&aqs=chrome.0.0j69i60j0j69i60l2j69i57.1679j0j7&sourceid=chrome&ie=UTF-8

1.3 Project roles

National Grid managed the Project. Through this role, the Company partnered with or hired various entities providing skills and services needed to operate the Project. Table 1-1 lists these Project-supporting stakeholders and the services they provided.

The BNMC coordinated the public meetings held at the beginning of the Project, and later assisted with customer engagement of a faith-based organization.

NYSERDA, under a memorandum of understanding with National Grid, provided residential EE services to residences located within the Project area. National Grid also hired GE Global Research ("GE") to conduct grid efficiency analyses to determine the impact of concentrated solar PV systems on the local distribution system. Other local businesses were hired to provide printing and neighborhood canvassing.

Solar Liberty provided turnkey solar installation services., which included conducting all site pre-inspections, developing solar array designs, obtaining all permits required for solar PV system construction, procuring and installing all materials to install and connect each solar PV array, connecting the arrays to the local grid and conducting all customer interfacing required for scheduling all pre- and post-inspections. Additionally, Solar Liberty was responsible for conducting certain initial community outreach efforts, also accompanied National Grid during outreach visits to faith-based organizations based in the Project area.

The City of Buffalo's building code requires building permits to be issued for all solar PV systems. The City's Building Department reviewed all permit requests, which included reviews by their electrical, structural, and fire safety inspectors. Additionally, the City of Buffalo conducted post-installation inspections required by the building code, which included on-site electrical inspections and solar-specific inspections. The City also issued a Certificate of Compliance for each solar PV system installed.

The Fruit Belt Coalition, Inc. became a strong partner during the Project by providing support in multiple ways. The organization's leadership allowed National Grid to attend its meetings and make presentations about enrolling in the Project, and encouraged its membership to become solar hosts. They also suggested the idea of including the neighborhood faith-based organizations in the outreach effort and conducted the initial outreach to those entities located within the neighborhood.

Table 1-1: Supporting Stakeholders and Services Provided

Entity	Relationship	Service Provided
Solar Liberty	Contractor	Turnkey Solar Installation
NYSERDA	Partner/Contractor	Residential EE Program Implementation
GE Global Research	Contractor	Grid Efficiency Analysis
BNMC	Partner	Project Design and Customer Engagement
City of Buffalo	Partner	Permitting and Inspections
West Monroe Partners	Contractor	Benefit/Cost Analysis Planning
Fruit Belt Coalition, Inc.	Partner	Encouraged membership to enroll in this Project, and conducted initial outreach to faith-based organizations

1.4 REV Goal Support

This Project met several REV goals as below noted in Table 1-2.

Table 1-2: REV Goals Supported by the Fruit Belt Neighborhood Solar REV Demonstration Project

REV Goal	Supported by Project?	
	Yes	No
Make energy more affordable	X	
Build a more resilient energy system		X
Empower New Yorkers to make more informed energy choices	X	
Create new jobs and business opportunities	X	
Improve New York's existing initiatives and infrastructure	X	
Support cleaner transportation		X
Cut Green House Gas ("GHG") emissions by 80% by 2050	X	
Protect New York's natural resources	X	
Help clean energy innovation grow	X	

Source: Reforming The Energy Vision, Learn More; https://www.ny.gov/reforming-energy-vision/learn-more

The most prominent REV goal supported by this Project is "Make Energy More Affordable", as the very nature of the Project centers on this theme. Additionally, this Project supported the REV goal of 'Creating New Jobs and Business Opportunities' by creating demand for solar installers based in the local area. Generation and use of solar energy in the neighborhood contributes to regional GHG emission reduction, while the Project itself is a demonstration of clean energy innovation. Data used from this Project will also be used to gauge the prospect of implementing potential future solar projects.

1.5 Project Presentations

Several presentations featuring this Project were given during the course of the Project. Table 1-3 lists the presentation forums, dates, and locations.

Table 1-3: Presentations Featuring the Fruit Belt Neighborhood Solar REV Demonstration Project

Forum	Date	Location
Northeast Sustainable Energy Association (NESEA) BuildingEnergy NYC 2016	November 3, 2016	Manhattan, NY
Electric Utility Conferences, Inc. (EUCI) REV Conference	April 25, 2017	Queens, NY
NYSERDA LIFE Conference, 2017	May 13, 2017	Buffalo, NY
NYSERDA LIFE Conference 2018	May 22, 2018	Albany, NY
NESEA's BuildingEnergy NY 2018	October 4, 2018	Manhattan, NY
Distributed Energy Resource Conference	October 17, 2018	Denver, CO

2.0 Project Tasks and Key Findings

Each major task is described below. Note that not all tasks were conducted sequentially. Customer engagement, solar installation, and green job creation were conducted concurrently. The bill credit lottery and required a significant portion of the solar PV system to be completed before initiation. Arrearage analysis and overall grid impact analysis were conducted following solar PV system installation, in order to evaluate data from the systems' presence.

2.1 Customer Engagement and Acquisition

Customer engagement evolved after the methods originally planned proved to be relatively ineffective. Initial methods consisted of advertising for, then holding, a set of public meetings and drop-in sessions at the community center located near the middle of the Fruit Belt neighborhood. These were followed by advertising Project enrollment opportunities in two weekly newspapers that hold significant readership in the neighborhood; sending out post cards to all residents; presenting at a community organization meeting; staffing a table at the weekly neighborhood farmer's market; and twice mailing letters to customers living within the Project area. Five months into the engagement effort, only two solar PV systems totaling 12.2 kW (out of a 500kW goal) had been installed. National Grid subsequently designed a grassroots outreach approach and hired a local canvassing contractor. Table 2-1 lists the customer engagement methods utilized and the dates they were deployed.

