U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

SOLAR ENERGY TECHNOLOGIES PROGRAM

Integrating Photovoltaic Systems into Low-Income Housing Developments:

A Case Study on the Creation of a New Residential Financing Model and Low-Income Resident Job Training Program

SEPTEMBER 2011

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Sponsor

This report was made possible through funding from the Solar America Showcase activity of the U.S. Department of Energy's Solar Energy Technologies Program. To learn more, please visit:

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Northeast Denver Housing Center, NREL/PIX 19188

Publication Date

September 2011

SUMMARY

Affordable housing developers use myriad financing mechanisms to help meet local and national demands for low-to-moderate income, affordable housing developments. Since 1987, the Low-Income Housing Tax Credit (LIHTC) program has been the federal government's primary vehicle for producing rental housing that is affordable to low-to-moderate income households. From 1995 to 2007, 1.4 million housing units in almost 19,000 projects were developed using this financing mechanism.[1] In the past, solar projects have not been incorporated into LIHTC projects because of the unique challenges associated with integrating photovoltaic (PV) systems into existing financing models and the added cost to the new and existing developments.

The Northeast Denver Housing Center (NDHC), in partnership with Del Norte Neighborhood Development Corporation, Groundwork Denver, the National Renewable Energy Laboratory (NREL), Bella Energy, and the Governor's Energy Office of Colorado, has successfully installed PV systems on 12 separate existing buildings to provide renewable energy to 30 affordable housing units. NDHC was able to finance the PV system installations by blending private equity funding with utility rebates, federal tax credits, and public sector funding. A grant provided by the Governor's Energy Office was the key element that allowed for the creation of the new financing model and made the projects successful.

The program incorporated an innovative low-income job training program, an energy conservation incentive program, and a program that integrates renewable energy systems into existing affordable housing developments. Integrating PV systems into what is considered the most successful housing production model for affordable housing has the potential to significantly increase the deployment of PV systems across the United States. Throughout the process of addressing these challenges, NDHC was able to successfully accomplish the following project objectives:

- PV systems were installed on low-income housing properties in order to reduce the electric bills of Denver's most economically distressed families and provide electricity cost stability for 30 low-income residents.
- A new green-jobs training program was created for low-income residents that provided PV system installation training to 15 low-income residents. On-the-job PV system installation training was provided for four residents, as well as ongoing employment opportunities. As a result of the training program, two of the trainees are now employed as salesmen for a local solar company.
- A new energy conservation incentive program was developed in an attempt to motivate and empower all of the residents in the Whittier neighborhood to conserve energy. The program received funding through the reduction in electric bills from the roof-mounted PV systems.
- An innovative financing model was created and piloted, which affordable housing developers, owners, and managers can replicate throughout the country.
- NDHC will receive a net profit of $158,000 over the 25-year life of the project. These funds will be reinvested into additional renewable energy projects.
- Local jobs were sustained for a local solar company.

SOLAR AMERICA SHOWCASES BACKGROUND

The Solar America Showcases program was designed to accelerate demand for solar technologies among key end-use market sectors. As part of this activity, the U.S. Department of Energy (DOE) provided technical assistance, through its national laboratories, to large-scale, high-visibility solar installation projects that have the ability to impact the market for solar technologies through large project size, use of a novel solar technology, and/or use of a novel application for a solar technology. Selected showcase projects were intended to be replicable or have replicable components.

The community-based nonprofit NDHC in Denver, Colorado, was selected for a 2007 DOE Solar America Showcase award. The housing development, known as Whittier Affordable Housing Project (WAHP), is located in the historic Whittier neighborhood of northeast Denver and contains 86 rental units. The Whittier neighborhood is a mixed-income neighborhood that is ethnically and racially diverse. The housing units that received PV systems serve very low-income families who generally earn less than 60% of the area median income, which is $36,480 for a

1 Updating the National Low-Income Housing Tax Credit Database: Projects Placed in Service Through 2007. http://www.huduser.org/Datasets/lihtc/tables9507.pdf

family of two. The 86 units of WAHP consist of 19 single-story duplexes, 2 single-story triplexes, 2 two-story 6-to 7-unit townhomes, and 2 small apartment buildings. The units are owned by a limited liability company composed of NDHC as the general partner and a consortium of housing tax credit investors as the limited partners. This is the typical structure of an LIHTC affordable rental property in Colorado.

