Massachusetts Renewable Energy Trust
Green Affordable Housing Initiative

# Early Results and Lessons Learned



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# Acknowledgements

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# Executive Summary

Wisdom Way Solar Village, courtesy of **HAP**Housing

In 2005, the Massachusetts Renewable Energy Trust (MRET), a division of the Massachusetts Technology Collaborative (MTC), launched the Green Affordable Housing Initiative (GAHI) as a demonstration program with the goals of stimulating use of renewable energy and green building practices in affordable housing. Through GAHI, MRET provided $25 million to eight grantees (referred to as Partners) that represent a range of organization types, from public funders to private developers, as well as a range of approaches and strategies for using the GAHI funds. The fundamental goals of GAHI were to (1) build a base of experience and data about the feasibility, benefits, and costs of incorporating green features in affordable housing; (2) identify successful approaches; and (3) support greater use of green features, including renewable energy, by sharing the results and lessons with the affordable housing sector and policymakers. To this end, MRET specifically sought to develop more than 1,600 green affordable housing units and install 2,175 kilowatts (kW) in renewable energy capacity through GAHI. GAHI funds will support completion of 68 housing developments, including 3,121 housing units, and installation of 2,580 kilowatts in renewable energy systems to support the developments.

GAHI is scheduled to be completed in early 2011. The purpose of this report is to share early findings and lessons learned by the Partners for the benefit of the affordable housing sector. At the time of this report, the Partners have completed 57% of their planned green housing developments (39 properties), enabling the summary and evaluation of a significant portion of the early outcomes. The findings, lessons, and potential next steps presented here are drawn from data on completed and planned GAHI properties, and from observations and insights shared by GAHI Partners.

In this report, readers will learn about the early results and findings related to the ongoing GAHI. First, readers will learn about the early housing, energy and environmental accomplishments (sections 2.2–2.5) and the organizational and market changes to date that relate to GAHI (section 2.6). Second, readers will learn about key lessons on the use of renewable energy and energy efficiency features in affordable housing. These lessons may be of use among affordable housing funders, developers, builders, and policymakers as they pursue ways to lower energy costs in affordable housing (sections 3.1 and 3.3). Third, readers will be presented with the factors that should be considered and how best to address them when considering photovoltaic (PV) for affordable housing properties (section 3.2), along with a discussion of alternative third-party ownership as a financing option for PV in affordable housing (section 4.1).

## Summary of GAHI Accomplishments as of August 2009

**At just over half completion, GAHI already has met or exceeded several key initial targets, including green certifications achieved by Partners, the number of affordable units created by the program, and the total kilowatt capacity of renewable energy systems installed.**

**GAHI also has contributed to transformational changes in the affordable housing sector that will support further "greening" of the affordable housing stock in the Commonwealth.**

## Findings

The major findings from the GAHI Partners' work up to this point include:

- GAHI's 68 developments will result in 3,121 housing units, almost double the original target.
  - 2,886 of these units will be affordable green housing units.
  - More than half of these units were produced through rehabilitation or conversion projects.
  - Most GAHI units are rental units, most are in multi-family properties, and some are mixed income or mixed use.
- GAHI will result in approximately 2,580 kilowatts (kW) in renewable energy system capacity upon completion of all remaining housing developments and systems (19% above original target).
  - GAHI properties offer the potential to ultimately generate 2,790,430 kilowatt-hours (kWh) annually.
  - 78.5% of the total square footage in GAHI developments will benefit from renewable energy systems.
- Based on only those photovoltaic (PV) systems currently installed, single-family developments will realize an annual savings of $27,623 based on an expected production of 183,126 kWh per year,[1] which corresponds to an average savings of $511 per unit. This figure may change with the installation and operation of additional renewable energy systems (nine single-family systems are in the pipeline with an expected production of 133,790 kWh).
- By replacing energy generated from fossil fuels, has already prevented 1.6 million pounds in carbon dioxide emissions—the equivalent of removing 112 cars from the road for 12 months.
- GAHI has created or catalyzed changes within the Partner organizations and within the broader affordable housing sector that support market transformation and sustained change beyond this demonstration program.
  - Partners have modified affordable housing financing policies to require or encourage use of green building practices.
  - Partners have increased their capacity to implement or oversee use of green building practices, including changes in operating procedures/tools, staffing, and training.

See section 2 of the report for a full discussion of these findings.

## Lessons Learned

Collectively, the experience of GAHI Partners translates into several overall lessons that inform future affordable housing programs, policies, and funding given the questions and challenges that MRET identified when it established GAHI. A full discussion appears in section 3 of the report.

- Lesson #1: All GAHI Partners report there is clear value in applying green building features, including renewable energy, to the development of affordable housing.

[1] These figures were derived based on installed annual capacity for 27 single-family units (total installed production estimate of 183,126 kWh per year) and the electricity rates of the utility providers for these GAHI properties: CLC, NGRID, NSTAR, Unitil, and WMECO. The residential utility electricity rates for these providers vary from $0.13/kWh to $0.20/kWh.

- Lesson #2: Incorporation of green building practices into public funding criteria and private housing development planning and operations supports continued development of green affordable housing (i.e., market transformation).
- Lesson #3: Energy efficiency measures offer the most cost-effective strategy to reduce energy costs and mitigate environmental impacts, warranting inclusion in all projects.
- Lesson #4: Data on building performance (energy, water) are critical in designing renovations and evaluating new system performance, but such data are still challenging to collect and analyze.
- Lesson #5: Because occupant behavior directly affects energy consumption, education efforts about how to best use energy-efficient fixtures and appliances and how to "live green" in the new GAHI units are critical.
- Lesson #6: Photovoltaic systems (PV) become more financially attractive for buildings with higher energy efficiency because a substantial amount of the energy needs can be met by solar production (particularly in single-family structures), driving toward net zero energy buildings.
- Lesson #7: When considering PV, developers and funders should carefully evaluate the site and planned building to make a realistic assessment of their feasibility for solar production and return on investment.
- Lesson #8: At this time, PV systems continue to require subsidies to be financially viable in affordable housing projects.
- Lesson #9: Due to regulatory changes and market forces, continued application and use of third-party ownership of PV systems are needed to fully determine the viability of this approach in affordable housing.
- Lesson #10: The flexible funding offered by GAHI allowed GAHI Partners to experiment with a range of models and approaches. This flexible grant approach is producing results that far exceed the initial projects' goals and is leading to long-term sustainable change in the affordable housing sector.

## Potential Next Steps for the Affordable Housing Sector

The summary of potential next steps identified below is drawn from the results of the work by GAHI Partners, and their feedback about ways members of the affordable housing sector can support the greening of this housing stock. A full discussion appears in section 5 of the report.

- Property Owners and Developers – Incorporate energy efficiency and water conservation in new and existing properties to the greatest extent feasible; monitor energy and water usage in your properties; consider renewable energy generation where feasible; and pursue funding for green improvements to your properties.
- Massachusetts Affordable Housing Lenders and Funders – Support a single, consistent set of application requirements and core green certifications; collect and analyze data on energy and water usage in properties you finance; and offer monitoring and technical assistance.
- Policymakers – Facilitate electronic access to utility data for owners and lenders; link financial support for renewable energy to energy efficiency improvements in properties; and continue financial support for renewable energy in affordable housing properties.

# 1.0 Introduction and Background

89 Oxbow Development (DHCD), courtesy of Building Initiatives, LLC

In January 2005, the Massachusetts Technology Collaborative (MTC) launched a $25 million demonstration program, the Green Affordable Housing Initiative (GAHI or the Initiative), with the goals of stimulating greater use of green building design and renewable energy in affordable housing. Prompting creation of this program were two major factors: (1) the limited adoption of green building features (including renewable energy) in the affordable housing sector in Massachusetts, and (2) sustained high increases in energy costs contributing to a substantial rise in overall housing costs for lower income residents. The program began with two grantees, or Partners, and ultimately was expanded to include a total of eight Partners to reflect a range of organizational types, geographic focus, and green building approaches. The following report summarizes the progress and accomplishments of GAHI to date. In providing this summary, the authors note that many of the GAHI Partners are still finishing projects and bringing them into operation.

## 1.1 Background

MTC was created in 1982 as an independent quasi-public agency to advance the growth of the technology sector of the Massachusetts economy through collaborative activities among industry, universities and state government. In the 1990s, MTC's responsibilities were expanded to include the newly created Massachusetts Renewable Energy Trust (MRET or the Trust). Funded through an excise tax on all ratepayers for electricity consumption, MRET's mission is to help Massachusetts citizens better realize the environmental and economic benefits of clean energy through a number of initiatives, financial incentives and rebates, and outreach efforts that target individuals, businesses, nonprofit organizations, housing developers, and energy producers.

Recognizing the potential benefits of "greening" affordable housing and the significant impact that utility expenditures have on housing costs for low- and moderate-income residents, MRET began to create GAHI in early 2005. The Initiative allocated $25 million for a range of approaches that would provide benefits to Massachusetts's lowest income ratepayers and was designed to encourage affordable housing developers, lenders, public agencies, and contractors to include renewable energy and green design features in both new and renovated affordable housing developments MRET.

## 1.2 GAHI Program Design and Goals

In establishing GAHI as a demonstration program, MRET sought to encourage new approaches to the financing, design, construction, and operation of green affordable housing by funding a variety of organizations and approaches that reached across key stakeholders. MRET met with parties from the affordable housing industry, including developers, builders, financing entities, and public and private agencies, to solicit input on design and delivery of the demonstration program. Their feedback revealed many common, important obstacles to broad adoption of renewable energy and other green building practices in affordable housing, including:

- Lack of understanding and misperceptions about green building practices, including renewable energy systems
- Uncertainty about costs and fear that they outweigh benefits
- Developer concerns that green features could actually work against them when seeking financing from affordable housing programs and lenders
- Uncertainty about the actual performance of green features in affordable housing properties and the types of projects that will yield reliable benefits

MRET designed GAHI based on a "theory of change" developed specifically to address these obstacles. More detail about the theory can be found in appendix 3.

The emergent program design provided funding for incorporation of renewable energy and green building features in affordable housing projects, allowing Partners to experiment and develop experience with green building and renewable energy.

Through GAHI, MRET sought to:

- Increase the numbers of affordable housing units with renewable energy systems and green design elements
- Identify new strategies to make green affordable housing more financially feasible
- Improve understanding of the reliability and feasibility of green technologies (with a focus on renewables), identifying ways to minimize the risks associated with these technologies and practices, and evaluating their long-term value in affordable housing projects
- Identify how to most effectively support permanent and self-sustaining market changes to incorporate renewable energy and green design in the affordable housing development process
- Determine how best to serve low-income ratepayers and affordable housing occupants, who have been underrepresented as beneficiaries of MRET programs

### GAHI Theory of Change

**Financial assistance (grant awards) and technical support provided to key organizations involved in development, preservation, and operation of affordable housing would increase knowledge within the affordable housing sector about renewable energy systems and other green building practices, including successful transferable models and tools. This knowledge and replicable models would, in turn, result in additional sustainable actions across Massachusetts's affordable housing sector to pursue green affordable housing projects.**

Fundamentally, the Initiative was based on the premise that incorporating renewable energy and green building features into residential housing can reduce long-term energy costs and improve building performance. Renewable energy installations can provide a reliable supply of energy at a stable cost, reducing vulnerability to fluctuating fossil fuel prices. In turn, these installations can contribute to increased economic activity resulting from services provided.

Under GAHI, MRET defined "green" to include energy efficiency improvements, other green building features, and renewable energy generation as part of each development. In particular, the funding guidelines required that all GAHI-funded developments meet or exceed an ENERGY STAR® rating or its equivalent.

Beyond establishing a baseline for green with the ENERGY STAR requirement, MRET intended GAHI to be a flexible program to maximize its demonstration focus and experiment with a range of approaches and different types of grantees. MRET sought to create a *partnership* between MRET and its grantees, terming them "Partners," to provide them with the funding and framework to explore and learn from one another as different approaches and models were tested. Partners used GAHI funding for different types of affordable housing developments, renewable energy systems, green and energy-efficient features, and, for some, training and education (see section 2.1).

## 1.3 GAHI Partners

MRET selected GAHI's eight Partners in two rounds, with funding awards ranging from $1.5 million to $8.5 million. Initially, MRET made two awards totaling $10 million—one to the Joint Management Committee (JMC) and one to the Massachusetts Housing Finance Agency (MassHousing). These two organizations, described in more detail below and in appendix 2, were selected because of their broad reach across the Commonwealth and ability to influence a large range of affordable housing properties and stakeholders. MRET then developed the Challenge Program for the remaining $15 million, designed to encourage experimentation among a range of additional Partners.

In February 2006, as MassHousing and JMC were just launching their GAHI programs, MRET issued a competitive solicitation for the remaining $15 million in GAHI funds. Ultimately, 18 applicants submitted a total of 21 unique proposals. Of these proposals, 14 sought to fund multiple developments, with the remaining 4 applicants seeking funds for single, state-of-the-art, green, affordable housing projects. The proposals sought a total of $76 million. MRET asked applicants to reconfigure their proposals and reduce their funding requests to match the available funding. Subsequently, an external 19-member evaluation team reviewed the proposals and selected the winning applicants.