Sign-in sheets from the first public meeting, held on April 18, 2016, revealed the majority of customers heard about that meeting by reading about it on the door hangers hung on resident doors the previous weekend. Thirty-four residents attended the first meeting. Based on this success, National Grid held a second public meeting; this time on a Thursday afternoon rather than a Monday evening. Three persons attended this meeting.

After holding two informal 2-hour long public drop-in sessions, one on a Thursday afternoon and one on a Friday afternoon, the Project team turned its customer engagement efforts to using printed matter. Post cards advertising the enrollment opportunity were mailed to all Fruit Belt customers in June 2016. These were followed by a more descriptive letter that was mailed out to all customers on July 19, 2016. Additionally, Project enrollment advertisements were printed in the two community newspapers offered in this neighborhood. Lastly, copies of the post card and a Frequently Asked Question ("FAQ") handout were distributed to several local churches and to a convenience store located within the Project area. Monitoring the quantity of printed materials placed at each location revealed very few copies had been taken. This outreach method was subsequently determined to be ineffective and was terminated.

Table 2-1: Customer Engagement Methods Utilized, Deployment Dates, and Effectiveness

Engagement Method	Time Frame Utilized	Effectiveness Rating
Door Hanger advertising public meeting #1	April 3-16, 2016	High
Public Meeting #1	April 18, 2016	Moderate
Frequently Asked Questions ("FAQ") Publication distribution	April – Dec, 2016	Low
Door Hanger advertising public meeting #2	May 12-14, 2018	Low
Public Meeting #2	May 19, 2016	Low
Community Center Drop in Sessions	April -May 2016	Negligible
Printed Media Drop Off at area Churches	May-July, 2016	Negligible
Customer Letters	July 2016	Negligible
Customer Post Cards	May-June, 2016	Negligible
Newspaper Articles	July, 2016	Low
Newspaper Advertisements	July, 2016	Negligible
Staffing Table at Farmer's market	Aug 2016	Low
Presenting at a Fruit Belt Coalition Meeting	Sept 2016	Moderate
Electric Bill Insert	October 2016	Low
Door-to-Door Canvassing	Fall 2016 ; Spring 2017	High
Fruit Belt Coalition Engagement	Jan 2017 – Dec 2018	High

As a method of meeting residents face-to-face to inform them of the Project, National Grid staffed a table one day at the local farmer's market held at the Community Center. The two-hour time at this event yielded table visits by two residents, neither of whom enrolled to either host a solar PV system.

As of September 15, 2016, through all outreach efforts held to date, a total of 60 residents expressed interest in Project enrollment, and fewer than half of those qualified to become a solar host. With a significant enrollment shortfall, National Grid chose to hire a canvassing team to conduct door-to-door customer visits. This effort proved highly successful. By the end of October 2016, the quantity of residents expressing interest had increased to 133. The canvassing team continued their enrollment efforts through December 2016, then resumed in the Spring of 2017.

In addition to the canvassing, a bill insert advertising the Project was also printed and distributed in the October 2016 customer bills. Telephone conversations about the Project held with customers who called National Grid's call center in October to November 2016 revealed none of those calls were precipitated by the bill insert.

In addition to enrolling customers in the solar PV portion of this Project, National Grid's outreach efforts also encouraged enrollment in NYSERDA's residential EE program offerings administered through their EmPower Program. EmPower program enrollment forms were distributed during neighborhood canvassing and made available, along with other customer-facing documents, during the public meetings. Additionally, National Grid staffed a table at the local event of the National Night Out program, held on August 1, 2017. Hosting this table resulted in 17 EmPower program enrollments; most of which were located within the Fruit Belt neighborhood.

A review of the total amount of solar generation capacity that had enrolled as of early November 2016, in conjunction with the total quantity of houses located within the Project area, revealed that the 500kW goal would to not be met due to an insufficient amount of qualifying roof space meeting the Project's eligibility criteria. Various options to address this issue were identified and explored. Of those, three options were ultimately exercised, as listed in Table 2-2 and explained in detail, below.

Decrease Minimum Hosting Capacity
The least complicated option explored was to decrease the minimum solar PV system host capacity from 5kW to 3kW. The minimum size criterion was originally established based on the fixed cost of any system. National Grid reviewed the costs with Solar Liberty, who then calculated a per-watt differential to pay for the fixed costs incurred in the smaller systems. This change contributed to 29 homes becoming solar PV hosts.

Table 2-2: Program Participation Barriers and Changes Instituted

Program Participation Barrier	Barrier Description	Change Instituted	Resulting Program Enrollment
Minimum Hosting Capacity	Minimum participating solar PV hosting capacity set at 5kW.	Decreased minimum hosting capacity to 3 kW.	29
Roof Replacement	Roof condition of interested participants requires replacement.	Allocated funding not used on electrical or structural solar readiness to instead be used toward roof replacement.	32
Faith-Based Organization Participation	Faith-based non-profit organizations were not permitted to participate in this Project.	Allowed faith-based non-profit organizations to participate in the Project.	3
Non-Profit Organization Support	Non-Faith-Based non-profit organizations were not permitted to host a solar PV system.	Allowed non-faith-based non-profit organizations to participate as hosts without receiving a bill credit.	2

Note: The above changes were not mutually exclusive; a house capable of hosting a PV system between 3 and 5 kW may still have required roof replacement.

Contributions Toward Roof Replacements
Comparing the quantity of customer expressions of interest to the quantity of eligible houses in December of 2016 revealed nearly one third (1/3) of the houses owned by individuals interested in enrolling were not suitable to host a solar PV system because their existing roof condition indicated roof replacement would be required immediately or between the next 5-10 years. The condition of some roofs was too poor to be safely accessed for detailed inspection. Discussions with several of these home owners revealed either a lack of funds or a lack of interest in paying for roof replacement. National Grid recognized that without these homes hosting solar PV arrays, there were not enough other qualifying roofs within the Project area to meet the Project's 500 kW installation goal. Meeting the installation goal would require changing some Project design criteria. Moreover, a mechanism to inspire interested customers to replace their roofs needed to be enacted.