The unique mixture of low-income rental property and multi-family, multi-site, LIHTC-financed housing properties presents a series of formidable challenges, but also creates the potential to impact housing authorities throughout the country. The technical and financial barriers that were addressed through the implementation of this project are outlined in the following sections, with links to additional resources on specific topics provided in the Resources section at the end of this report.

SITE ANALYSIS AND SELECTION

An initial screening of 86 rental properties in an assortment of apartment complexes and multi-family townhomes was conducted using aerial imagery of the Whittier neighborhood in an attempt to eliminate locations with excessive shading and poor solar access. NREL and Groundwork Denver then evaluated 28 apartment complexes, townhomes, and duplexes for the application of roof-mounted PV systems. Any house that had an annual solar access of less than 85% (meaning the roof was shaded for more than 15% of the daylit hours throughout the year) or an excessive number of roof obstructions was eliminated from the study. PV systems were recommended for 12 multi-family units, providing electricity to 30 rental units, with a total installed capacity of 47.72 kilowatts (kW). An additional 9.4-kW system was installed on the roof of one Del Norte property. This resulted in PV systems being installed on 44.2% of the rental properties in the Whittier neighborhood.

After the final sites were selected, electricity bills for calendar year 2007 were processed for seven dwelling units in the Whittier neighborhood. Five of the electricity bills were associated with sub-metered single-family units, and two bills were associated with larger apartments that contain multiple individual-family units. To conservatively estimate the annual electricity usage of each unit, the PV systems were sized to meet 85% of the average unit's annual electricity use:

3,331 kWh/yr * 0.85 = 2,831 kWh/yr

Notably, this is equivalent to 100% of the lowest use tenant's annual electricity use. Comparatively, the typical American home uses approximately 11,040 kilowatt hours (kWh) of electricity each year.[2] In 2003, NDHC and the tax credit investors purchased and rehabilitated the rental properties to an energy efficient standard that included ENERGY STAR® appliances, compact fluorescent lighting, increased attic insulation, air sealing, and double-glazed, low-emittance windows. These homes are smaller and more efficient than a typical home and the tenants consequently use significantly less energy than the average American home.

A 1.88-kW PV system was installed on each rental property that received a roof-mounted PV system. The majority of the PV systems were installed on duplex units with the following characteristics:

- Building type: Single story
- Roof slope: 22°
- Azimuth angle:[3] Facing due south (180°)
- Roof type: Shingle
- Roof condition: Good
  (Each duplex was re-roofed in 2003)

The net metering agreement with the local utility, Xcel Energy, allows an electric customer to net meter electric production up to 120% of the customer's total annual electricity use. The systems were thus right-sized to avoid exceeding the net excess generation cap.

After the initial site selection and sizing process was complete, a competitive request for proposals (RFP) document was created and the project was bid out to local PV installers. The RFP included specifications for the procurement of equipment, hardware, documentation, labor, and the supervision required to install multiple grid-connected PV systems. In addition to the standard labor, equipment, and installation requirements, a number of unique requirements were built into the contractual documents.

Photovoltaic Panel Security System

All of the PV systems that were installed on single-story duplex units were required to include a PV panel security device, which was required based on the prevalence of theft and vandalism in the surrounding neighborhoods. The contractor was given the flexibility to propose a PV panel security device that was affordable and functional. Examples of acceptable security devices included theft-proof locking bolts, key locking mechanisms, or electronic alarm systems. The selected solar installer chose to use

2 Typical American Home Energy Use. http://www.eia.doe.gov/ask/electricity_faqs.asp
3 Azimuth Angle - The angle clockwise from true north that the PV array faces. See http://www.nrel.gov/rredc/pvwatts/changing_parameters.html#azimuth_angle .

breakaway nuts and bolts as an inexpensive and effective means of securing the solar PV systems from vandalism. The installer had used this method in the past and believed it to be the most effective security device.