## What Is ENERGY STAR?

ENERGY STAR® is the U.S. Government–backed label for energy efficiency. The ENERGY STAR label identifies homes, buildings, and consumer products that meet specific standards for energy efficiency and performance. The ENERGY STAR Qualified Home standards are applicable only to properties of three stories or fewer, including multi-unit properties. There are currently no established energy performance standards for new construction of multi-unit properties more than three stories because the definition of energy efficiency in these buildings is difficult. The U.S. Environmental Protection Agency (EPA) is piloting an ENERGY STAR labeling program for multi-family buildings with four or more floors.

Under the Challenge Program, MRET awarded $14.5 million to six additional Partners.[2] In making these selections, MRET noted the Partners had the most potential to (1) target a range of segments of the affordable housing stock, (2) try innovative approaches, (3) catalyze affordable housing stakeholders, and (4) minimize the risk to MRET of not getting results due to a lack of diversity in projects. The Partners represented a portfolio of programs with the opportunity to influence a large number of future and existing affordable housing units by:

- Employing a range of program tools for encouraging renewable energy installations (e.g., grants, financing, technical assistance, etc.) to determine which tools work best and under what circumstances
- Incorporating integrated design practices, energy efficiency, and green building features that are financially feasible for affordable housing properties and meet existing standards, including ENERGY STAR, LEED[3], or performance beyond Commonwealth energy codes
- Encouraging diversity of renewable energy technologies
- Encouraging projects that will implement the Commonwealth's Sustainable Development principles

The additional six Partners are: Boston Community Capital (BCC), Cape Light Compact (CLC), the City of Boston's Department of Neighborhood Development (DND), HAP, Inc. (now **HAP**Housing), the Massachusetts Department of Housing and Community Development (DHCD), and WinnDevelopment (Winn).

Exhibit 1 provides a brief summary of each Partner, including the type and mission of a Partner's organization, amount and length of GAHI award, objective of their proposed GAHI program, geographic area targeted, type of units built, and type of renewable energy systems used and considered. The unit types presented include new construction, rehabilitation, and conversion units.[4] See appendix 2 of this report for additional detail on each Partner, including accomplishments to date.

[2] MRET also awarded six planning grants to develop an operational plan that will lead to a program incorporating renewable energy, energy efficiency, and green design as part of affordable housing developments. These planning grants were not part of the GAHI Monitoring and Evaluation initiative.

[3] LEED is the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ that provides a framework for building both residential and commercial buildings to meet specified green building, energy efficiency, and conservation metrics for construction and operation. LEED Homes and LEED New Construction have multiple certification tiers including certified, Silver, Gold, and Platinum scoring levels.

[4] Newly constructed units must be units built where none previously existed, abandoned or fire-damaged units being returned to residential use, or residential units vacant for 2+ years. Conversion units are new residential units being created in a previously existing structure that was nonresidential or nonresidential zoned prior to conversion of the interior units. Conversion units are a subset of new units as the units themselves are new. Rehabilitation units are those in an existing residential building undergoing construction improvements.

**Exhibit 1: Summary of GAHI Partners**

| | Organization | | GAHI Award | | GAHI Program | | | |
|---|---|---|---|---|---|---|---|---|
| Partner | Type | Mission | Amount | Length | Proposed Objective | Geographic Area | Type of Units | Type of RE System |
| Boston Community Capital | Nonprofit community development financial intermediary agency | Provides loans to organizations for housing, community facilities, and social service projects | $5 million | 36 months | Develop a sustainable market-based model for financing renewable energy systems in affordable housing | Statewide | ▪ Multi-family<br>▪ Rehab<br>▪ Rental<br>▪ Affordable | PV |
| Cape Light Compact | Regional energy services organization serving Cape Cod and Martha's Vineyard | Administers the regional energy efficiency program and works with the combined buying power of the region's electricity consumers to negotiate for lower cost electricity | $1.5 million | 49 months | Provide financial incentives to building developers and home builders for advanced building performance and find ways to shrink the environmental footprint of homes on Cape Cod/Martha's Vineyard | Counties of Barnstable, Dukes | ▪ Single-family & multi-family<br>▪ Conversion & new construction<br>▪ Homeowner & rental<br>▪ Affordable | PV (considered wind) |
| City of Boston Department of Neighborhood Development | Housing and community development agency for city of Boston | Provides neighborhood housing services and economic and community development programs in Boston | $2 million | 36 months | Incorporate renewable energy, energy efficiency, green design, and healthy homes construction techniques into an affordable housing program for Boston | City of Boston | ▪ Single-family & multi-family<br>▪ Rehab & new construction<br>▪ Homeowner & rental<br>▪ Affordable & market-rate | PV |
| **HAP**Housing | Private nonprofit housing organization in western Massachusetts | Provides housing services to tenants, property owners, homebuyers, homeowners in Hampden and Hampshire counties | $2 million | 36 months | Provide grants to developers for advanced building performance, including installation of renewable energy systems and rebate incentives for eligible affordable housing developers to install systems in their developments | Counties of Berkshire, Hampden, Hampshire, Franklin | ▪ Single-family & multi-family<br>▪ New construction<br>▪ Homeowner & rental<br>▪ Affordable & market-rate | PV (considered wind, bio-diesel, hydroelectric) |

| | Organization | | GAHI Award | | GAHI Program | | | |
|---|---|---|---|---|---|---|---|---|
| Partner | Type | Mission | Amount | Length | Proposed Objective | Geographic Area | Type of Units | Type of RE System |
| Joint Management Committee | Committee comprising various utility companies and energy efficiency service providers in Massachusetts | Sponsors the Massachusetts New Homes with ENERGY STAR Program | $1.5 million | 54 months | Focus on education, outreach, and training in the areas of green construction and renewable energy incentives or rebates to developers and builders that incorporate renewable energy systems in their affordable housing projects | Statewide | ▪ Single-family & multi-family<br>▪ Conversion & new construction<br>▪ Homeowner & rental<br>▪ Affordable & market-rate | PV |
| Massachusetts Department of Housing & Community Development | Massachusetts State affordable housing agency | Supports construction and rehabilitation of affordable housing in Massachusetts | $1.5 million | 36 months | Provide additional funding to affordable housing developers as an incentive to bring green building design into their projects; use funds to include energy conservation and generation in new buildings | Statewide | ▪ Single-family & multi-family<br>▪ New construction<br>▪ Homeowner<br>▪ Affordable | PV |
| MassHousing | Quasi-public affordable housing lender | Uses bond financing and other funds to finance affordable housing developers for low and moderate income residents | $8.5 million | 48 months | Provide feasibility, design, and construction grants to developers to assess, design, and install renewable energy systems in affordable housing developments | Statewide | ▪ Multi-family<br>▪ Rehab & new construction<br>▪ Homeowner & rental<br>▪ Affordable & market-rate | PV (considering wind) |
| Winn Development | Private affordable housing developer | Develops, owns, and manages affordable housing units in Massachusetts and nationwide | $2.5 million | 42 months | Incorporate energy efficiency and renewable energy in affordable properties that represent three building types — townhouse, apartment style, and historic mill building — to test ROI and cost effectiveness | Statewide | ▪ Multi-family<br>▪ Conversion & rehab<br>▪ Homeowner & rental<br>▪ Affordable & market-rate | PV (considered wind) |

## 1.4 Overview of Partners and Select Goals

The following table provides an overview of all eight Partners in terms of key high-level goals, including planned number of units and renewable energy system capacity in kilowatts (kW) Note: Data on Partner accomplishments to date (as distinct from planned targets below) can be found in section 2.

**Exhibit 2: Partner Summary[5]**

| Partner | Number of Planned Units | Total Planned System Capacity (kW) |
|---|---|---|
| BCC | 500 | 700 |
| CLC | 62 | 124 |
| MassHousing | 340 | 740 |
| JMC | 39 | 136 |
| DND | 200 | 130 |
| HAP | 130 | 125 |
| DHCD | 50 | 80 |
| Winn | 300 | 140 |
| **TOTALS** | **1,621 units** | **2,175 kW** |

## 1.5 GAHI Monitoring and Evaluation

GAHI monitoring and evaluation activities were guided by the evaluation design[6] developed by the evaluation team and approved by MRET leadership in November 2007, together with the accompanying implementation plan for data collection and analysis. The structure of the evaluation is to:

- Measure Partner performance and results (e.g., number of housing units assisted, capacity of renewable energy systems installed, green building features incorporated into GAHI properties)
- Capture lessons from the experience of Partners that will inform current and future efforts in the affordable housing sector to develop properties with renewable energy and other green features
- Provide the basis for examining program outcomes and impacts in the future, once GAHI properties have been in operation long enough to provide the necessary data

Appendix 3 provides a summary of the evaluation design.

At the time of this report, GAHI Partners have completed most of their projects, and some projects have been in operation long enough to provide an initial report on the program. Important to note is that Partners did experience schedule challenges in implementing their grants due to several factors, including the 2008–2009 economic downturn that affected housing finance markets.

[5] Information on planned units, types of units, and system capacity are from original program agreements between each Partner and MRET with the exception of MassHousing targets, which are from the annual documents for Fiscal Years 2006–2010.
[6] *GAHI Monitoring and Evaluation Plan, October 2, 2007,* Submitted by ICF International to MTC/MRET.

This report documents Partners' performance through August 2009 and addresses five key evaluation questions listed below.

Visiting Nurse Association Senior Living Community (MassHousing), courtesy of MRET

## Key Evaluation Questions Addressed in This Report

1. What are the definitions of "green housing" used by the Partners and how do they compare with other common definitions used by key actors?
2. What changes has the Initiative achieved in terms of renewable energy capacity and generation in the affordable housing sector?
3. To what extent did the Initiative reduce adverse environmental impacts that stem from consumption of energy from fossil fuel sources?
4. To what extent did the Partners' activities contribute to permanent, self-sustaining change in terms of using renewable energy and other green building practices in the affordable housing sector?
5. What are the lessons from the experience of the Partners about ways that renewable energy and other green housing practices can be successfully incorporated into affordable housing programs and projects?

The early evaluation findings regarding GAHI Partner performance and the five evaluation questions are addressed in sections 2 and 3. Section 4 presents several profiles that highlight innovative practices used by Partners that could be used by others in the affordable housing sector. Section 5 describes the conclusions from the data available at this point in the program, and recommends actions for the affordable housing sector based on Partner experiences.

Once the remaining GAHI projects are completed and placed in service for an adequate period, the results presented in this report can be updated to provide a final picture of Partner accomplishments. While an update will provide a full accounting of Partner results, the evaluation team believes the major overall findings presented in this report will not change.

Finally, the Partner data, analysis, and results presented in this report provide an important foundation for potential future evaluations examining the program outcomes and longer term impacts of GAHI. A framework for examining GAHI outcomes and impacts is outlined in the evaluation design document. See appendix 3 for more information.

# 2.0 Overall Achievements of the Initiative

This section summarizes the key results and accomplishments of GAHI from its inception through the May 2009 reporting period.[7] In summarizing the data currently available for the Partners' 68 housing developments, it is important to note that many of the developments are either still in the construction phase or in the early stages of occupancy, and/or have not had sufficient operating periods to draw definitive conclusions about the benefits of their green and renewable energy features, particularly their cost savings. Because of these factors—combined with the variety of approaches undertaken by the GAHI Partners (a deliberate decision given the demonstration nature of the program)—this section primarily focuses on the results associated with *completed* developments, but also includes some data on pipeline developments.

## Summary of GAHI Accomplishments As of August 2009

At just over half completion, GAHI already has met or exceeded several key initial targets, including green designations achieved by Partners, the number of affordable units created by the program, and the total kilowatt capacity of renewable energy systems installed.

GAHI also has contributed to transformational changes in the affordable housing sector that will support further greening of the affordable housing stock in the Commonwealth.

Thirty-nine GAHI housing developments (57%) are currently completed. Of the remaining 29 developments in the pipeline, thirteen will be completed by the end of 2009. Thirteen developments are set for completion in 2010, and one in 2011. Completion dates are unknown for two planned developments. Because of the staggered start of the program, Partners' developments also are staggered in terms of completion, occupancy, and operation. To conclusively assess the program's outcomes and impacts, a summary evaluation would need to be done upon completion of GAHI.

## Findings

- GAHI has catalyzed or effected changes within the Partner organizations and within the broader affordable housing sector, creating the opportunity for longer term and sustainable change beyond the demonstration program.
- GAHI will result in 3,121 housing units, almost double the original target.
- GAHI will result in approximately 2,580 kW in capacity (19% above the program's original target) upon completion of all remaining developments.
- GAHI will ultimately generate approximately 2,790,430 kWh annually from renewables.
- GAHI has installed enough renewable electricity capacity so that 78.5% of the total square footage of all developments in the program will benefit directly from renewable energy systems.
- Based on those PV systems currently installed, single-family developments will realize a total annual savings of $27,623 based on an expected production of 183,126 kWh per year, which corresponds to an average savings of $511 per unit. This figure may change with the installation and operation of additional renewable energy systems (nine single-family systems are in the pipeline with expected production of 133,790 kWh).
- GAHI renewable energy generation has already prevented 1.6 million pounds in carbon dioxide emissions, the equivalent of removing 131 cars from the road for 12 months.