The Project budget included $2,000 for per house to pay for upgrading exterior electrical connections to bring them into code compliance, providing structural improvements to enable a house's roof to support the weight of a solar PV system and patching roofs. Roof reviews revealed patches would not be useful; entire roof replacements were required for roofs deemed to be in poor condition through Solar Liberty's roof condition review process. Furthermore, some houses required exterior electrical upgrading to become code-compliant. In December 2016 National Grid, after consultation with Public Service Commission ("PSC") Staff, expanded the use of those funds, whereby a house's solar readiness funds not already spent on electrical or structural upgrades were then offered to customers as a roof replacement incentive. This ultimately resulted in 32 residential roofs being replaced and becoming solar PV system hosts.

Faith-Based Organization Participation
The Fruit Belt Coalition, Inc.'s leader originated the idea of allowing faith-based organizations located within the Fruit Belt to enroll in this Program. The concept was initially tabled because the Project's goal centered only on residential enrollment. Facing a shortfall of roof space needed to meet the 500 W goal, expanding Program eligibility to faith-based organization buildings located within the Project area was explored. Since ten such structures are located within the Project area, and considering these buildings are usually billed at the SC-1 (residential) rate, it was feasible that at least some would agree to be solar PV hosts. National Grid, after consultation with PSC Staff, then moved forward to modify the Project work scope to permit enrollment of faith-based non-profit organization buildings. National Grid and Solar Liberty together proceeded to follow up on the Fruit Belt Coalition's outreach to all ten faith-based organization leaders. These customer engagement outreach efforts resulted in three faith-based organizations agreeing to host a solar PV system, and cumulatively resulted in 60.17 kW of solar PV generation being installed.

Non-Faith-Based Non-Profit Organization Support
Discussions with the non-faith-based non-profit organization leadership operating two buildings in the Project area revealed their interest in supporting the neighborhood. However, the electric accounts serving the buildings were SC3, meaning they are commercial-size accounts. As such they could not receive the monthly bill credit from the solar PV generation because the bill crediting system established for this Project was configured to credit only residential accounts, and changing that configuration would have required extensive changes to the bill generation coding program, which was both expensive and not readily feasible. While the Project Implementation Plan did not address 'contribution-only' hosting, an analysis revealed the two proposed solar PV installations on these buildings were not preventing further residential participation; rather, they were fulfilling an enrollment gap that otherwise would have gone unfulfilled. Financial analysis concluded that allowing these two buildings to host solar PV systems yielded a positive net impact on the Project. Their participation resulted in installing solar PV systems totaling 48.4 kW; nearly 10% of the Project's generation capacity goal. Table 2-3 reports Project participation resulting from the various customer engagement efforts.

Solar market penetration in most LMI communities around the US is near 0%. By National Grid owning the solar arrays, a residential solar market penetration of nearly 15% was achieved in the Fruit Belt neighborhood. This demonstrates that a utility-owned approach to solar PV systems offers a new opportunity for LMI customer participation in the clean energy services market.

Table 2-3: Fruit Belt Neighborhood Solar Project Participation Metrics

Metric	Building Type	
	Homes	Faith-Based and Non-Faith-Based Non-Profit Organization Buildings
Building Quantity	69	5
Roofs Replaced Through the Project Roof Replacement Incentive	32	3
Buildings Requiring Electrical Solar Readiness Upgrading	4	2
Buildings Requiring Structural Solar Readiness Upgrading	1	0
Installed kW For the Building Type	392 kW	108 kW
Min| Avg. | Max kW Installed Per Facility	3.12/5.496/10.728	15.95/21.7/28.05

2.2 Solar Installation

Customer enrollment began with Solar Liberty conducting a curbside review, during which the roof condition, orientation, angle, usable roof space (which excluded protrusions such as chimneys, dormers, and vents), and shading were identified. Provided the roof passed the roof space criteria, Solar Liberty scheduled with the home owner a structural review in which a structural engineer entered the crawl space or attic of a house to evaluate the integrity of the roof support system to ensure it could support a solar PV system. For each house or building passing these inspections, Solar Liberty designed a solar array, then had its architectural contractor develop the associated one-line electrical drawing. Once completed, Solar Liberty completed and submitted a solar PV system construction application to the City of Buffalo Building Department. Once the City approved the application, Solar Liberty procured all solar PV system materials, then scheduled and installed the array. Solar Liberty's electrical contractor installed the electrical tie-in equipment. Once connected to the grid, Solar Liberty scheduled a post inspection with the City of Buffalo, which subsequently issued a Certificate of Completion ("COC"). Upon COC receipt, Solar Liberty commissioned the solar PV system, which included energizing the array and activating the electronic metering equipment to measure and record generation output.

The solar PV system installation process required extensive coordination with National Grid, including bi-weekly team conference calls, as well as an electronic tracking system to monitor and facilitate reporting on the progress of each solar PV system installation.

Generation data and solar PV system operation status is reported in near-real time via a Project-specific password-protected web site. Besides reporting individual solar PV system generation, the metering system aggregates all generation data from all solar PV systems installed under this Project into hourly readings. Every 15 days the reporting system generates a report listing the total energy generated by the Fruit Belt Project solar PV systems for each hour of each day during that particular reporting period, then electronically transmits the report to National Grid. National Grid then inputs that data and hourly price data for the reporting period involved into a Project-specific algorithm to calculate the value of the energy generated on an hourly basis. The two 15-day reports per month are combined to calculate the bill credit value that gets issued for that month.