Photovoltaic Monitoring System

All of the PV systems were required to include performance metering hardware and associated communications and reporting equipment. The intention was to create a web-accessible monitoring system. The metering systems were installed; however, they are not currently connected to any type of Internet-based communication system due to communication accessibility issues. The meters are manually read by NDHC staff once a month.

Photovoltaic Shading Analysis

Some of the installations have some level of shading from adjacent buildings, roof obstructions, and trees. The contractor mitigated the implications of shading obstructions on the performance of each PV array through the use of clever panel placement, tree trimming, and micro-inverters on each panel. Individual micro-inverters on each panel provide maximum power point tracking at the module level, which increases the overall electricity output of the array and provides additional output in partially shaded applications.

INNOVATIVE FINANCING MODEL

NDHC used a Denver-based investment company to finance the PV system installations. The program is set up as a third-party finance model that allows nonprofits to benefit from available federal tax incentives through a lower cost of solar electricity in the form of a Power Purchase Agreement (PPA). The PV project received the 30% federal investment tax credit, and the Modified Accelerated Cost Recovery System (MACRS) accelerated depreciation. Local utility incentives were also available through Xcel Energy's Solar*Rewards rebate program for $2 per watt, plus a production incentive of $0.11 per kWh over a 20-year period. In order to capture the federal tax credits, the equity investor created a limited liability corporation for this project and will own the system for 20 years.

The financial agreement is set up such that the investor will own the PV systems for 20 years and sell solar electricity to NDHC through a PPA. The payment schedule is based on annual average production, on-site shading calculations, and a projected annual performance degradation loss. At the beginning of year seven, NDHC will have the option to purchase the PV systems from the investor at the fair market value of the PV systems at that time. During that year, NDHC will purchase the PV systems from the investor (using the proceeds from an escrow account described below). Given that the investor will have received significant tax and utility incentives by the seventh year and the systems will have been fully depreciated, the fair market value of the PV systems negotiated between NDHC and the investor should be much less than the original installation price.

A grant from the state of Colorado's Governor's Energy Office for $107,500 was awarded to NDHC to finance the PV systems. The grant was then invested into the project in the form of a loan from NDHC to the investor, which combined the loan with the Xcel rebate, its own equity, and the federal tax incentives to pay for the installation of the PV systems.

Figure 1. Single-story duplex PV systems. *Photo from Northeast Denver Housing Center*

The investor has signed a PPA with NDHC/Del Norte and sells them electricity at a blended electric rate of $0.08 per kWh over the 20-year period. The PPA payments will escalate at a rate of 5% per year over the term of the agreement, and NDHC will be paying $0.1021 per kWh in year six. The average blended electric rate for a typical NDHC rental property as of April 2008, was $0.095 per kWh, thus the PPA reduces the bills for NDHC and the fixed PPA escalation rate provides electric rate cost security to NDHC over the next six years.

In addition to the electricity payments NDHC makes to the investor, the investor is required to make interest and principal payments to NDHC on the $107,500 loan.

The cash flow that NDHC receives as a result of the loan payments is escrowed and placed in a separate account. The total financial value of the loan payment was set up such that its value in year seven is expected to be in line with the fair market value of the PV system at that point in time. Thus, NDHC is projected to buy out the system at no cost to NDHC in year seven.

This financial model provides a number of benefits to both NDHC and the low-income tenants, such as:

- By loaning the grant proceeds to the private sector, the NDHC is able to capture all applicable tax and financial incentives, which it would otherwise be unable to do alone. Using the PPA structure also allows NDHC to avoid any up-front capital costs to install PV systems. Lending the grant proceeds to the PPA developer also allowed NDHC to install more PV systems than simply using the grant itself.
- The cost of electricity in the PPA ($0.08 per kWh) is less than current electric rate ($0.095), saving the NDHC money over the course of the PPA.
- In year seven, NDHC will be able to acquire the PV systems using the escrowed loan payments. At this point, NDHC will continue to receive a production incentive from Xcel Energy for the next 13 years for $0.11/kWh. The total value of the offset electricity and renewable energy credit (REC) payment to NDHC after year seven is $13,000-$14,000 per year.
- Although NDHC may operate at a loss for the first six years of the project (due to a "Project Challenge" described below), they will receive a net profit of $158,374 over the 25-year life of the project as a result of the innovative financing structure.
- NDHC will significantly reduce the greenhouse gas emissions from its rental properties as a result of this PV project.