[7] Some data are more recent than the formal Partner development reports submitted in May 2009. Actual kilowatt-hour production data from the MRET Production Tracking System (PTS) are current as of June 30, 2009. Partners also updated some development data through August 31, 2009, during interviews.

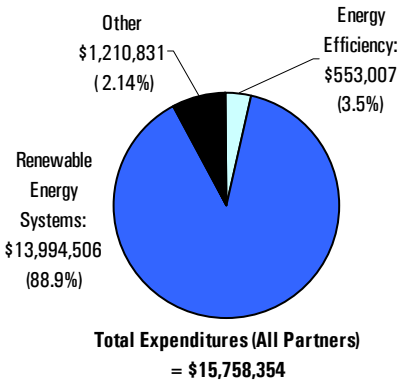
This section discusses the key results of GAHI so far, but also has notations about critical plans for what will be accomplished in the remaining 6–18 months (notably, planned or pipeline units and renewable energy production). Data are provided at the program, Partner, development, and unit levels to show a comprehensive view of GAHI's early results. In the following sections, data are presented in tables and charts together with an analytical narrative that discusses the key findings regarding the program. Where results or accomplishments have not yet been realized (for example, pipeline or in-construction units, or estimated annual kilowatt production), the assumptions or estimates used are included and footnoted as necessary.

## 2.1 Budget and Expenditures

Of the $25 million in grants that MRET allocated to the eight Partners, $15,758,344 (64%) have been expended to date. Some Partners are still in planning and/or construction phases for some of their housing developments. Again, MRET intentionally selected Partners and approaches to provide an array of models for the demonstration program. The budgets and expenditures of Partners, therefore, reflect an array of acceptable activities, including not only the required unit construction or rehabilitation and installation of renewable energy systems, but also training, outreach, education, and administrative costs. For the six Partners seeking to use the funding for renewable energy systems and green measures, MRET mandated that at least 70% of GAHI funds be spent on renewable energy and no more than 30% be spent on energy efficiency.[8]

Within these expenditures, 89% ($13,994,506) of all GAHI funds to date have been spent on renewable energy. Excluding MassHousing and BCC, which spent all their funds on renewable energy, the Partner expenditures to date for renewable energy are just under 85%. Three and a half percent of funds ($553,007) have been spent on energy efficiency. A tiny portion (0.14%) of GAHI funds was spent on training, by HAP in 2007 and 2008 (not shown in Exhibit 3). Winn and DND also conducted trainings but used other funding sources.

**Exhibit 3: Breakdown of GAHI Partner Spending to Date**




Total Expenditures (All Partners) = $15,758,354

Exhibit 4 provides the original budgets for each Partner, expenditures through the May 2009 reporting period, and a detailed breakdown of the major categories of spending among the Partners. Figures for expenditures are based on Partner payment requisitions and budgets through May 2009, supplemented by Partner interviews. Percentages in the table are based on expenditures, not on the Partner's total budget.

As discussed, most GAHI Partners were required to spend at least 70% of funds on renewable energy (and all opted for photovoltaic (PV) systems in this category). Their performance so far suggests that the target will be exceeded. The average percentage of *expended-to-date* funds devoted to renewable energy was 73%, with the lowest percentage at 62%.[9] The second largest category of spending is energy efficiency measures. The most commonly used energy efficiency measures are captured in section 3.3 of this report. DHCD has spent the most on energy efficiency measures, at 21% of its grant. Many Partners leveraged other grants, organizational funds, and rebates to supplement their GAHI funding for green features and improvements.

[8] As stated in their GAHI contractual agreements with MRET, MassHousing and BCC planned to use all GAHI funds for renewable energy installations.
[9] This percentage will likely rise for the Partners that are currently less than 70% as they complete additional units and report these expenditures. MassHousing and BCC, which spent 100% of GAHI funds to date on renewable systems, were excluded from this calculation.

## Exhibit 4: Partner Budget and Expenditures to Date

| | | | Expenditures to Date | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Partner | Total GAHI Grant Award | Total Spent | % Spent on EE | % Spent on RE | % Spent on Training | % Spent on Administration & Direct Labor | % Spent on Marketing | % Spent on Subcontractors | % Spent on Travel | % Spent on Overhead | % Spent on Other Direct Costs[10] |
| BCC | $5,000,000 | $4,922,000 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CLC | $1,500,000 | $462,364 | 0.6 | 62 | 0 | 7 | 0 | 13 | 0.5 | 0.5 | 17 |
| DND | $2,000,000 | $903,182 | 7 | 93 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DHCD | $1,500,000 | $655,998 | 21 | 79 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MassHousing | $8,500,000 | $4,257,147 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JMC | $1,500,000 | $1,169,326 | 0 | 67 | 0 | 32.45[11] | 0.55 | 0 | 0 | 0 | 0 |
| HAP | $2,000,000 | $960,328 | 3.5 | 64 | 2.32 | 16.5 | 0 | 7 | 1 | 6 | 2 |
| Winn | $2,500,000 | $2,427,999 | 13 | 73 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| **TOTAL** | **$24,500,000** | **$15,758,344** | | | | | | | | | |
| **AVERAGE** | **$3,062,500** | **$1,548,049** | **5.64** | **79.75** | **0.29** | **6.99** | **0.07** | **2.50** | **0.19** | **0.81** | **4.13** |

[10] Per the Partners, these other direct costs include performance incentives to achieve higher LEED scoring, LEED certification fees, legal fees, construction management fees, and design and program management costs not covered by the other categories.

[11] The JMC partnership was structured slightly differently than other GAHI grants. Within spending allocated to Administration and Direct Labor, JMC includes project recruitment, project administration, and data reporting requirements.

### 2.1.1 Cost of Installed Renewable Systems

To date, all completed GAHI Partner developments have installed PV systems as their renewable energy systems. Only one development in the pipeline is considering another type of renewable system. As a result, this report uses the term PV interchangeably with renewable energy systems. Among completed developments for which cost and capacity data were available (33 developments), the average cost per kilowatt is $8,600 (median is $7,973).

In comparison, MRET's Commonwealth Solar program, which provides rebates to residential, commercial, industrial, and public facilities for PV installation through a noncompetitive application process, reports an average cost per kilowatt of $7,140 for 959 systems. The breakdown of both GAHI and Commonwealth Solar cost per kilowatt by PV system size is shown below (note that the Commonwealth Solar cost figures are based on a much larger number of systems and costs than the GAHI figures.[12])

**Exhibit 5: Comparison of Average Cost Per Kilowatt for Installed PV Systems**

| Size | GAHI | GAHI PV Systems | Commonwealth Solar | Commonwealth PV Systems |
|---|---|---|---|---|
| 25 kW and fewer | $8,028 | 58 | $8,100 | 879 |
| > 25–100 kW | $9,137 | 43 | $7,040 | 46 |
| > 100–200 kW | $9,688 | 3 | $6,480 | 24 |
| > 200 kW | $7,498 | 1 | $6,570 | 10 |

## 2.2 Housing Achievements – Number of Developments and Units

In launching GAHI, MRET sought to create a total of 1,621 green affordable units and install 2,175 kW of renewable energy system capacity to help reduce energy costs. These figures were based on goals set by Partners in their original GAHI proposals and subsequent grant agreements with MRET, although this figure includes only Fiscal Year (FY) 2007 and FY 2008 targets for MassHousing.

To date, GAHI Partners have exceeded the overall target for number of housing units, and 29 developments remain to be completed.

**Exhibit 6: GAHI Program Targets and Results to Date**

| | Target # | Completed # | Pipeline # | Estimated Total # |
|---|---|---|---|---|
| Units | 1,621 | 2,195 | 926 | 3,121 |
| Kilowatts | 2,175 | 1,861 | 719 | 2,580 |

### 2.2.1 Partner Target Developments and Units

The eight Partners currently plan to complete a total of 68 GAHI developments, including some properties with a mix of GAHI-funded green affordable units, market-rate units, and retail space. Within the GAHI developments, there are a total of 3,121 units. This figure includes 2,306 GAHI-funded units (74%) and 815 non-GAHI funded units (26%). (Partners could use GAHI funds only for units that meet the program's affordability requirement, not for market-rate units that might be built as part of the same development. In some developments, however, all units benefit from renewable energy systems supporting common

[12] *Commonwealth Solar Summary Data* provided by MRET and available on the MRET Web site (http://www.masstech.org/SOLAR/CommSolarSummaryData.pdf).

areas.) Unless otherwise noted, the following summaries include all units developed in conjunction with GAHI.

Within the GAHI developments, 2,195 units are completed or will be completed by August 31, 2009. A total of 926 units are in the pipeline.

Exhibit 7 provides a detailed breakdown of total and GAHI-funded units for each Partner, including the original target number of total units for each Partner (taken from Partner Program Agreements), completed units, and pipeline units.

**Exhibit 7: Unit Targets and Results by Partner**

| Partner | Partner Total Unit Target | Completed Units | | Pipeline Units | | Total Units Installed and in Pipeline |
|---|---|---|---|---|---|---|
| | | Rental | Homeowner | Rental | Homeowner | |
| BCC | 500 | 1,008 | 0 | 0 | 0 | 1,008 |
| CLC | 62 | – | 22 | 12 | 28 | 62 |
| DND | 200 | 133 | 1 | 60 | 16 | 210 |
| DHCD | 50 | – | 50 | 0 | 20 | 70 |
| MassHousing | 340 | 523 | 0 | 673 | 0 | 1,196 |
| HAP | 130 | 0 | 11 | 10 | 87 | 108 |
| JMC | 39 | 6 | 42 | 12 | 8 | 68 |
| Winn | 300 | 324 | 75 | 0 | 0 | 399 |
| **TOTAL** | **1,621** | **1,994** | **201** | **767** | **159** | **3,121** |

As the table shows, two Partners (BCC and Winn) have completed their construction. DND has completed 74% of its units, and JMC has completed 71%. CLC, DHCD, HAP, and MassHousing have units in the pipeline. Construction is expected to continue into late 2011 for at least one development.

### 2.2.2 Characteristics of GAHI Developments

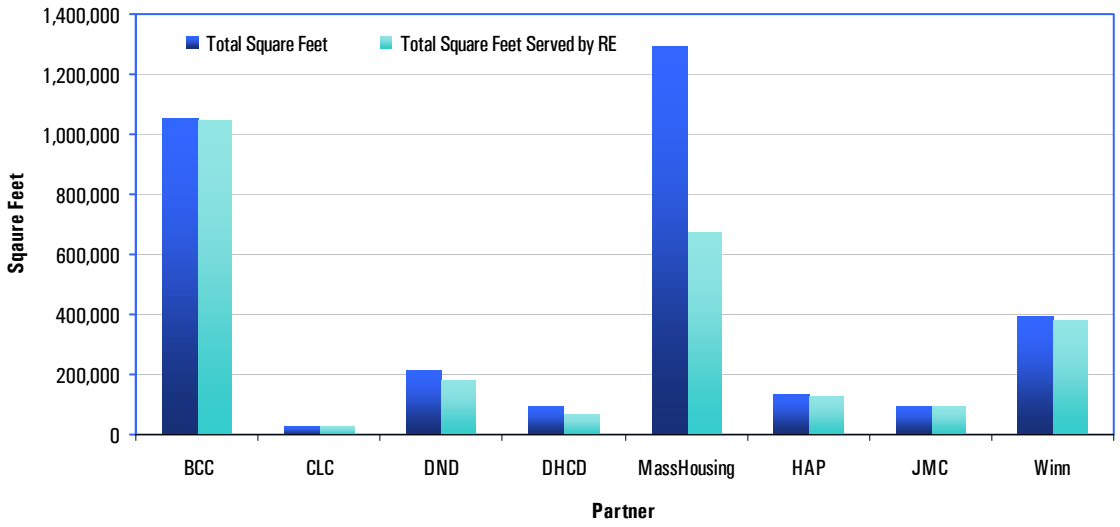
GAHI developments represent a mix of small and large units, homeowner and rental, new construction (and conversion) and rehabilitation, and small and large PV systems. Some developments also include retail space as an added attraction to occupants and as part of larger strategic plans to stimulate local economic development in a target area. The following charts and tables illustrate the housing characteristics of these developments. Section 2.3 describes the green certifications achieved, and section 2.4 describes the PV system characteristics and energy production accomplishments to date.

#### Development Square Footage

The GAHI-funded developments vary in size from a 1,200-square-foot, single-family home to a 337-unit development of 377,666 total square feet. The smallest individual unit in the GAHI portfolio is a 584-square-foot condominium. Ultimately, GAHI will result in more than 3.27 million square feet of new or rehabilitated green affordable housing units (square footage not available on all planned developments). This figure includes 2.43 million square feet of residential living space. Partners have used GAHI funds to develop residential or resident-occupied units, common areas, or both residential and common areas.