2.3 Bill Credit Lottery

As described in the Implementation Plan, a bill credit lottery was held to spread the Project's solar-based benefit to more of the neighborhood than just solar hosts. Community engagement activities identified several neighborhood residents interested in hosting a solar array but who, for various reasons and circumstances beyond their control, could not become a solar host under this Project. Reasons included, but were not limited to, excessive roof shading, excessively steep roof angle, and not owning the house in which they lived. Names of these customers were entered into a lottery, to receive the same monthly bill credit amount as the solar PV hosts receive.

The bill credit lottery recipient quantity was originally planned to be 50% of the quantity of solar PV hosts. However, this approach did not account for the very large systems installed at faith-based and non-faith-based non-profit buildings. Furthermore, it did not account for non-faith-based non-profit organizations donating 100% of the power generated by their systems to the neighborhood. The original bill credit recipient quantity was based on an average solar PV system size of 5kW; one recipient per 10kW installed. It was determined that this approach would be applied to the total kW installed on non-profit buildings, as well as to the non-profit organization power donation.

Table 2-4: Bill Credit Lottery Recipient Calculation

<table>
<tr><th>Credit Start Date</th><th>Contribution Source</th><th>Building</th><th>Installed Total System kW</th><th>5kW Residential System Equivalents*</th><th>Credits Taken by Building</th><th>Bill Credits Available</th></tr>
<tr><td rowspan="4">January-18</td><td>50% of Residential PV System Equivalent Accounts</td><td>Houses</td><td>305.956</td><td>61.19</td><td>0</td><td>30.60</td></tr>
<tr><td>Faith-Based Non-Profit Organization Buildings</td><td>Faith-Based Non-Profit Organization Building 1</td><td>22.275</td><td>4.455</td><td>1</td><td>3.455</td></tr>
<tr><td>Non-SC1 Equivalents</td><td>None</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td colspan="5">Total Bill Credit Lottery Recipients Starting Credit Receipt in January 2018:</td><td>34</td></tr>
<tr><td rowspan="5">July-18</td><td>50% of Residential PV System Equivalent Accounts</td><td>Houses</td><td>86.330</td><td>17.27</td><td>0</td><td>8.63</td></tr>
<tr><td>Faith-Based Non-Profit Organization Buildings</td><td>Faith-Based Non-Profit Organization Buildings 2 and 3</td><td>37.895</td><td>7.58</td><td>2</td><td>5.579</td></tr>
<tr><td>Non-SC1 Equivalents</td><td>Community Non-Profit Building 1</td><td>28.050</td><td>5.61</td><td>0</td><td>5.61</td></tr>
<tr><td>Non-SC1 Equivalents</td><td>Community Non-Profit Building 2</td><td>20.350</td><td>4.07</td><td>0</td><td>4.07</td></tr>
<tr><td colspan="5">Total Bill Credit Lottery Recipients Starting Credit Receipt in July 2018:</td><td>24</td></tr>
<tr><td colspan="6">Total Bill Credit Lottery Recipient Quantity:</td><td>58</td></tr>
</table>

* = Based on a 5kW residential system.

A single lottery event was originally planned to be conducted following completion of all solar PV system installations. However, the lengthy customer engagement and solar installation processes delayed reaching the 500 kW construction goal. Part of this Project's work scope was to evaluate the impact of bill credits on customer arrearages. Thus, to enable the bill credit impact analysis task to be executed and provide several months of data for analysis, the bill credit lottery was divided into two rounds. First round recipient selections started receiving the solar PV bill credit on their January 2018 bill, while second round customer selections started receiving the credit in July 2018. Table 2-4 lists the bill credit lottery quantity amounts and the credit start dates.

2.4 Arrearage Analysis

One of this Project's hypotheses postulated that customers receiving a monthly bill credit would use the credit to decrease the cumulative amount they owed from historical billing, (*i.e.,* the "arrearage amount"). Arrearage amounts for all bill credit recipients were analyzed for the period starting with the first bill credit received and extending through to 12/31/18. Customers having an arrearage amount for a single month within the study period, but not in successive months, were interpreted as missing a payment date, but not a chronic arrearage customer. For any customer showing an arrearage amount for two or more consecutive months, the billed amounts were compared to the paid amounts to determine whether or not the customer was paying a fixed amount each month, an amount in excess of the arrearage so as to slowly pay off the arrearage, or a smaller amount than invoiced, resulting in growth of the total arrearage amount.

National Grid completed an arrearage rate change analysis as described in the Project Implementation Plan. Per company protocol, arrearages under $25 were not included in the analysis. Arrearage rates were calculated using the last five quarters of the Project duration – Q4 2017 through Q4 2018. Arrearages were calculated starting with the month in which the customer received the first bill credit if the credit wasn't already being received at the beginning of the evaluation period. The rate of bill credit recipients decreasing their arrearage over the evaluation period was calculated to determine the arrearage impact. To date, not all of the customers receiving bill credits have used such credits to pay down their arrearages. In fact, arrearages increased for this set of customers, while arrearages actually decreased by 7% in the control population of customers who did not receive bill credits. Arrearage analysis findings are presented in Table 2-5.

Table 2-5: Arrearage Rate Analysis Findings

		Study Period Start		Study Period End			
Study Group	**Active Account Qty**	**Qty of Customers In Arrears***	**% of Study Group Population**	**Qty of Customers In Arrears***	**% of Study Group Population**	**Arrearage Change Rate**	**Collection Rate During Study Period**
Fruit Belt Bill Credit Recipients	111	39	35%	42	38%	8%	69%
Non-Credit Recipient Accounts Located in the Same Zip Code	150	69	46%	64	43%	-7%	88%

**Those with arrearage totaling >$25.*

2.5 Green Job Creation

One of these Project goals was to hire and train two Fruit Belt residents interested in becoming solar PV system installers. Solar Liberty advertised for an installer on a temporary hiring basis, with the expectation of hiring the person full-time provided their work load existed outside the Fruit Belt and the employee was interested in continuing in the position. National Grid conferred with the Fruit Belt Coalition several times on advertising the positions, and provided information on the positions to other non-profit organizations operating in the Fruit Belt neighborhood. Advertising efforts resulted in two candidates applying for the positions; both were accepted. The first candidate chose ultimately not to accept the position after it was awarded, while the second worked for two days before leaving the position. There were no other applicants for the positions, which were advertised for over one year.