A flow diagram outlining the PPA financial process is provided in Figure 2. A cash flow diagram from the start of the project through the end of year six is provided in Figure 3. In year seven, NDHC will purchase the PV systems from the investor for fair market value with the funding from the original loan. The cash flow diagram also illustrates the cash flow for the remaining life of the project.

Sub-Metering and Billing Option Analysis

Affordable housing financing structures provide two distinct ways that tenants are billed for their energy use (usually electricity or gas). In the first scenario, the property owner pays the utility bills directly and will pass the cost to the tenant through an increased rent payment. In the second scenario, the tenant pays his or her own utility bills and receives a precalculated reduction in rent.

For the first scenario, the building owner can set these utility allowances and increase the rental payments based on the allowances published by the local Public Housing Authority. These are calculated by HUD in the state of Colorado and published based on average energy usage of the tenants. In the first scenario, integrating PV into the utility billing system is relatively simple. Any savings from the PV system will be savings to the owner and/or investors. For example, if the PV system produces $10,000 per year in electricity, the owner and/or investors capture that savings, as determined by the financing structure put in place for the PV system.

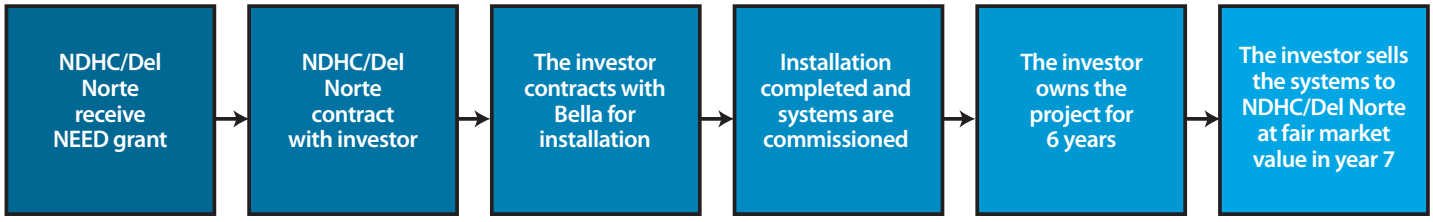

Figure 2. PPA Financial flow diagram

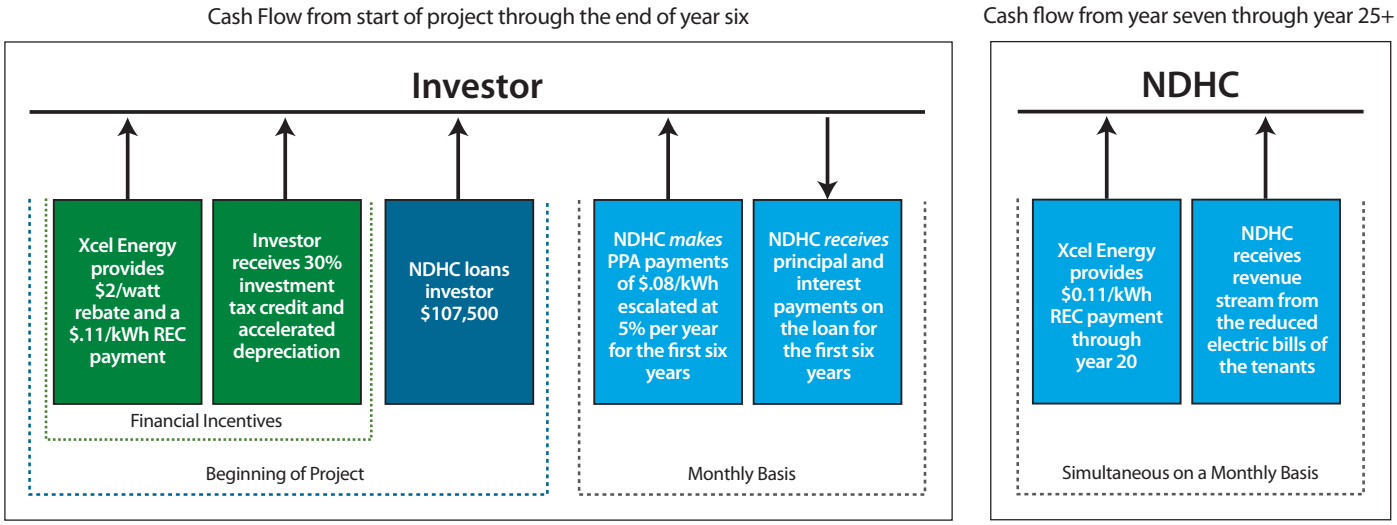

Figure 3. Project cash flow diagram

A well-documented limitation to the attractiveness of this structure is that tenants in rental housing use electricity more conservatively if they pay the bills themselves. Paying the utility bills for the tenants disincentivizes their conservation of energy, sometimes to the point of negating the savings from PV.

In the second scenario, the tenants are responsible for paying their own utility bills. If the tenants are responsible for paying their own utility bill, the owner must provide them with a utility allowance in the form of reducing the allowable rent for the unit.

If the second scenario is selected, the building owner may not be able to capture the PV savings, but the tenants of PV-equipped properties will benefit from the savings. In order for the owner to capture the savings, the housing provider would have to install a sub-metering system, bill the tenants for PV production, and collect the payments. The legality of this type of arrangement hasn't been verified in Colorado. In addition to the inherent problems associated with bill collection, sub-metering can be costly.

Implemented Solution