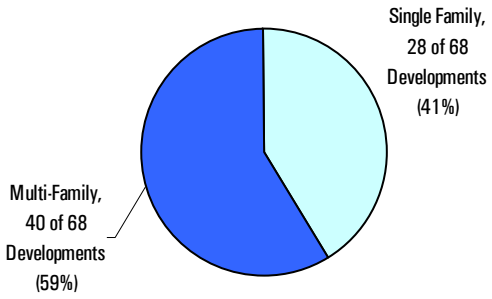
Within the 3.27 million square feet of space, 2.57 million square feet (78%) will be supported with electricity generated from the installed renewable energy systems. All the square footage in JMC's developments and 99% of that in BCC's developments will be supported with the installed renewable energy (PV) systems.

**Exhibit 8: Partner Square Footage**




### Structure Type

**Exhibit 9: Structure Type**

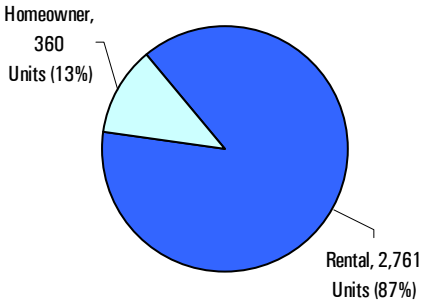



The GAHI-funded developments range from single-family, detached homes to large, multi-unit, multi-building developments representing both rental and homeownership units. The median number of units in the GAHI-funded developments is 16. In this report, we use the definition of multi-family from the U.S. Department of Housing and Urban Development (HUD): containing five or more units. As a result, our analysis considers developments up to four units (including single-family homes and duplexes) as single-family and all developments containing five or more units as multi-family.

**Most GAHI developments (60%) are multi-family.** The 40 multi-family developments include 2,980 units (95% of all units). Multi-family developments vary greatly in size. Just over half (53%) are 5–50 total units. About one-eighth (13%) are composed of 51–100 units, and about one-third (33%) include 101 units or more. The median number of units in the multi-family developments is 46.

## 2.2.3 Characteristics of GAHI Units

**Exhibit 10: Unit Ownership Type**



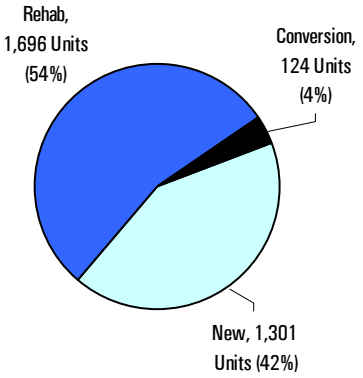

GAHI developments include a range of different unit types in terms of homeowner and rental units, and affordable and market-rate units.

### Unit Ownership Type

**Most GAHI units are rental units (87%).** Of these 2,761 rental units, bedroom data are available for 2,561 units. Of these, most are 1-bedroom (30%) and 2-bedroom (29%) units. Of these rental units, 18% are efficiency units. Of the 360 homeowner units, 19% are 2-bedroom, and 31% are 3-bedroom units.

### Construction Type

**Exhibit 11: Construction Type**



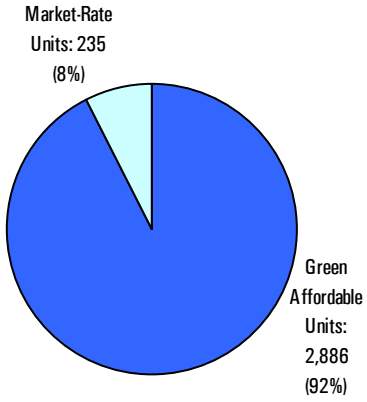

**Most GAHI units were created through rehabilitation or conversion of existing structures.** Just over half of all units involved rehabilitation of existing housing units. New construction accounts for 42% of units, and conversion for 4%.

### Mix of Affordable & Market-Rate

**Some units are market-rate.** While 92% of units are green affordable units, 8% are market-rate units associated with GAHI developments. Of these 235 market-rate units, 210 (89%) are green. GAHI funds were not used to support the development of market-rate units.

## 2.3 Green Certifications

**Exhibit 12: Green Affordable vs. Market-Rate Units**




Under GAHI, MRET requires that projects achieve a baseline of ENERGY STAR or an equivalent as the most basic component of greening the properties. This requirement recognizes that ENERGY STAR is not applicable to all construction types, such as multi-family developments of more than three stories, but provides a foundation on which to base energy efficiency goals. Beyond this baseline requirement, MRET gave Partners the flexibility to propose additional measures for their developments that would achieve green improvements and could be most readily implemented given their proposed approach.

**Most Partners have pursued green certification beyond the ENERGY STAR guidelines,** such as LEED or another building designation, creating housing units that achieved improved energy efficiency and attained other goals, such as improved indoor air quality and efficient use of materials and resources. (See appendix 3 for a description of the major certifications sought and/or achieved by GAHI Partners.)

**CLC's Gulls Nest condominium development in Provincetown was the first affordable housing development on Cape Cod and in the United States to achieve a LEED for Homes Platinum rating.**

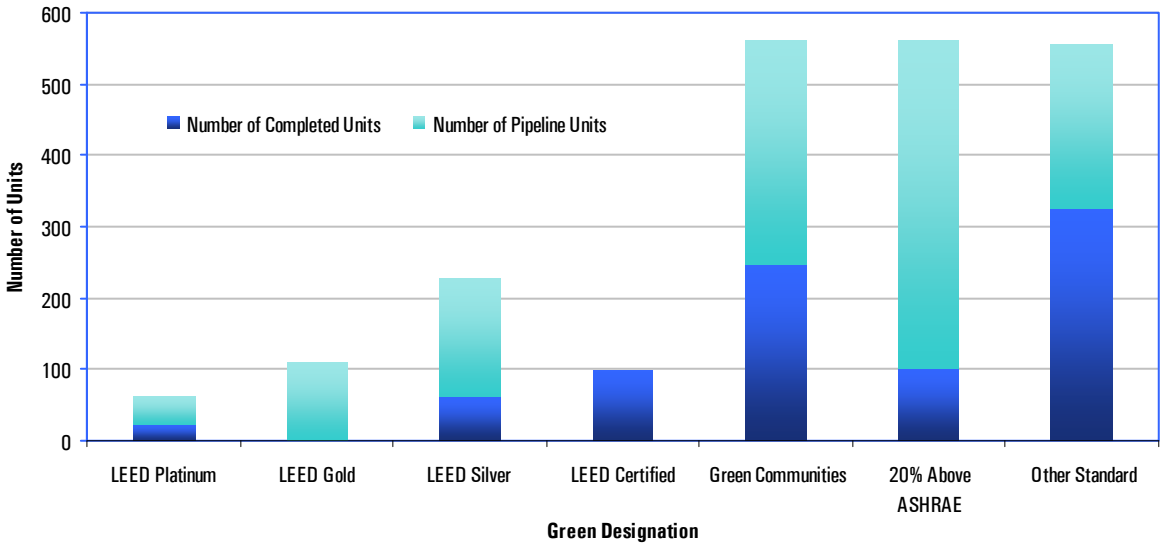
Six of the eight GAHI Partners selected LEED certification or "certifiable" green designations within the tier structure of the U.S. Green Building Council's program. LEED "certifiable" adheres to the same LEED rating system, requiring the same set of criteria and points to achieve a certification level (such as Silver), but without the final, independent certification step. LEED ratings are slated for 23 developments containing 427 housing units (308 affordable units). At this point in GAHI, the following achievements have been realized using LEED for Homes.

**Exhibit 13: Summary of LEED Achievements Among Completed GAHI Developments**

| LEED Achievements | Developments | Units |
|---|---|---|
| LEED Platinum | | |
| CLC | 2 | 22 |
| HAP | 2 | 2 |
| **Total** | **4** | **24** |
| LEED Gold | | |
| JMC | 1 | 1 |
| **Total** | **1** | **1** |
| LEED Silver | | |
| DHCD | 2 | 34 |
| JMC | 2 | 3 |
| MassHousing | 1 | 24 |
| **Total** | **5** | **61** |
| LEED Certified | | |
| DND | 1 | 90 |
| JMC | 2 | 7 |
| **Total** | **3** | **97** |
| **TOTAL** | **13** | **183** |

Other designations adopted by GAHI Partners include the Green Communities Standard established by Enterprise Community Partners, meeting 20% above ASHRAE, NYSERDA Existing Multi-Family Energy Conservation Standards, Home Builders, and the NSTAR Construction Solutions program. Exhibit 14 summarizes the designations for units that are completed compared to units in the pipeline.

**Exhibit 14: Green Designations Achieved and Planned**

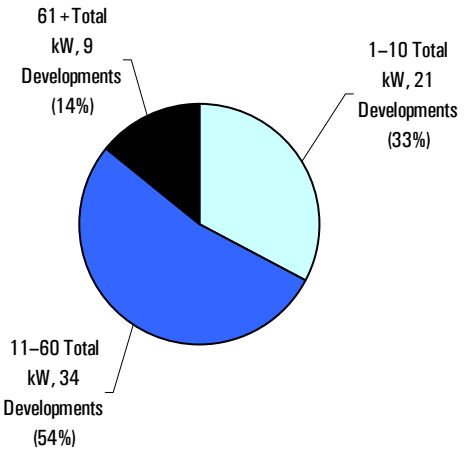


## 2.4 Early Energy Results and Achievements

Given GAHI's emphasis on renewable energy and MRET's overall mission, the Initiative's energy impacts and results are of high interest and importance. In fact, two of the program's core evaluation questions specifically address energy production and impacts: renewable energy capacity in the affordable housing sector and the lessons learned among Partners about ways that renewable energy and other green housing practices can be successfully incorporated into affordable housing programs and projects.

To date, Partners have installed a total of 1,861 kW of system capacity (PV systems) in 39 developments. These *installed* systems are expected to generate 2,030,072 kWh annually, but at this time there has not been sufficient operating time to fully assess production. Another 719 kW in system capacity is in the pipeline for future installation in 25 developments. Upon completion of all remaining developments, GAHI will have resulted in approximately 2,580 kW in capacity—19% above the program's original target of 2,175 kW. The Partners estimate these systems (installed and pipeline) will generate 2,790,430 kWh annually.

**Exhibit 15: System Capacity Breakdown By System Size**




The installed renewable systems vary in size across the Partners and across developments, ranging from a low of 1.5 kW (DND's Sussex single-family unit development and the individual systems installed on CLC's Jenney Way units) to a high of 391.3 kW (BCC's 337-unit Mishawum Park). Just over half the *installed* systems are in the 11–60 kW range. All are PV systems.

Exhibit 15 presents the range of system sizes. Sixty-four of the 68 completed and pipeline developments have reported system capacity. Four developments have not yet reported system capacity. Of the 21 developments reporting capacity in the 1–10 kW range, 13 systems have been installed (8 are in the pipeline). Of the 34 reported systems in the 11–60 kW range, 18 are installed and 16 are in the pipeline. And of the nine larger systems of 61 kW or more, all but one have been installed.

### 2.4.1 System Production

While it will be at least another year before the systems in all 68 developments have been in operation for at least 1 year (to generate reliable, actual production results and energy impacts), some early production data for the "oldest" systems are available through MRET's Production Tracking System (PTS). All GAHI-funded PV systems are linked directly to PTS and provide automated monthly production output to its database.[13] Based on this information, 99 systems in 31 GAHI developments have produced 870,007 kWh through June 30, 2009 (the latest date for which production data are captured in this report). Among these 99 systems are some that have been in operation for as little as 1 month and one that has been in operation for 34 months.

Nine developments have a total of 49 renewable energy (PV) systems that have been in operation for 1 year or more. Eight of these developments have complete system production information for 1 year that was captured by PTS. The ninth development had two system failures. Among the eight developments, two developments have 1 year of production that exceeds the estimated annual targets. Two developments have exceeded their annual kilowatt-hour production targets slightly, at 2.16% and 3.99%, respectively.

[13] Projects greater than 10 kW are required to automatically report monthly for 20 years in PTS. Projects of 2–10 kW have the option to automatically report monthly, or are allowed to manually report, which can be as frequently as monthly or as infrequently as once per year. Projects less than 2 kW can report manually, can be as frequently as monthly, or as infrequently as once per year.

Across all eight developments, total production is under total annual production targets by 9.22%. Two developments are operating at more than 30% below their target production: a MassHousing development at 36.22% under target and a JMC development at 30.94% under target. The longest operating PV system is located at a JMC single-family development and has been in operation for 34 months. A 3.22 kW system, it has produced a total of 11,677 kWh during this period. Its yearly total output for 2007 was 4,129 kWh, and its output for 2008 was 4,573 kWh. For context, the average annual household electricity consumption of a single-family home in New England is 7,432 kWh.[15]

**Exhibit 16: PV System Total Production Estimates by Partner[14]**

| Partner | Estimated Annual RE System Production (kWh) - All Developments, All Systems |
|---|---|
| BCC | 969,850 |
| CLC | 26,287 |
| DND | 123,384 |
| DHCD | 201,770 |
| MassHousing | 745,336 |
| HAP | 190,111 |
| JMC | 194,311 |
| Winn | 339,381 |
| **TOTAL** | **2,790,490** |

Exhibit 16 shows estimated production figures for each Partner. These figures are missing production estimates for nine developments (five by CLC, two by MassHousing and two by HAP). The variation in estimated production is directly linked to the capacity of the planned and/or installed renewable energy systems. For example, BCC's estimated capacity of 969,850 kWh is based on a total system capacity (across five developments) of 918.3 kW. DND's estimate of 123,384 kWh is based on an aggregate system capacity of 117.63 kW across 5 developments.