2.6 Residential Energy Efficiency

National Grid partnered with NYSERDA to enable further reducing the energy cost burden of Fruit Belt residents by integrating an energy efficiency component into this Project. NYSERDA offered its EmPower program to all Fruit Belt residents, regardless of HEAP[1] qualification status, solar PV system host status, and arrearage status. National Grid encouraged customers to enroll in NYSERDA's EE program throughout many customer engagement activities, as discussed in Section 2.1. In addition, National Grid staffed a table at a local community event that was part of National Night Out on August 1, 2017, with the sole objective of garnering EE program enrollment.
Beyond reducing participant energy cost burdens, energy efficiency steps implemented during this Project also achieved other benefits, including decreased carbon emission, increased system-wide efficiency, and enhanced energy literacy for customers relative to understanding the elements of the energy bills.

The Implementation Plan assumed EE services would be provided to 100 solar PV system hosts, 50 bill credit lottery winners, and also to 150 non-hosts and non-lottery credit winners. The customer engagement process revealed hesitation by many customers to accept NYSERDA's EE offering. Part of that reluctance was found to originate from tenants explaining the option to landlords, and landlords rejecting the offer because of their concern that a person from a state agency would then inspect their property, which they worried could result in the landlord's financial liability for any required upgrades the inspector deemed necessary. Another concern expressed was more straightforward: Some residents felt the offer was "too good to be true." One additional common reason for EE program participation rejection was the perceived scheduling difficulty, as the EE process requires multiple visits. While the total EE program participant quantity was lower than the goal stated in the Implementation Plan, NYSERDA reported the 19% enrollment rate achieved under this Project is nearly four times the typical market penetration rate of 5% for executing the EmPower program. Table 2-6 lists NYSERDA's EmPower program customer outreach and participation quantities for this Project, while Table 2-7 lists the EmPower program participation quantities by participant type.

NYSERDA reported that of the fifty-two (52) completed energy efficiency projects, eighteen (18) projects received electric reduction services while thirty-four (34) received comprehensive energy efficiency improvements, at an average cost of $2,300 per project. NYSERDA further reported that, on average, households receiving energy efficiency services are estimated to save 29.6 dekatherms (Dth) of gas and 430kWh of electricity annually.

[1] HEAP is a federally funded energy program that assists qualified low-income households in meeting their heat related energy costs.

Table 2-6 Energy Efficiency Program Application and Participation Quantities

Customer Category	Customer Quantity
Completed EE projects	52
EE Projects Cancelled	25
EE Applications Not Returned	193
Duplicate EE Applications filed by customer	33
Total EE Applications Received	**303**
Total EE Applications Excluding Duplicates	**270**

Table 2-7: Energy Efficiency Component by Participant Category

Status	Solar Hosts	Bill Credit Lottery Recipients	Non-Hosts	Total
Customers contacted [a]	26	59	189	274
Customers who responded [b]	13	12	56	81
Projects completed [d]	10	8	34	52

a. *Customers contacted:* Unduplicated number of customers responding to National Grid outreach efforts indicating that they are interested in energy efficiency services as of 9/30/18.
b. *Customers who responded*: Quantity of customers that have returned an application for energy efficiency services to NYSERDA as of 9/30/18.
c. *Enrollments:* Quantity of energy efficiency projects in process as of 9/30/18.
d. *Projects completed:* Quantity of energy efficiency projects that have been completed as of 9/30/18.

2.7 Grid Impact Analysis

The Fruit Belt neighborhood is served by three feeders. Most of the load is served by feeders 3466 and 3467, while forty-seven residences located at the southeast corner of the Project area are served by Feeder 3463. Each feeder continues past the Project study area and is connectable through switches to other nearby neighborhoods. Solar-generated power input onto a feeder must be sufficiently large to be recognizable as compared to the background load fluctuations. For this reason, although some solar PV systems were installed on Feeder 3463, the generation quantity is not sufficient to consistently produce a recognizable difference from the baseline condition. While solar impacts on both feeders 3466 and 3467 were large enough to be studied, Feeder 3466 has the greater amount of solar PV installed on it, and thus was selected for the grid impact analysis.

National Grid contracted with GE to determine what effects concentrating solar PV generation would have on a local grid. The project Implementation Plan schedule indicated this analysis would take place over one year. However, with the last of the solar PV systems being installed and commissioned at the end of September 2018, combined with the Project close-out schedule of December 2018, a full year of generation data could not be collected and analyzed without extending the Project. Analysis was performed on data collected through November 30, 2018. Results were extrapolated to simulate a full one-year duration provided based on assumptions in load variance and annual solar PV generation.

One way to evaluate how effective electricity is being used is by comparing the real power used to the apparent power required to power the equipment. This comparison, or ratio, is called the power factor (pf)[2]. The higher the pf of a system, the more efficiently it uses power, or stated another way, the less expensive it is to energize. The maximum pf a system can achieve is 1.0, meaning that no reactive power is required to power the equipment. Part of GE's analysis included evaluating energy loss reduction provided by the solar PV systems through the pf settings of the micro-inverters mounted to each solar PV panel.