For this project, NDHC decided to implement the first scenario, where NDHC increases the tenant's rent by an amount predetermined by HUD. For this arrangement, NDHC will pay tenants' electric bills and thus the tenant portion of rent will increase by $25 per month. Tenants will, in turn, receive a decreased utility allowance to cover the natural gas portion of their monthly energy expenses.

JOB TRAINING PROGRAM

One of the innovative aspects of this Solar America Showcase project is associated with the development of a job training program for low-income residents. The job training program was designed to train multiple groups in solar installation, including:

- NDHC staff (program, property, and construction managers)
- Groundwork Denver staff (program managers, and training coordinators)
- Fifteen low-income community members.

The training program was structured as a grassroots effort to build capacity to design, specify, maintain, and live with PV systems within the local community. The training program also contained educational elements that were designed to build the internal capacity within the partnering organizations, identify appropriate rental properties for future PV systems, and develop bid documents and review forms to select the appropriate PV system type and installer.

The primary focus of the program centered on teaching low-income residents with no formal trade skills how to install PV systems. The Colorado Solar Energy Industries Association (COSEIA) (www.coseia.org/newsite/home.html) and Solar Energy International (SEI) (www.solarenergy.org/) are the leading solar workforce training institutions in the state of Colorado. The various training elements that were incorporated into this project were built on the local training opportunities offered through these organizations. Thus, these existing training programs served as the foundation and critical element needed to

make this training program successful. A listing of the job training programs that were incorporated into this program and the focus of the training program are provided below.

COSEIA Grid-Tied PV Class Plus Hands-On Workshop

Ten people attended a four-hour grid-tied PV class and four-hour hands-on workshop. These courses provided an introduction to PV system design and theory as well as the hands-on experience of installing and wiring a small, grid-tied PV system.

COSEIA PV/NEC Codes Course

Five of the attendees that attended the grid-tied PV class and hands-on workshop also attended a COSEIA one-day advanced PV/NEC codes course. This built upon the previous classes and provided more in-depth information on installation of grid-tied systems in Colorado.

SEI Training

Four of the trainees also completed the Solar Energy International online PV Design training. This five-week, self-paced course provides an overview of the PV system applications, primarily focusing on grid-tied systems. The course focused on:

- System components
- Site analysis
- PV module criteria
- Mounting solutions
- Safety
- Commissioning.