**Exhibit 17: PV System Production to Date by Partner**

| Partner | Number of Installed RE Systems | kWh Production to Date | Range of Production Operation for Systems |
|---|---|---|---|
| BCC | 5 | 207,732 | 2–3 months |
| CLC | 5 | 20,671 | 10–23 months |
| DND | 10 | 23,790 | 5–9 months |
| DHCD | 16 | 5,004 | 0–4 months |
| MassHousing | 4 | 118,259 | 1–23 months |
| HAP | 14 | 45,674 | 0–18 months |
| JMC | 43 | 154,454 | 4–34 months |
| Winn | 4 | 294,423 | 6–29 months |
| **TOTAL** | **101** | **870,007** | |

In contrast, exhibit 17 shows the *actual* production to date as captured by PTS. These kilowatt-hour production figures are aggregate figures across all the developments in a Partner's portfolio that are operating and connected to PTS. The number of systems, size of systems, and months of operation reflected in exhibit 17 vary significantly across the Partners. For example, BCC has five developments, each with a single PV system. The combined capacity of these systems is 918.3 kW. The figure below for BCC—207,732 kWh—reflects 2 months of system operations (May–June 2009) for four systems and three months (April–June 2009) for one system. In two developments (one DHCD and one HAP), systems are installed but not yet reporting production to PTS. In these, production operation below is reflected as zero.

### 2.4.2 Cost Savings for Occupants

Reviewing only those single-family developments with installed PV systems (27), the renewable energy systems are expected to save about $27,623 annually based on an expected production of 183,126 kWh per year.[16] This corresponds to an average savings of $511 per unit. Among multi-family developments for which renewable energy is powering residential spaces (15), the installed renewable systems are expected to save

[14] Estimated annual renewable energy system production for CLC was based on two of seven developments only, for MassHousing 15 of 17 developments and for HAP six of eight developments only.

[15] The Energy Information Administration's 2005 Residential Energy Consumption Survey: http://www.eia.doe.gov/emeu/recs/recs2005/c&e/detailed_tables2005c&e.html.

[16] These figures were derived based on installed production estimates for 27 single-family and 15 multi-family developments (total installed annual production estimate of 183,126 kWh and 1,091,048 kWh per year, respectively) and the electricity rates of the utility providers for these GAHI properties: CLC, NGRID, NSTAR, Unitil, and WMECO. The residential utility electricity rates for these providers vary from $0.13/kWh to $0.20/kWh).

approximately $167,508 annually based on expected production of 1,091,048 kWh per year, which corresponds to an average savings of $144 per unit. These cost savings figures may change as more renewable energy systems are installed in GAHI developments. Annual production figures are based on estimates provided by the Partners (again for residential spaces only as opposed to common areas).

**Exhibit 18: Annual Occupant Savings***

| Utility Supplying Occupant | Units | Pipeline Annual RE Production (kWh/yr) | Installed Annual RE Production (kWh/yr) | Utility Consumption Rate ($/kWh) | Annual Occupant Savings | Annual Occupant Savings Per Unit |
|---|---|---|---|---|---|---|
| Single-Family | | | | | | |
| CLC | 2 | 0 | 7,468 | $0.20 | $1,486.58 | $743.29 |
| NGRID | 29 | 0 | 99,587 | $0.14 | $14,224.01 | $490.48 |
| NSTAR | 5 | 0 | 10,349 | $0.16 | $1,699.82 | $339.96 |
| Unitil | 7 | 0 | 28,183 | $0.18 | $5,166.51 | $738.07 |
| WMECO | 10 | 71,474 | 35,171 | $0.13 | $4,689.35 | $468.93 |
| Unknown | 1 | 0 | 2,368 | $0.15 | $357.20 | $357.20 |
| **Subtotal** | **54** | **71,474** | **183,126** | | **$27,623.47** | **$511.55** |
| Multi-Family (Residential Areas) | | | | | | |
| NGRID | 142 | 0 | 193,420 | $0.14 | $27,626.18 | $194.55 |
| NSTAR | 758 | 0 | 594,710 | $0.16 | $97,681.12 | $128.87 |
| WMECO | 120 | 48,000 | 213,200 | $0.13 | $28,425.96 | $236.88 |
| Unknown | 143 | 108,300 | 89,718 | $0.15 | $13,774.32 | $96.32 |
| **Subtotal** | **1,163** | **156,300** | **1,091,048** | | **$167,507.57** | **$144.03** |

*Units without a listed utility provider are classified as being served by an "Unknown" provider. For these units, the electricity rate is estimated as the weighted average of the rates from known providers. The average is weighted based on the installed annual renewable capacity known to be served by each provider.

## 2.5 Early Environmental Benefit Indicators

The amount of $CO_2$ not produced from traditional *fossil fuel sources* due to the energy from GAHI renewable energy systems produced to date is equivalent to removing 112 cars from the road for 12 months.

To date, GAHI has realized multiple housing and energy accomplishments, as discussed in the previous sections. While many of the energy benefits in terms of lower energy costs will be realized in future years as operation of the renewable systems continues, some early energy-related environmental and human health benefits already can be seen. Producing energy from renewable energy sources offsets emissions that would have been generated if a nonrenewable energy source, such as coal or natural gas, had been used. These emissions include harmful nitrogen oxides ($NO_x$), sulfur oxides ($SO_x$), and carbon dioxide ($CO_2$), which contribute to creation of harmful particulate matter and smog, and some have been linked to human cancers and health risks. One of the intended results of GAHI was to lower these emissions for positive environmental benefits, and one of GAHI's evaluation questions was specifically included to address this environmental benefit.

As already explained, renewable energy system production is still limited by the early stages of many of the developments and their renewable systems. To estimate the amount of avoided emissions, two components are needed: (1) the amount of electricity produced by the PV systems (in kilowatt-hours hours converted to megawatt-hours for calculations), and (2) the emissions factors (in pounds of avoided pollutant per megawatt-hour). In generating the data featured in exhibit 19, several assumptions about production were made and are explained below.

At this point (with production data for a limited number of systems through June 30, 2009), the renewable energy systems installed through GAHI have helped to avoid 3,049 pounds of $SO_x$, 595 pounds of $NO_x$, and

1.3 million pounds of $CO_2$. The amount of $CO_2$ *avoided* (*not required to be produced) from traditional fossil fuel sources* due to the energy supplied from GAHI renewable energy systems— 1,348,855 pounds of $CO_2$ since the program's inception in 2006—is equivalent to removing 112 cars from the road for a year. It also is equivalent to 9.5 tanker trucks worth of gasoline or the emissions from energy use from 55.7 homes in a year. These figures were derived using a calculator for $CO_2$ emissions available on the U.S. Environmental Protection Agency's Web site, (http://www.epa.gov/cleanenergy/energy-resources/calculator.html), which includes detail on the assumptions and methodology used. Going forward as more systems are installed and operating for longer periods of time, greater annual emissions savings will be realized.

**Exhibit 19: Avoided Emissions**

| Year | Avoided Source Energy (kWh) | NEPOOL* $SO_x$ Emissions Rate (lbs/kWh) | NEPOOL $NO_x$ Emissions Rate (lbs/kWh) | NEPOOL $CO_2$ Emissions Rate (lbs/kWh) | Avoided $SO_x$ (lbs) | Avoided $NO_x$ (lbs) | Avoided $CO_2$ (lbs) |
|---|---|---|---|---|---|---|---|
| 2006 | 7,014 | 0.0029 | 0.0008 | 1.37 | 20 | 5 | 9,628 |
| 2007 | 171,244 | 0.0029 | 0.0006 | 1.36 | 500 | 103 | 232,139 |
| 2008 | 304,189 | 0.0027 | 0.0006 | 1.35 | 835 | 181 | 411,076 |
| 2009 | 509,738 | 0.0033 | 0.0006 | 1.37 | 1,694 | 305 | 696,012 |
| **TOTAL** | **992,186** | – | – | – | **3,049** | **595** | **1,348,855** |

*The New England Power Pool (NEPOOL) is an organization of participants in New England's electric market, encompassing CT, MA, ME, NH, RI, and VT.

Monthly site-level metered data for each PV installation were used as the primary source to determine production. Meter readings were not completed for some months; therefore, an estimate of production was required during these gaps. A simple estimate of production during these gaps was achieved by using the same value as metered values from adjacent time periods. In all, about 14% of the total energy produced by the PV systems was estimated using this method, while the remaining 86% relied on metered data.

Estimates of site-level energy production were then increased to account for line losses. For every unit of energy delivered to an end user, an additional amount of energy is actually produced, which is lost during transmission (as quantified by line losses). To address this factor, a value of 11.4% was used, consistent with the assumption from a recent analysis in Massachusetts[17]. Therefore, for every megawatt-hour produced onsite, approximately 1.114 MWh were avoided by the utility (i.e., avoided at the source).

The quantity of emissions avoided per megawatt-hour produced depends on multiple variables, including the generating fuel and efficiency of the generating unit. Due to a constantly fluctuating mix of generation sources and operating conditions, the emissions rates vary continuously. For simplicity, however, annual emissions rates were determined for each of the three emissions types. Emissions rates were calculated using data from EPA's Clean Air Markets Division (http://camddataandmaps.epa.gov/gdm/index.cfm). This data source provides total emissions produced and total electricity generated for all units within NEPOOL's geographic territory, encompassing CT, MA, ME, NH, RI, and VT. This enables calculation of annual emissions rates in pounds of pollutant per megawatt-hour of electricity produced. Values were calculated for each year between 2006–2009 to correspond with the metered data of the PV systems. These metered data were then multiplied by the annual emissions rates to calculate total avoided emissions, as captured in exhibit 19 above.

[17] The original source of the distribution losses was an average of the values provided to ICF by two utilities in New England during an analysis completed in spring 2008 (independent of GAHI). Jeremy Newberger provided the value for National Grid and Richard Oswald provided the value for Northeast Utilities. The two values were averaged to create a representative value for Massachusetts. The original source of the reserve margin and transmission loss values was Biewald, B., Chernick, P., Drunsic, M., Hornby, R., Kallay, J., Swanson, C., White, D. (2007). Avoided Energy Supply Costs in New England: 2007 Final Report. Cambridge, MA: Synapse Energy Economics, Inc.

## 2.6 Organization Changes and Market Transformation

Kirby Hollis Development (JMC), courtesy of MRET

An important aspect of the program design for GAHI is that it would serve as a catalyst for change by helping to overcome obstacles to greater use of green building practices and consequently transform the affordable housing sector. When MRET established GAHI, one important expected benefit was improved knowledge among design and construction professionals about renewable energy in affordable housing and creation of green affordable housing standards. When GAHI was expanded with an additional $15 million later that same year, MRET reiterated its desire that the program "lead a permanent transformation of the market for affordable housing." This transformation would mean there would be regular and sustained use of green building practices in affordable housing without the need for a grant program such as GAHI.

The early results of the efforts of GAHI Partners reveal that important transformational changes have occurred and continue to occur. Thus far, Partners have implemented a range of changes that support continued use of green building practices and promote consideration and use of PV in affordable housing. On a broader scale, there also are early indicators of sustained market changes, some directly attributable to GAHI and others influenced by GAHI activities.

These are promising indicators that a transformation is in progress. However, it is too early to draw a clear conclusion that market transformation has occurred, as the properties developed by GAHI Partners are just being completed. If the Partners and others in the affordable housing sector in Massachusetts continue to finance and develop green properties in the years after GAHI ends, that will provide strong evidence of sustained market transformation.

### 2.6.1 Early Indicators of Market Transformation and Sustainable Change

The early indicators of market transformation and sustainable change fall into three main categories:

1. Changes in funding criteria among public funders to incorporate green practices
2. Green building knowledge transfer through training and outreach
3. Internal organizational shifts within individual Partners to incorporate green practices and build green capacity that may have lasting impacts on other stakeholders

#### Changes in Financing Criteria to Support Use of Green Building Practices

Among the GAHI Partners are four financing entities: DHCD, DND, MassHousing, and private lender BCC. These Partners use a variety of lending sources, including tax credits, low-interest loans, equity investments, and grants to finance construction or rehabilitation of affordable housing. As lenders, they also establish funding requirements, construction or rehabilitation standards, and underwriting criteria that developers must meet to qualify for financing of their affordable housing properties. Each Partner, by virtue of its ability to establish green building criteria and other requirements as a condition of financing, has the ability to achieve significant and long-term sustainable impacts on the greening of affordable housing in the Commonwealth.

All four of these Partners made important, ongoing changes in their financing requirements that will increase the use of green building features in affordable housing. These changes are discussed below and include specific financing requirements or incentives to incorporate green features, requiring a green strategy and requiring property owners to collect and make available specific building performance data.