Electrical energy is also lost through transmission; the greater then transmission distance, the greater the energy lost. Also, the greater the energy demand is from remote electricity generation plants, the greater the energy that is lost. Introducing solar-generated electricity into the neighborhood grid where the electricity is used locally eliminates the need to transmit an equal amount of electricity from a generation source located far away from the neighborhood. Additionally, using the solar-produced electricity also avoids losing some power to the transmission process.

GE evaluated energy losses on electric feeders using the various pf settings on the solar PV systems. Their analysis included solar PV micro inverters operating with a fixed pf ranging from 1.0 to 0.8; as well as systems operating with a dynamically adjusted pf that changed depending on the amount of solar PV generation. Results showed deploying 242 kW dc of solar PV on Feeder 3466, corresponding to a 15% solar PV penetration level on the load, will reduce energy losses on that feeder by 25.6 MWh annually even if the PV system pf is set to 1. Results also showed that enabling the solar PV systems to operate at a pf less than 1.0 will slightly reduce the energy loss even further, although the additional energy savings value from doing so is relatively small. A solar PV system pf of 0.97 was determined to be the most beneficial setting in this study; it reduced annual energy losses by 28.6MWh annually. Table 2-5 lists the net benefit achieved from various pf settings on feeder 3466.

Table 2-8: Net Power Benefits of the PV System Installation on Feeder 3466

	Annual PV Generation (MWh)	PV production lost (MWh)	Total Feeder load (MWh)	Additional Feeder import due to PV production loss (MWh)	Total Energy imported (PV+power plant) (MWh)	Total Loss factor (transmission to secondary)	Net Benefits of PV presence (MWh)
Baseline	0.0	0.0	5365.9		5652.2	0.0875	0.0
PV pf = 1.0	287.0	0.0	5068.1	0.0	5626.6	0.0833	-25.6
PV pf = 0.97	278.4	-8.6	5075.9	7.8	5623.6	0.0828	-28.6
PV pf = 0.94	269.8	-17.2	5084.4	16.3	5624.6	0.0830	-27.7
PV pf = 0.9	258.3	-28.7	5095.9	27.9	5624.7	0.0830	-27.5
PV pf = 0.85	244.0	-43.1	5110.5	42.4	5625.2	0.0831	-27.1
PV pf = 0.8	229.6	-57.4	5125.1	57.1	5625.8	0.0832	-26.4
PV pf = dynamic	261.4	-25.6	5093.1	25.0	5625.3	0.0831	-27.0

pv = photovoltaic
pf = power factor
MWh = megawatt hour

[2] In AC circuits, the **power factor** is the ratio of the real **power** that is used to do work and the apparent **power** that is supplied to the circuit. The **power factor** can get values in the range from 0 to 1. When all the **power** is reactive **power** with no real **power** (usually inductive load) - the **power factor** is 0. Source: https://www.google.com/search?q=What+is+power+factor&rlz=1C1GCEV_enUS830US830&oq=What+is+power+factor&aqs=chrome..69i57l2j69i59l2j69i60j69i65.2511j0j7&sourceid=chrome&ie=UTF-8

2.8 Hypothesis Analysis

Two hypotheses were tested by this REV Demonstration Project; both were explored through three test statements that fall into two main categories: (1) customer bill payment behavior and arrears management, and (2) grid efficiency benefits. Table 2-9 presents these test statements; findings are described following the table.

Hypothesis 1:

> Providing solar bill credits to Project participants located in an LMI neighborhood, as well as partnering with NYSERDA to deliver energy efficiency programs to further drive energy bill savings, will have a positive impact on bill payment behavior and enable customers in arrears to better manage their arrearage.

Test Statement 1 was proven, as providing solar and energy efficiency to customers did lower their electric bills by a significant amount. A minimum $15 bill credit was established, which translates to between 15% and 20% of the electric bill for many customers.

The nature of Hypothesis 1 centers on Test Statement 2. Providing solar credits and energy efficiency upgrades to participants in a LMI neighborhood did reduce participant utility bills. However, it did not yield a positive impact on bill payment behavior and enable better management of arrears. Based on this finding, Hypothesis 1 and Test Statement 2 are both considered disproven.

From a purely mathematical perspective, the first consequence listed for Test Statement 2 was partially disproven because the arrearage amounts varied, and thus their total balance varied. While participants receiving the bill credit via the lottery received the same bill credit amount available each month, all of them will not necessarily be able to pay 3-5% more of their total balance (current charges + arrears) than the control group, as totals varied so widely.

Hypothesis 2:

> Concentrating distributed solar PV resources capable of dispatching reactive power support within a boundary served by a common substation (versus scattered deployment of conventional solar PV) will deliver measurable grid efficiency benefits.

Hypothesis 2 was proven, through GE's analysis, as follows:

- GE's study found the power factor of customers' electric service improves, reducing local losses. The extrapolated power factor analysis data reveal the dollar value of concentrated 242kW DC of solar on a single feeder is at least $893 annually.

- Improving customers' electric service power factor helped improve substation power factor. Improving substation power factor has more impact on reducing transmission losses than reducing local system losses.

- Circuit and substation losses were proven to be reduced based on the quantity of solar PV generating capacity installed on the feeder. However, the effect weakens as larger sizes of individual systems are installed.

Test Statement 3 was proven, as grid efficiency analysis revealed concentrating distributed solar resources with VAR support within a boundary served by a common substation will deliver measurable grid efficiency benefits.