The course also covered the basics of sizing a residential grid-direct system, wire sizing, over-current protection, and grounding.

Ongoing Training for Community Members

In addition to these discrete classes, Groundwork Denver worked with four selected community members in an ongoing training program to help increase their knowledge and familiarity with building applications and energy efficiency. The training introduced the selected community members to solar energy by visiting solar installations, NREL, and local solar businesses, and by participating in energy audits. The trainees worked with Groundwork Denver for at least 40 hours in this capacity.

On-the-Job Training

The RFP required the selected solar installer to include up to five trained community members on its crew for these PV installations for 80-120 hours. The contractor was required to indicate in the proposal the plan to integrate these trainees into their workforce and any additional costs incurred for this requirement. The contractor was also required to describe any similar projects that involved working with trainees.

The solar installer integrated the trainees into these projects by first offering on-site training by one of their solar technicians on standard PV system installation practices. Once the trainees completed the preliminary training, each crew of trainees was assigned to a solar installer crew leader to guide them through the entire installation.

Two trainees were selected to work on the PV system installations. They assisted with panel and rack assembly and installation, wiring, and other job-site duties. Because of project installation delays, two additional trainees worked on job sites with another solar installation company prior to the NDHC solar installation; both were hired as solar salesmen for that company. Figure 4 shows a photo of the trainees installing PV systems.

Figure 4. Trainees installing PV systems. *Photo from Northeast Denver Housing Center*

TENANT EDUCATION

Tenant education was an essential component of the project. The education helped tenants understand the purpose of the PV installation while also providing the opportunity to assist them in lowering their energy bills. NDHC communicated with the tenants several weeks before the system was installed to explain the community-wide benefits of PV and what they might expect during installation, including noise, people on the roof, and minor service disruption.

NDHC designed a complementary energy conservation incentive program in an effort to motivate and empower all of the residents in the Whittier neighborhood to conserve energy. Specifically, the program helped to ensure that the tenants with the PV systems would maintain or lower their current electricity use once the electricity bills were in NDHC's name. NDHC is actively involving all of the residents in the program, regardless of whether they live in a unit with the PV system, to ensure they equally benefit from the program. Through the associated education program, residents learn how the solar panels produce energy, how simple changes in behavior can reduce energy consumption, and how the savings can benefit the entire Whittier community.

This second piece of the program was designed to help motivate all residents to fully participate in saving energy, giving them an equal opportunity to become involved and benefit from the program. NDHC is working with residents to set individual and community goals to reduce usage. The details of the incentives program are currently being refined.

PROJECT CHALLENGES

One of the fundamental challenges the project development team faced over the course of this project involved the amount of time required to secure funding for the installations of the PV systems. NDHC is a nonprofit organization that manages a large stock of low-income housing properties. Although there is a competitive pool of funding available for new housing developments, NDHC has a limited number of funding options to finance PV systems for existing rental properties. The only options available to NDHC throughout the course of this project were to raise money through fundraisers or secure funding through local grants. Consequently, it took almost a year and a half to secure grant funding to pay for the installation of the PV systems. This caused problems with the job training program based on the fact that the trainees received instruction toward the beginning of the program, but had to wait more than a year for the solar installations to start. As a result of this delay, two of the trainees started working with another solar installation firm as NDHC worked to secure funding.

Another significant challenge for the project was related to electricity billing. As previously described, one of the billing structures would have had the tenants maintain the utility bills in their own names. This was an attractive option because it incentivized the tenant to save energy. However, in this case, the tenant would receive the benefits of the solar system directly, but the owner could not capture the savings in order to pay back the investor for the PPA. In order to realize these savings, the owner would have to sub-meter the system and bill the tenant. This proposition had several problems:

1. NDHC was unable to get confirmation from HUD that this direct billing of tenants would be allowed.
2. Revenue grade sub-meters are expensive (at least $2,500 each).
3. Billing tenants would be time consuming, expensive, and would set up challenging situations for the owner or property manager when bills weren't paid on time.