### *Financing Requirements/Incentives for Green Features*

Leading the way among these Partners in terms of broader market impact through modification of funding criteria is DND, which began requiring LEED Silver certifiable elements (LEED Homes or LEED New Construction depending on the size of the project) in all submissions for funding as of May 2007. DND's standards also call for all buildings to have solar-ready roofs. To support the changes in standards, DND modified its internal project review and oversight procedures to track green building practices and developed new tools such as a model Request for Proposals (RFP) for solar design/installation. While these changes were not due solely to participation in GAHI, DND reported that the Initiative played an important role in supporting this policy change, which was consistent with the Mayor's commitment to increase green building practices in affordable housing.[18]

DHCD also has made changes to its funding guidelines due to its participation in GAHI, specifically making modifications to its scoring of applications for financing, underwriting procedures, and Qualified Allocation Plan (QAP).[19] While DHCD was already planning to change some elements of the QAP to include green building, the agency credits GAHI as the prompting factor to place greater emphasis on green building and renewable energy in the 2007 QAP. The QAP's Appendix G now includes a self-scoring process for developers applying for DHCD funding to identify the green (and accessible) features of their proposed projects. For example, Appendix G includes a matrix of 25 green features, including water conservation, air sealing, use of low VOC paints, and solar PV, which applicants are asked to address and describe for their proposed projects. While developers are not required to achieve a green designation beyond ENERGY STAR, applicants for DHCD funding have the opportunity to gain optional points in the very competitive evaluation of potential projects if their developments incorporate meaningful green features consistent with Appendix G. DHCD notes that if all other factors are equal, proposed projects with greater green features will receive the funding first.

### *Requiring a Green Strategy*

Similarly, BCC is now requiring property developers to submit initial green screening summaries in terms of what green and energy efficiency strategies they plan to employ as a condition of applying for financing. This requirement builds developer experience with green features and indirectly leads them to make changes in their systems and processes for developing designs for upcoming residential projects. As developers gain experience and make changes in their systems, they are more likely to incorporate green features into future projects.

### *Requiring Building Performance Data*

MassHousing reports that, as a result of GAHI, it now plans to collect data on energy and water usage from the buildings it finances. This policy change will have a lasting impact as it will direct owners/developers to benchmark their buildings and begin to understand their buildings' performance. The importance of this requirement in transforming the market is that property developers and managers will now collect and use building performance data that they did not previously gather. The experiences of WinnDevelopment and other Partners is that using these types of data helps identify opportunities for achieving operational cost savings and improved building performance through energy conservation, renewable energy, and other green features.

[18] MRET has given the city of Boston several grants that supported the city's green building and renewable energy efforts.

[19] Each year DHCD must update its QAP, which details the selection criteria, standards, and application requirements for awards to be made under the Federal Low Income Housing Tax Credit, the largest Federal subsidy source for new or rehabilitated affordable rental housing. The Massachusetts QAP also reflects the sustainable development priorities of the current administration, including expanding housing opportunities and promoting clean energy.

## Green Building Knowledge Transfer

The feedback that MRET received from the affordable housing sector as it was designing GAHI strongly emphasized that the lack of understanding of green features and ways they can be effectively incorporated into residential property development and operations was a key obstacle to greening affordable housing properties. The Partners have achieved notable increases in the level of knowledge within the affordable housing sector.

Across all the Partners, there have been nine external/public trainings and two outreach events since 2007, totaling 33 training hours and reaching 343 individuals. These trainings focused on a number of topics related to renewable energy, energy efficiency, and green building principles, and targeted developers, builders, funders, and other stakeholders. HAP, DND, and Winn provided training. In addition, JMC provided outreach and support directly to developers as part of its GAHI mandate. For example, JMC was able to work with four Habitat for Humanity affiliates to include PV in their low-income housing developments. The experience gained by the four chapters is expected to help increase the focus on energy efficiency and renewable energy among other Habitat chapters.

HAP provided five trainings between May and November 2008 to increase the knowledge of affordable housing developers and stakeholders as well as its internal staff. The 3–4 hour trainings attracted 18–36 individuals each and covered a range of topics:

- Solar thermal
- PV
- High-performance HVAC systems
- Green material selection

**HAP also has partnered with Greenfield Community College to create curricula and course content for a Green Building certificate in renewable energy and energy efficiency. The program is open to all students, and HAP employees can take courses at reduced or no cost.**

DND also provided training for developers, architects, renewable energy system installers, contractors, and other interested parties. In May 2007, DND required participation in a bidders' conference for all entities considering working with the city of Boston on affordable housing. This 1-hour information session was followed by four targeted trainings between June 2007 and March 2008, each attended by 35–38 individuals representing developers and other affordable housing stakeholders from Boston:[20]

- Developer Training – Integrated Design for Developers
- Introduction to Renewable Energy and Energy Efficiency
- Developer Training – Indoor Air Quality for Developers
- New Homes with ENERGY STAR

In 2007, Winn partnered with Steven Winter Associates to provide two sessions of Energy Efficiency in Multi-Family Buildings (8 hours each), reaching 160 Winn staff, including building managers and operations staff. Winn also held a contest among property managers to encourage lower energy consumption and costs. Winn sees itself as a model for other developers and believes it can demonstrate the financial benefits of green building.

[20] City of Boston Department of Neighborhood Development (DND) Green Affordable Housing Program Web site (http://www.cityofboston.gov/dnd/D_Green_Housing.asp#Training).

### Internal Organizational and Operational Changes to Incorporate Green Practices

**Winn's Utility Diagnostic and Repair Kit includes:**

1. Utility Tracker
2. Principles of Building Systems notebook
3. Sample Auditor RFP
4. Funding strategies
5. Vendor hiring guide

Several Partners have made internal changes in how they approach designing new projects, as well as building management and operations. These changes include altering (1) how they assess potential projects for renewable energy and energy upgrades, (2) how they monitor energy consumption and returns on investment related to building modifications, and (3) how they maximize and sustain energy benefits through outreach to occupants. For example, HAP's newly created *Single-Family Homeownership Specifications*, which now guides project selection, is continually expanded to include more environmentally friendly and energy-efficient features, such as low VOC paints, high-efficiency boilers, the Carpet and Rug Institute's Green Label certified carpeting, and UV.31 windows. HAP also has developed the Green Checklist for use by developers, a list of the top 25 green and low-cost features that have proven return on investment and performance success, the Solar Easement document, and the internal Solar Screening Assessment tool. HAP's project monitoring and assessment practices have incorporated additional green diagnostics, such as blower door testing to assess air tightness. This internal expertise proved helpful in adjusting the installation of insulation and air sealing in several projects. HAP provides all single-family homeowners who purchase HAP properties with a homeowners guide and education on maximizing the energy performance of their homes.

WinnDevelopment also implemented a series of internal changes, including a shift in organizational planning and operational priorities to place greater emphasis on implementing green building practices across its portfolio. These changes not only address GAHI-funded properties, but also other Winn-owned and Winn-managed properties.

At the building operations and maintenance level, Winn has modified its traditional capital replacement plans for boilers to include building envelope work to improve overall savings; developed new unit turnover procedures that specifically involve low VOC paints, green cleaning products, and air sealing activities; and has instituted portfolio-wide monitoring of utility costs (using an outside company) to identify properties that are large consumers of electricity and water to prioritize these properties for energy-saving upgrades. To support these efforts, Winn has developed a template for use in the budgeting process that includes status and cost line items in 33 categories, including energy audit status, electricity, plumbing, landscaping, HVAC, weatherization, and monitoring. Properties also must complete the new Energy Conservation Measure (ECM) Progress Report and file it with the Winn Green Committee. A focus on water usage in particular has allowed Winn to reduce water consumption in 17 properties, with a savings of roughly $1 million per year from an initial investment of $340,000. Winn also has expanded its training for staff, notably for property managers, to emphasize the importance and specific strategies involved in not only green building design, but green property management.

With two staff dedicated to green building and its partner greenGoat, Winn has developed the comprehensive Utility Diagnostic and Repair Kit. This data-driven tool measures utility consumption and optimizes utility performance. Still in its formative stages, the Kit will ultimately allow users, such as Winn building managers and operations and maintenance staff, to track utility consumption and identify higher-than-normal usage levels, secure a utility audit to diagnose the cause of the problem(s), and ultimately to take appropriate corrective action.

Winn also created a separate entity, WinnSolar, to facilitate development of PV projects in a manner that takes advantage of the tax credit benefits and related financial benefits of third-party ownership. (See section 4 for a greater discussion of alternative ownership.) Finally, WinnDevelopment has made a commitment that all new developments will achieve a LEED certifiable standard.

CLC also has made organizational changes to incorporate energy efficiency practices and renewable energy systems. In fact, CLC is considering its next steps to continue its leadership in promotion of net-zero energy homes or passive homes. It also has grown into a new role as a technical assistance provider and broker on Cape Cod, fielding requests for developers and other affordable housing stakeholders, more information and lessons learned in green affordable housing, and how best to use renewable energy in the market. For example, leveraging lessons from its GAHI experience that focused mostly on small PV systems that are not financially feasible without a subsidy such as GAHI, CLC plans to investigate bulk buying options that could work in rural areas on Cape Cod.

These internal changes not only offer positive indicators of market change, they also provide an opportunity for lessons learned and potential for replication among other developers seeking to incorporate green building techniques, improve operational efficiencies in their housing portfolios, and improve occupant health.

# 3.0 Best Practices for Greening and Installing PV in Affordable Housing

Bowdoin Building 1 (Winn), courtesy of MRET

This section focuses on some of the best practices learned from GAHI to date in terms of the decisionmaking and screening processes for evaluating affordable housing developments (new and existing) for installation of PV systems and common green features used by the GAHI Partners in their developments. As GAHI progressed, its Partners evolved (and continue to evolve) in their own capacity and knowledge about using PV and green features in affordable housing. These lessons address one of GAHI's core evaluation questions.

## 3.1 Lessons Learned

In designing and implementing GAHI, MRET sought to address several barriers that hindered the affordable housing sector's sustained adoption of renewable energy and green building practices. These barriers included doubts among developers and lenders about the actual performance of PV and new technologies in affordable residential properties, and perceptions about the costs, benefits, and return on investment of renewable energy. MRET also recognized that the need and urgency to increase the supply of affordable housing in the Commonwealth creates some tension against the GAHI program goal of making these properties green, which may add to the time and cost of developing these properties. A key goal for MRET was to gain lessons from the experience of GAHI Partners that would help address these barriers.

All the Partners have gained lessons from their experiences. Collectively this experience translated into several overall lessons that inform future affordable housing programs, policies, and funding given the questions and challenges that MRET identified when it established GAHI. In addition, MRET explicitly asked Partners to identify green building practices they plan to continue once GAHI funds have expired, practices they would like to continue but face obstacles preventing adoption, and activities they will not continue. These observations are woven into the lessons learned and explicitly listed below.

- Lesson #1: There is clear value in applying green building features, including renewable energy, to development of affordable housing. The Partners' participation in GAHI and their experience incorporating energy efficiency and other green features overcame their doubts about the feasibility and value of incorporating these features. All Partners reported that they would continue working to incorporate green features into properties to the greatest extent feasible because the features improve the quality and sustainability of the properties. Over time, as more performance data from GAHI properties become available, the data can help the affordable housing sector better understand the financial and operational benefits from the different types of green features, and inform decisions about upfront investments in these features.
- Lesson #2: Incorporation of green building practices into public funding criteria and private housing development planning and operations supports continued development of green affordable housing (i.e. market transformation). Partners universally endorsed efforts by public funders to adopt general green building program criteria (e.g., DND's adoption of LEED certifiable standards) as a strategy to ensure high-performing buildings are constructed. Private developers such as WinnDevelopment and those receiving funding from other organizations have committed to following green principles and designations in future projects.
- Lesson #3: Energy efficiency measures offer the most cost-effective strategy to reduce energy costs and mitigate environmental impacts, warranting inclusion in all projects. GAHI Partners agree on the value of energy efficiency measures such as air sealing, super insulation, energy-efficient lighting, and efficient heating and cooling systems. These features were among the most commonly pursued by all developers (see section 3). The Partners who are public funders have adopted ENERGY STAR criteria as a baseline, in

some cases providing extra credit in funding applications for pursuing more aggressive measures. Partners who are private developers, such as Winn, are pursuing aggressive energy efficiency measures in all future developments, and have established energy performance criteria against which to evaluate building performance to assess alternative designs and strategies.