Table 2-9: Supporting Test Statements

Test Statement		If…	Then…
1.	Providing solar and energy efficiency to customers will lower their electric bills by a significant amount.	The value of solar generation of 100 units (estimated at 5 kW each) is divided equally among 150 participants as a bill credit, and participants are offered additional ways to save energy through efficiency.	The expected bill reduction will be at least $15 per month or about 15-20% of their monthly electric charges.
2.	Providing solar credits to participants in a LMI neighborhood, as well as offering energy efficiency to further drive bill savings through reduced energy consumption, will have a positive impact on bill payment behavior and enable better management of arrears.	LMI participants' electric bills are reduced due to solar bill credits and energy efficiency.	Participants will be able to pay 3-5% more of their total balance (current charges + arrears) than the control group.
			Participants will pay down 5% more of their arrears balance compared to the control group.
3.	Concentrating distributed, solar resources with VAR support within a boundary served by a common substation vs. scattered deployment of conventional rooftop solar will deliver measurable grid efficiency benefits.	Volt/VAR[1] optimization is enabled on a per-system basis.	Then the power factor of customers' electric service will improve, reducing local losses.
		Power is generated along the feeder and Volt/VAR optimization is enabled on a substation basis.	Substation power factor will improve, reducing system losses.
			Circuit and substation losses would be reduced based on the number of systems installed on the homes on each circuit.

[1] Volt/Var Optimization ("VVO") is a process of optimally managing voltage levels and reactive power to achieve more efficient gird operation by reducing system losses, peak demand or energy consumption or a combination of the three. ... The efficiency gains are realized primarily from a reduction in the system voltage.

2.9 Major Lessons Learned

Multiple lessons transferrable to other projects, both internal and external to National Grid, were learned during this Project. Each quarterly report includes a listing of the lessons learned that quarter. Table 2-10 lists the major lessons learned from this REV Demonstration Project.

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Table 2-10: Major Lessons Learned

Issue or Change	What was the resulting change to Project scope/timeline?	Strategies to resolve	Lessons Learned
The Project's rooftop solar PV installation quantity goal was greater than the quantity of residential roofs capable of hosting a solar PV system, using the Project roof size criterion.	The Project PV installation goal of 500 kW could not be met using only residential roofs located within the Project study area.	The minimum roof size criterion was decreased to allow smaller roofs to participate; and both faith-based and non-faith-based non-profit organization buildings were allowed to participate.	Establish a solar PV market penetration goal only after first surveying the neighborhood housing stock to estimate the amount of roof space viable for solar PV system hosting.
At times during the Project, several weeks went by without contacting the customer, leading to various customer inquiries about the Project status.	The contractor's Project manager spent additional time fielding customer calls and explaining the overall application review and permitting process.	Proactively provide each solar PV host with a flow chart showing the Project steps and timeline.	Provide customers a flow chart listing Project steps and timeline to set customer expectations for the Project timeframe.
Customers expected to receive bill credit immediately following solar PV array installation.	No change to scope or timeline.	The flow chart showing the steps in the process was re-issued to the customer upon their signing the solar PV host agreement, and timeframes for the upcoming steps were explained to the customer.	Reviewing the implementation timeframe for a customer's specific roof, drawing attention to upcoming steps, helps prevent unrealistic expectations.
Customers do not always attend an appointment at their house, despite self-selecting the time and date.	Multiple missed appointments occurred, delaying Project enrollment.	Provide a reminder call one week in advance of an appointment, in addition to the two-day notice call.	A reminder call two days in advance of an appointment is insufficient. A one-week advanced reminder call added to the two-day notice call was more likely to result in a customer keeping an appointment.

Issue or Change	What was the resulting change to Project scope/timeline?	Strategies to resolve	Lessons Learned
The City of Buffalo Building Department used web research, including Google map views, for desktop review of building locations, which were not always current or accurate.	Building permits for two houses and one faith-based organization building were initially denied based on outdated information.	National Grid requested on-site meetings with a Building Department staff member and Solar Liberty to review the issues. The Building Department staff ultimately issued the permits.	Compare Google Earth images with field conditions and submit photographs of actual structure conditions and surroundings for any buildings for which the Google Earth image is no longer accurate.
Customers did not use bill credits to reduce arrearages.	None	In future projects, National Grid should consider applying the bill credit directly to arrearages for those customers who have them.	Bill credits can only reliably be used to reduce arrearages if they are automatically credited against amounts owed.

2.10 Project Evolution

National Grid made various modifications to the Project's implementation in response to Project task and sub-task outcomes, as well as information gathered during the course of Project execution. Listed below are the most relevant modifications. These are explained in further detail in Section 2.1 above.

A. Modification of customer engagement methodology from direct mail and newspaper advertising to a neighborhood canvassing;

B. Decreasing minimum roof size criteria;

C. Allowing faith-based organization buildings to participate in the Project;

D. Permitting unused roof repair funds to be applied toward roof replacement;

E. Permitting non-profit organization buildings using 3-phase power to host solar PV systems without receiving a monthly bill credit; and

F. Focusing the detail grid efficiency analysis to the one feeder most affected by the Solar PV installation.

2.11 Project Accounting

Incremental costs consisted primarily of labor and contractors hired specifically for this Project. The Incremental Project budget was $3,792,200. Table 2-12, below, lists the total Project cost, the incremental cost budget, and the funded non-incremental costs.

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Table 2-11: Fruit Belt Neighborhood Solar REV Demo Project Costs

Project Task	Amount
CapEx	
Total Capex Cost (Entirely Incremental)	$1,909,578
Capex Budget	$2,468,868
Unspent Capex Funds Remaining	$559,290
OpEx	
Opex Cost as of 3/14/19 (Incremental and Non-incremental)	$1,675,116
Estimated Close-out Cost	$3,000
Total Opex Cost	$1,678,116
Incremental Opex Budget	$1,323,332
Funded Non-Incremental Costs	$1,080,154
Total Opex Budget	$2,403,486
Unspent Opex Funds	$725,370
Estimted Total Project Cost	$3,587,694
Total Project Allocated Funding	$4,872,354
Total Unspent Allocated Project Funding	$1,284,660
Percent Under Budget	**30.2%**

3.0 Project Benefits and Costs Review

3.1 Project Benefits and Costs

Benefits

The Project delivered both tangible benefits to which a monetary value can be assigned as well as intangible benefits, which are not readily quantifiable. Furthermore, the experiences and data from Project will provide valuable information to National Grid and other utilities, which they can use to engage low-to-moderate income communities in other solar PV projects. This Project provides a blend of customer, utility, and societal benefits, which are listed in Table 3-1.