The most realistic and expeditious option was for NDHC to take the meters into its name. In doing so, NDHC could recapture the utility allowance that is currently paid to the tenants who pay their own bills. In the case of Whittier Affordable Housing, this utility allowance, as set by the local HUD administrator, is only $25 per month for electricity, even though the average electricity bill for the units is at least $35 per month. As HUD states in their 4350 Handbook, the allowance is "not meant to cover all actual utility costs, but rather it is to reimburse a prudent utility consumer for their utility expense," which holds true in the case of the 12-month study of the 18 duplex units at Whittier. It was also noted in the review of the utility allowance and expenses that the allowance has not changed over the past 5+ years to match market increases. After further research and discussion with the local administrator, NDHC learned that the only way to increase (or decrease) the allowance is for the owner or management agent to submit a request to HUD if the utility rate "would cause a cumulative increase of 10% or more in the most recently approved allowances." NDHC and its team are now conducting this study to see if the project would be eligible for an increase.

Because of this challenge, assuming the tenants' electricity consumption remains constant after their electric bills are paid on their behalf, NDHC will be operating at a loss for the

first six years of the project. A hypothetical calculation for a one-unit property with a 1.88-kW PV system illustrates this challenge:

- Current annual electricity use: 3618 kWh/year
- Projected system output: 2723 kWh
- Money owed to investor for electricity production: $0.08/kWh * 2723 kWh = $218
- Electricity bill after net metering: (3618 kWh – 2723 kWh) * $0.093/kWh + ($6.75 x 12) = $164
- Utility allowance maintained by NDHC: $25/mo * 12 mo = $300 per year
- Balance owed by NDHC: $218 + $164 – $300 = $82.

So, NDHC will owe $82 more than they will receive through the combined savings from the PPA and the utility allowance for each residence. If the 18 duplex units maintain their historical usage, NDHC will have a negative cash flow of $2,908 at the end of the year. If tenants increase their usage by 10%, which could happen once they are no longer responsible for the bills, NDHC will face a negative cash flow of $3,654 at the end of the year. For this reason, NDHC must institute a successful incentive program to lower the tenants' utility bills. As of the publication date of this case study, NDHC is awaiting HUD's decision regarding whether incentives with monetary value can be provided to some tenants in a development, while not offering them to others.

Although NDHC will potentially operate at a loss for the first six years, when they purchase the PV systems with the principal and interest payments on the loan to the investor, they will receive $13,000-$14,000 in revenue from the electricity savings and REC payments each year. Over a 25-year period, they will receive a net income of $158,000 from the PV systems, with an estimated net present value of $67,000. Thus, this project will generate a significant revenue stream for NDHC after year seven and will provide enough funding to invest in additional renewable energy projects.

The final challenge faced in this project is based on the Whittier neighborhood being located in a historic neighborhood. The streets are lined with old-growth trees, some higher than 60 feet tall, and shading the majority of the residential rooftops. In addition, the majority of the homes were constructed before the first solar zoning codes were adopted in the 1950s, and some are located so close to one another that many existing residences shade NDHC's rooftops. Thus, only a small percentage of NDHC's housing stock has rooftops appropriate for solar energy systems.

CONCLUSION

The Northeast Denver Housing Center (NDHC) has successfully installed PV systems on 12 separate existing buildings to provide renewable energy to 30 affordable housing units. Although there were a number of challenges to be overcome, the program successfully incorporated an innovative low-income job training program, an energy conservation incentive program, and an innovative PV system financing model. The financing model and job training program were the first of their kind for low-income housing authority property owners, and laid the foundation for a replicable model for other affordable housing developers throughout the country.

Resources

Database for State Incentives for Renewables and Efficiency, including Net Metering
www.dsireusa.org/

Solar Ready Buildings Planning Guide
www.nrel.gov/docs/fy10osti/46078.pdf

Solar Photovoltaic Financing: Residential Sector Deployment
www.nrel.gov/docs/fy09osti/44853.pdf

Solar Photovoltaic Financing: Deployment on Public Property by State and Local Governments
www.nrel.gov/docs/fy08osti/43115.pdf

Determining the Value of Housing Tax Credits: An Example
www.hud.gov/offices/cpd/affordablehousing/training/web/lihtc/calculating/value.cfm

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