- **Lesson #4: Data on building performance (energy, water) are critical in designing renovations and evaluating new system performance, but such data are still challenging to collect and difficult to analyze.** Partners commented about the value of benchmarking existing buildings as part of any process to upgrade a building's green features and track changes. Numerous Partners expressed frustration over the difficulty in obtaining energy usage data from their respective utilities. Partners also were universally interested in tracking the performance of GAHI buildings for renewable production (which will be done through the MRET Production Tracking System (PTS), energy usage, water usage, and relevant indoor air quality observations, but noted there was not an entity currently charged with this task).
- **Lesson #5: Because occupant behavior directly effects energy consumption, education efforts about how to "best use" energy-efficient fixtures and appliances and how to "live green" in the new GAHI units are critical.** Nearly all Partners indicated they will provide such education to homeowners and/or tenants.
- **Lesson #6: PV becomes more financially attractive for energy-efficient buildings because a substantial amount of the energy needs can be met by solar production (particularly in single-family structures), driving toward net zero energy buildings.** Developers and builders have recognized it is more cost-effective to aggressively pursue energy efficiency measures and size a smaller PV system that can provide the bulk, if not all, of a building's energy needs (electricity, heating using electric heat pumps) rather than constructing a traditional, less energy-efficient building with a larger PV on a less efficient structure. Several Partners noted that the costs of installing energy efficiency measures are generally less than those of creating the solar capacity to meet the energy needs that could have been avoided by efficiency.
- **Lesson #7: When considering PV, developers and funders should carefully evaluate the site and planned building to realistically assess their likely feasibility for solar production and return on investment.** Most Partners emphasized that it was important to undertake an initial site feasibility assessment for PV using a set of screening questions before pursuing time-consuming financial assessments and design studies. Partners universally endorsed, and plan to use, solar screening criteria in their development process; all believed this step was important and should be promoted in the affordable housing development community. None of the Partners developed screening tools for any other renewable resource (e.g., wind). The innovation profiles section of this report provides a summary of the recommended screening questions.
- **Lesson #8: At this time, PV systems continue to require subsidy to be financially viable in affordable housing projects.** Despite strong interest among developers and builders in PV as a renewable energy technology, it appears there is not a viable financial strategy to support installation of solar systems without significant subsidies, such as GAHI grant funding. All Partners indicated they would not continue to install PV systems without subsidies or grants like those provided by GAHI because of the high upfront costs and longer timeframe for return on investment. Partners did not feel the subsidy offered by Commonwealth Solar was sufficient to make PV systems financially viable for most affordable housing developments. A third-party ownership approach for PV systems, which was envisioned by some Partners as a strategy to achieve financial viability, has not yet achieved consistent success. (See Alternative Ownership innovation profile.)
- **Lesson #9: Due to regulatory changes and market forces, continued application and use of third-party ownership of PV systems is needed to fully determine the viability of this approach in affordable housing.** GAHI funding enabled two Partners, BCC and WinnDevelopment, to pursue alternative ownership models to help finance and operate PV systems. Recent Federal regulatory changes affecting a core element of the alternative ownership model (e.g., tax credits and grants) and a depressed market for tax credits and debt have altered the fundamental elements that both Partners relied on to structure their models, making the long-term viability of this approach uncertain. The models used by the Partners, given these regulatory and market changes, are not viable; however, BCC and WinnDevelopment are interested in adapting and

continuing to experiment with third-party ownership in the new environment. (See Alternative Ownership innovation profile.)

- Lesson #10: Flexible funding offered by GAHI enabled Partners to experiment with a range of models and approaches. This approach is producing results that far exceed the initial projects' goals and is leading to long-term sustainable change in the affordable housing sector. Although the variation in Partner models has made comparing grantees difficult, it has yielded a wealth of information and changes that might not have been possible in an alternate program design that was more focused on a single model that all Partners would be required to use. For example, the public funders have changed funding selection and construction standards to incorporate green design. Private and nonprofit developers have altered their design processes, pursued innovative green and renewable designs, incorporated green designations and approaches into asset management (where applicable), and are motivated to collect data and information to assess building performance. Other grantees have altered program designs to include renewables in ENERGY STAR evaluations, again securing long-term changes in core energy programs.

Below is a summary table of the key practices implemented by GAHI Partners organized by their likely future use.

**Exhibit 20: Green Practices and Likely Ongoing Use by Partners**

| Practices Partners Will Continue | Practices Partners Want to Continue But Obstacles Exist | Practices Partners Will Cease |
|---|---|---|
| 1. Screening sites for PV early in process.<br>2. Incorporating green building design in public funding criteria.<br>3. Gathering data on building energy and water performance to inform renovation decisions and evaluate system performance.<br>4. Installing energy efficiency measures, particularly those related to building shell.<br>5. Building solar-ready roofs, even if PV is not part of the initial development. | 1. Providing technical assistance to developers and builders new to green. Need: Funding/resources to support.<br>2. Performance testing for energy and green measures (e.g., commissioning, measuring energy performance of innovative system, comparing modeled energy estimates with actual). Need: Funds and lead organization to take responsibility.<br>3. Installing PV or other renewable energy technologies. Need: Additional financial support.<br>4. Using PTS to monitor solar production. Need: Administrative support for PTS.<br>5. Pursuing third-party ownership of PV. Need: Clarity of Federal tax credits or grants, more robust market for tax credits. (See innovation profile on Alternative Ownership.)<br>6. Forum to exchange learning on renewable technologies and green building, which has occurred at GAHI Partner meetings. Need: Funding and lead organization.<br>7. Collecting and publishing data on GAHI building performance. Need: Funding and lead organization. | 1. Using PV systems on marginal sites. Partners learned the value of screening sites and owners for solar feasibility earlier in the process. See site screening innovation profile.<br>2. Pursuing small PV systems (some partners). They felt very small systems (< 3 kW) were not worth the investment of time for single-family.<br>3. Separating solar feasibility, design, and installation services. Market has evolved to be a design-build industry. |

## 3.2 Key Factors to Consider When Deciding Whether To Install PV in Affordable Housing

Jenney Way Development (CLC), courtesy of MRET

Nearly all the Partners involved in the GAHI program indicated that the initial screening to determine whether a site or existing building was amenable to PV installation was a critical step in their projects. Many of the Partners felt the rigor and sophistication with which they screened buildings improved dramatically over the course of their involvement in GAHI. A streamlined screening process helps owners and PV providers exclude inappropriate or marginal sites or buildings early in the development process, avoiding unproductive time to explore a project that is unlikely to move forward. PV developers have also found market value in developing such screening tools as part of their business models. With the growing sophistication of online mapping and geographic information tools such as Google Earth, many owners and developers are, with relative ease, able to ascertain whether a project has potential for solar panels.

### Typical Screening Questions and Issues

The screening questions below were compiled based on feedback from numerous GAHI Partners and their PV installers. Several of the Partners and PV installers have developed their own site evaluation checklists, and samples from Winn and Borrego Solar, which worked with Winn and BCC, are attached in appendix 5.

**Exhibit 21: Tier 1: Screening Tasks Prior to Site Visit**

| Issue | Task | Key Considerations | Resource | Task to Be Completed by... | Outcomes |
|---|---|---|---|---|---|
| Roof | Determine age of roof | ▪ The most viable projects have a new roof, one that is less than 2–3 years old, or are planning re-roofing.<br>▪ Roofs older than 8 years are not typically candidates for solar. | | Owner | Roof is _____ years old |
| | Determine warranty status of roof | ▪ Is the roof under warranty?<br>▪ If yes, what is the duration of the warranty? If yes, check how the warranty would be affected by a PV installation. | | Owner | Roof under warranty?<br>○ Yes (duration: _____) ○ No |
| | Identify type of roof | ▪ Flat roofs are ideal.<br>▪ Sloping roofs may be appropriate if the slope faces south. | Google Earth | Owner | Roof is: ○ Flat ○ Sloping |
| | Determine ease of structural attachment | ▪ If the roof is obscured by roof vents, penetrations, skylights, chimney stacks, or other structures that might shade or make installation difficult, the site typically is less desirable. | Google Earth | Owner | Multiple penetrations or structures?<br>○ Yes ○ No |
| Solar Potential | Evaluate solar exposure | ▪ Southern exposure offers the greatest potential for solar gain. | Google Earth | | Southern exposure?<br>○ Yes ○ No |
| | Assess shade | ▪ Large trees that shade the roof can obscure the needed sun.<br>▪ 95% unshaded solar access is ideal.<br>▪ Evaluate tree growth during site visit. | | | ____% unshaded solar access current<br>____% unshaded solar access future |
| Housing Units in Multi-Family Properties | Count units in building | ▪ The larger the building the greater the common area electric load.<br>▪ Some solar developers/installers use a minimum of 50 units as a cut-off for economically viable multi-family projects. | | Owner | ____ units in building |
| Utilities | Determine price paid for electricity | ▪ The more the owner pays for electricity the greater the potential benefit from a solar installation. | Utility | Owner | Average cost of electricity is<br>$ ____ per month |

It is often helpful to provide information gathered during a Tier 1 screening activity to a potential solar provider to help it assess, with an owner, the likelihood that PV installation will be feasible and financially viable.

**Exhibit 22: Tier 2: Screening Tasks During Site Visit**

| Issue | Task | Key Considerations | Task to Be Completed by... | Outcomes |
|---|---|---|---|---|
| Roof | Identify roof materials and layers of roofing materials | | Solar Developer and Owner | Roof is made of _____ and has _____ layers |
| | Determine structural integrity of roof | ▪ Flat roof (ideal): Steel frame truss joist system; short spans between load-bearing walls; poured concrete or steel roof structure.<br>▪ Sloping roof (ideal): Wood frame construction; rafters larger than 2x4; rafters less than 24 apart; show snow guards in schematic plans. | Owner | Roof is: ○ Flat ○ Sloping<br>Roof is structurally sound? ○ Yes ○ No<br>Roof structure, describe: _____ |
| | Evaluate roof penetrations | ▪ Assess existing and planned roof penetrations (chimneys, parapets, vents) for shading and limits they may place on the size and number of panels. | Solar Developer | # and type of penetrations: _____<br>Penetrations create shading or limit size of PV panels? ○ Yes ○ No |
| | Evaluate roof condition | ▪ Confirm roof condition is good and structurally sound. | Solar Developer | Roof is in good condition and structurally sound? ○ Yes ○ No |
| | Evaluate roof mount conditions | | Solar Developer | Roof height from ground: _____<br>Orientation: _____<br>Roof pitch: _____<br>Ladder access: _____<br>Attic access: _____<br>Fire sprinklers in roof? ○ Yes ○ No |
| Solar Potential | Evaluate solar potential | ▪ Use Solar Pathfinder or other appropriate readings to assess solar potential.<br>▪ Use in conjunction with online spreadsheet to calculate system sizing. | Solar Developer | Solar potential is sufficient? ○ Yes ○ No |
| | Evaluate shading | ▪ Develop a tree plan to show types and ages of trees to assess how trees will grow over the next 20–30 years.<br>▪ Determine which if any trees may pose shading issues and who owns them. | Solar Developer | Tree growth will not create shading issues? ○ Yes ○ No<br>If tree growth may create shading, owner able to cut trees? ○ Yes ○ No |
| Electricity | Evaluate current energy used and price paid | ▪ Review 12 months of energy bills to understand usage and costs | Owner | Average monthly energy usage is _____kWh<br>Average cost of electricity is $ _____ per month |
| | Evaluate connection issues and locations for electrical equipment | ▪ Where to locate AC+DC run<br>▪ Service voltage<br>▪ Space for breaker | Solar Developer | AC/DC run available? ○ Yes ○ No<br>Service voltage OK? ○ Yes ○ No<br>Beaker space available? ○ Yes ○ No |

| Issue | Task | Key Considerations | Task to Be Completed by... | Outcomes |
|---|---|---|---|---|
| Building | Learn if the residence is under the jurisdiction of a homeowners association or other design review board, or is a historic building | May add complexity and delays to project implementation. | Owner | Building subject to design review? ○ Yes ○ No |
| | Determine existence of any code violations | ▪ Unpermitted remodels<br>▪ Unpermitted structures<br>▪ Unpermitted electrical work | Owner | Code violations? ○ Yes ○ No |
| | Determine if customer has drawings of the property or building | Having drawings will facilitate design. | Owner | Drawings of property or building? ○ Yes ○ No |
| | Learn if any other construction is planned for the near future | Construction might affect the roof or shading. | Owner | Construction planned? ○ Yes ○ No |

### Grantee Observations and Capacity

Several Partners indicated they have developed internal expertise to complete the Tier 1 questions and evaluate potential solar projects. For example, BCC has the capacity to evaluate a site's solar potential using Google Earth and information it gathers from owners. As a part of its Tier 2 screening, BCC completes an initial questionnaire as well as a site visit to avoid time wasted on projects that will not move forward. JMC and HAP have both developed extensive, in-house expertise for completing Tier 1 evaluations. HAP and JMC have purchased Solar Pathfinders, developed staff expertise, and regularly use these devices in evaluating and sizing PV systems. WinnDevelopment has refined its procedures in evaluating buildings for solar potential using its internal solar screening questionnaire (see appendix 5).

## 3.3 Summary of Key Green and Energy Efficiency Measures

As part of regular data reporting to MTC, Partners reported the major energy efficiency and green features in each of their developments. For Partners seeking certain Green Standard certification (notably LEED and Green Communities), certain features may have been required and appear across multiple projects having those certifications. Also, upon additional probing of Partners, certain green and energy efficiency measures emerged as more favored within the GAHI program.

### Green Features Used by All Grantees

PV installation and roof orientation were pursued by all Partners (but again, most Partners were required to spend 70% of GAHI funds on renewable energy systems).