Table 3-1: Ongoing Solar and EE Primary Benefits and Values

Item	Program Participant Primary Benefit Value	Primary Benefit Quantity	Societal Benefit
Monthly Bill Credits	≥$15/mo X 12 mo/yr = $4,500 over 25-yr equipment lifespan	128 Residences and 3 Faith-Based Non-Profit Buildings	Visible technological advancement of the neighborhood.
Electric Energy Efficiency	@ $0.14/kWh average = $60/yr.; $1,500/25 yrs.	42 Households; 430 kWh[a]	Providing non-carbon-based electricity to the area.
Gas Efficiency	@$1/therm, average; $296/yr; $7,400/25 yrs	42 households; 296 Therms/yr[a]	Reduction of GHG emissions.
Grid Efficiency	Increased grid reliability	Approx. 250kW of PV	Reduced grid stress and $892/year in energy cost savings.
Regional Greenhouse Gas Emission Reduction	Contributing to maintaining high regional air quality	1.004lbs/kWh[c]	206 tons based on estimated annual generation
Ongoing Benefit Totals:	$13,400	--	--

[a] Based on data provided by NYSERDA.

[b] Source:
https://www.google.com/search?rlz=1C1GCEV_enUS830US830&q=Co2/kWH+from+one+ton+of+coal&spell=1&sa=X&ved=0ahUKEwjf4oyGkvPgAhWjrFkKHaUDjgQBQgpKAA&biw=820&bih=474

[c] Source:
https://carbonfund.org/how-we-calculate/

Table 3-2: One-Time Financial Benefits of Solar and EE Program Implementation

Item	Customer Benefit	Societal Benefit	National Grid Benefit
Investment Production Tax Benefit	n/a	n/a	30% of Capital Expense
Increased home sales price	Approx. Range: $3,400 - $7,000 depending on array size and house location[1]	n/a	n/a

[1] Source: https://news.energysage.com/solar-can-increase-your-home-value-heres-how/ ; and location differential.

In addition to the tangible benefits, this Project also garnered the following non-quantifiable benefits:

- Increased community awareness of energy–related issues;
- Increased access to renewable energy and EE for LMI customers;
- Customer engagement in an underserved market;
- Local economic development, and
- Community stewardship.

Costs

Project costs consisted of capital costs for the solar arrays, and operational costs consisting of the Project budget management, reporting, contractor coordination and oversight, and general execution. Operational costs also included the evaluation and analysis efforts, including those conducted by contractors. These expenses were incurred executing the work scope per the Project Implementation Plan.

3.2 Benefit Cost Analysis

As a REV demonstration project in which various aspects of a concept were being explored, calculating a formal benefit/cost analysis for the Project was not appropriate.

4.0 Conclusions

4.1 Hypothesis Verification

This REV Demonstration Project posed the following two hypotheses:

> Hypothesis 1: Providing solar bill credits to participants in a LMI neighborhood, as well as partnering with NYSERDA to deliver EE programs to further drive energy bill savings, will have a positive impact on bill payment behavior and enable customers in arrears to better manage their arrearage; and
>
> Hypothesis 2: Concentrating distributed solar PV resources capable of dispatching reactive power support within a small area served by a single feeder (versus scattered deployment of conventional solar PV) will deliver measurable grid efficiency benefits.

Hypotheses 1 was partially proven. Providing solar credits and energy efficiency upgrades to participants in a LMI neighborhood did reduce Project participant utility bills. However, it did not yield a positive impact on bill payment behavior and enable better management of arrears.

Hypothesis 2 was proven through GE's analysis, which showed through extrapolated power factor analysis that monetary value of concentrating 242kW DC of solar on a single feeder is at least $893 annually. GE also showed that improving customers' electric service power factor helped improve substation power factor. Improving substation power factor has more impact on reducing transmission losses than reducing local systems losses.

4.2 Key Project Findings

The Fruit Belt Neighborhood Solar REV Demonstration Project offers several important findings. Chief among these are:

1. Solar market penetration in most LMI communities is near 0%. Utility ownership greatly increases solar market penetration in an LMI neighborhood. The utility-owned concept offers a new business opportunity and approach to increase LMI customer participation in the clean energy services market.

2. Grid impact from high roof top solar penetration can be significant, especially with voltage control. Steady-state 8760 hourly modeling identified several key variables necessary for grid optimization.

3. Increased penetration of clean energy use in LMI neighborhood yields a positive environmental justice result.

4. Customers are motivated by bill credits and roof incentives. Roof incentives represented <4% of the Project's capital budget.

5. Exterior electrical code non-compliance issues were identified and addressed during this Project, thereby improving the safety of homes and providing customers peace-of-mind.

6. Offering EE during solar customer engagement sessions was less disruptive to the customer and reduced NYSERDA's customer acquisition costs, while increasing NYSERDA's LMI EE penetration.

These findings are useful to National Grid and to other utilities interested in making renewable energy sources available to their LMI customers.

This Project clearly achieved several successes. It successfully proved LMI customer segment interest in using renewable energy, and it identified an effective customer engagement method. It also successfully demonstrated the need for solar readiness funds in an LMI community, as such communities may contain older building stock that will incur higher upgrading costs as compared to newer building stock. These findings contribute to the overall REV program success.

4.3 Project Scalability

This Project has led to National Grid evaluating development of a large-scale LMI solar offering across its upstate New York service territory. The evaluation uses this Project's data to configure the approach that economically best meets the renewable energy interests of customers, their energy efficiency needs, and New York State GHG reduction goals.