### Specific Green Features Used by a Majority of Grantees

- Improved energy efficiency through high-efficiency building envelope/reduced envelope leakage and experimentation in insulation
- Interior water efficiency
- Integrated project design team
- Walkable neighborhoods and access to public transportation
- Erosion control during construction
- Construction waste management (many Partners found this surprisingly cost-effective)
- Indoor air quality and health improvements: low VOC products and finishes, combustion venting of appliances, enhanced ventilation to meet industry best practices of ASHRAE 62.2, On-Demand Hot Water and pipe insulation, non-invasive plants, high-performing windows, and occupant education on how to maximize the green features of their new homes

Appendix 6 includes a table listing the specific major green and energy efficiency features and their reported use by Partners, which are summarized more broadly in exhibit 23.

**Exhibit 23: Summary of Green and Energy Efficiency Measures in GAHI Developments**

| Summary of Green and Energy Efficiency Measures in GAHI Developments | | | | | | |
|---|---|---|---|---|---|---|
| | CLC | DND | DHCD | HAP | Winn | MassHousing |
| Total Number GAHI Developments | 8 | 6 | 3 | 8 | 3 | 17 |
| Planning | | | | | | |
| Integrated Project Planning | ● | ● | ● | ● | ● | ● |
| Durability Management | ● | | ● | ● | | |
| Site & Construction Practices | | | | | | |
| Location | ● | ● | ● | ● | ● | ● |
| Site Stewardship | ● | ● | ● | ● | | ● |
| Landscaping/Surface Water Management | ● | ● | ● | ● | ● | ● |
| Conservation of Building Materials & Resources | ● | ● | | ● | ● | ● |
| Compact Development Feature(s) | | | ● | | | |
| Water Conservation | | | | | | |
| Exterior Water Conservation | ● | ● | ● | | ● | ● |
| Interior Water Efficiency | ● | ● | ● | ● | ● | ● |
| Energy Efficiency/Conservation | | | | | | |
| Energy Efficiency – Mechanical and Standards | ● | ● | ● | ● | ● | ● |
| Insulation & Building Shell Enhancements to Conserve Energy | ● | ● | ● | ● | ● | |
| Energy-Efficient Windows | ● | ● | ● | ● | ● | |
| Energy-Efficient Appliances | ● | ● | ● | ● | ● | ● |
| Energy-Efficient Lighting | ● | ● | ● | ● | ● | ● |
| Indoor Environmental Quality | | | | | | |
| Indoor Environmental Quality | ● | ● | ● | ● | ● | ● |
| Nontoxic Pest Control Feature(s) | ● | ● | ● | | ● | |
| Education | | | | | | |
| Occupant/Manager Education | ● | ● | ● | ● | ● | ● |

# 4.0 Innovation Profiles

In addition to the early lessons learned relative to the use of PV and energy-efficient features highlighted in the previous section, GAHI and its partners have identified some innovative approaches to using renewable energy systems and incorporating green and energy-efficient measures in affordable housing, all to reduce utility and operational costs and improve housing quality for occupants.

This section is divided into two parts. Section 4.1 discusses lessons learned from using alternative ownership models for PV systems in affordable housing based on the experiences of Winn and BCC. Section 4.2 describes five GAHI developments that offer interesting lessons in construction techniques and concepts, or innovation in green building in the affordable housing context. These "spotlights" are intended to feature aspects of these different developments, which vary in their stages of operation.

## 4.1 Lessons Learned in Alternative Ownership

### 4.1.1 Alternative Ownership Models

Several types of ownership structures are possible for solar PV projects to help meet the needs of building owners. The project can be structured so that it is owned by the end user, PV installer (the "integrator"), local utilities, or third-party investors. To meet the needs of the affordable housing sector, two Partners, BCC and WinnDevelopment, explored creating a third-party ownership structure. Their experiences and lessons learned can help inform future third-party ownership efforts.

### 4.1.2 What Is Alternative Ownership?

With third-party financing, the PV system is owned by an entity separate from the building owner or PV installer. The third-party financing entity has sufficient capital to pay for the entire installation, and the ability to make efficient use of Federal tax incentives for undertaking PV projects. To induce the third-party investor to extend the capital, the building owner, or "site host," signs a long-term contract agreeing to purchase all the power produced by the PV system—a Power Purchase Agreement (PPA).

Third-party ownership arrangements typically are best suited to:

- Integrators and site hosts that cannot utilize Federal or State tax benefits available for solar installations (such entities include governments, municipalities, schools, nonprofits, and other tax-exempt organizations)
- Integrators that prefer to be developers rather than long-term owners
- Integrators that lack capital needed to invest in solar power
- Site hosts that do not have the capital or ability to finance PV installation costs, and/or the expertise or capacity to develop and service the system

Third-party financing models have been used successfully in projects involving the commercial sector, municipalities, and utilities.

### 4.1.3 What Is the Affordable Housing Opportunity?

Several characteristics of affordable housing ownership make third-party financing a potentially attractive option. First, most affordable housing owners cannot take advantage of Federal tax credits, which exclude nonprofit owners and tax-exempt organizations. In Massachusetts, the State government, Federal government, or nonprofit organizations own most affordable housing. Many owners interested in installing

PV do not have sufficient capital to finance such a project or the capacity to operate and maintain a system, and are attracted to a one-stop shopping model to finance, install, and operate a system.

### 4.1.4 GAHI Supported Third-Party Financing Model Assumptions

In exploring this model, BCC endeavored to provide financing for any Massachusetts multi-family affordable housing owner that met the BCC selection criteria, while Winn created a new entity, WinnSolar LLP, to provide an alternative pathway for solar projects in its own portfolio, with an emphasis on projects in Massachusetts and Connecticut.

BCC and Winn initiated their efforts because they believed a third-party ownership model would optimize the financial benefits to all parties in the transaction. Each Partner created an entity that could take advantage of the Federal renewable energy tax credits, which could be combined with low-income housing tax credits, an essential ingredient in affordable housing development. Similarly, third-party owners with sophisticated financing expertise would have the capacity to maximize the economic benefits of the nascent Renewable Energy Credits (RECs) and advise owners to take the accelerated depreciation available for PV systems. (RECs are tradable environmental commodities that represent proof that 1 MWh of renewable electric energy was generated.) Project owners could benefit by locking in a power purchase rate to stabilize their energy costs (which were rising and expected to continue to rise when this work occurred in 2008). Additional potential benefits to owners included streamlining financing and securing the lowest possible installation, operations, and maintenance costs from working with a larger installer/system owner.

BCC and Winn also expected that this structure would simplify and reduce the risks to property owners in the procurement and system operation phases. Working with experienced entities, owners—many of whom have limited staff resources and/or expertise with renewable energy—could outsource the bidding and construction management associated with PV systems as well as ongoing operations. BCC also planned to combine its third-party financing with a related effort to aggregate affordable housing developments in need of energy efficiency efforts and buildings that are well suited to PV installation to attract an Energy Services Company (ESCO) interested in bidding on a combined package.

BCC was able to finance five projects, and Winn (as WinnSolar) undertook two projects in Massachusetts.

### 4.1.5 Preliminary Observations

- **A third-party ownership model has potential viability in the affordable housing sector when the Federal tax market is robust and the price of energy is high and likely to rise.** An underlying assumption of both the BCC and Winn models was their ability to market the Federal solar tax credit to the same investors who were interested in the low-income housing tax credit. The pool of institutional investors interested in Federal solar and low-income tax credits, always narrow, grew smaller due to the deep economic recession and general lack of debt financing, as banks previously active in the renewable energy arena pulled back and tightened credit requirements. WinnSolar was successful in syndicating tax credits for its projects when it went out to the tax credit market in 2008, before the market crashed. The timing of the BCC project put it on a crash course with the collapse of the credit and financing market in late 2008 and 2009, requiring BCC to re-evaluate and adjust its model to take advantage of the new Federal American Recovery and Reinvestment Act of 2009 (ARRA) rules. These allowed BCC to substitute the Federal Renewable Energy Treasury grant for the Federal renewable energy tax credit. BCC chose this route because it was more efficient and had significantly lower transaction costs than continuing to finalize the proposed tax credit ownership structure. At the same time, prices paid for energy, which had been rising consistently in the few years before 2008, began to stabilize in 2009, reducing some owners' interest in locking in a set price for energy under a PPA.

- **The startup transaction costs of a third-party ownership approach were substantially higher than originally anticipated,** but could be manageable with standardized program resources and a minimum project size. BCC and Winn cited the high legal costs of closing a deal with a new investor, particularly in 2009 when there were so few entities willing to participate. As investors became nervous, they sought to gain financial security in complex legal agreements. Both Partners believe a key to future success is to streamline legal and project financing documents and to only work with owners willing to accept a streamlined package. A second cost was the time spent selecting potential owners and buildings. The Partners developed informal screening criteria that they adhered to more strictly to rule out marginal sites as their projects evolved. There is an educational process working with any new owner to clarify what building information is essential to determine whether a project is feasible. Once the team understands what is needed, it is easier to evaluate a second building in the portfolio, creating a clear incentive to work with owners of large portfolios and experienced staff. Finally, WinnSolar has concluded that for its model to be most cost-effective, it should target larger projects (e.g., 80 kW).
- **Additional market changes in 2008–2009 reduced the interest of owners.** As credit tightened, the anticipated prices for RECs did not materialize, and in fact dropped from the initial year offerings. Currently, it is difficult to confidently forecast the financial benefits to the owners of any REC payments, making RECs non-bankable. Numerous owners, particularly with which BCC worked, did not value the ability to obtain accelerated depreciation as much as had been anticipated. Finally, as the market for PV systems increased, the prices declined in general, limiting the value a third-party ownership model could offer over standard market rates (i.e., there was a modest cost savings working with a third-party owner on the PV system price versus working directly with a PV provider).
- **Recent policy and changes in tax structure have altered the underlying rationale of the alternative ownership structure.** Recent changes under ARRA now offer eligible entities solar grants in lieu of tax credits. BCC was able to structure its transactions and entity to be fully eligible for the new solar grants, and intends to take advantage of this structure for the window of time the grants are available. WinnSolar is still evaluating how it might need to adjust its structure to become eligible for the grants, which are more financially appealing than the tax credits, particularly when the tax credit market is extremely soft.

### 4.1.6 Lessons for Property Owners Examining Third-Party Ownership

Despite the uncertainties associated with the viability of a third-party ownership model, the experiences gained from BCC and Winn suggest that for property owners with one or more of the characteristics listed below, it is useful to explore such a model.

- Owner has limited capacity to raise capital or operate a PV system.
- Owner has strong interest in stabilizing and establishing predictable energy costs.
- Owner has large portfolio with potential for large systems, or has roof capacity for a modest system and is highly motivated to make the project work and accept a streamlined set of project financing documents.

## 4.2 Partner Project Spotlights

### 4.2.1 Bread & Roses Housing, Lawrence – A Zero Energy Challenge Development

#### GAHI Partner: Joint Management Committee (JMC)

JMC provided GAHI-funded renewable energy and technical assistance to Bread & Roses Housing (BRH), a nonprofit charitable organization

Bread and Roses, courtesy of JMC

that creates and preserves affordable housing ownership for low-income households. BRH used JMC funding for one of its projects that includes six units of affordable, energy-efficient homes on three scattered sites in the Arlington neighborhood of Lawrence, MA. Among these homes is one two-family home that is the first project built with a near-zero energy goal.

### Highlights

*Building Characteristics*

- Six two-family homes, new construction, stock plans
- 2,080 sq. ft. conditioned space
- Wall insulation values 50% above MA-code minimum
- HERS Index of 27

*Green Features*

- 3.51 kW PV system to power residential areas in each home
- High-efficiency boiler and integrated hot water system

*Green Features*

The homes were situated to the extent possible to maximize southwestern solar exposure, reserve green space, and provide proximity (walking distance) to employers, service providers, schools, stores, city services, parks, regional transit, and Massachusetts Bay Transportation commuter rail.

The six-unit BRH development achieved a Home Energy Rating (HERS) Index of 27, having no prior experience in building to enhanced energy standards or with renewable energy systems. HERS raters conduct various diagnostic tests to measure a building's tightness and energy performance, then input data into an energy software program to produce a HERS Index. A home built to the specifications of the HERS Reference Home, based on the 2006 International Energy Conservation Code, scores a HERS Index of 100, while a net zero energy home scores a HERS Index of 0. The lower a home's HERS Index, the more energy efficient it is compared to the Reference Home. In the Massachusetts climate zone, a home must achieve an 85 or lower.

Building from stock Colonial-style, duplex house plans, the developer and builder focused on four important high-performance design strategies: increased insulation, minimal air infiltration, mechanical efficiencies, and renewable energy. The use of high-density spray foam and foam board boosted the wall insulation values by 50% above the Massachusetts-code minimum without radically changing the building design, and the unvented, hot-roof approach helped to minimize air infiltration.

The choice of a high-efficiency Munchkin 80M R2 95% AFUE boiler, in tandem with the SuperStor Ultra (SSU-45) integrated hot water system, allowed BRH to employ off-the-shelf, locally manufactured technologies that qualified for gas utility company incentives. The equipment achieved mechanical efficiency levels that are 15% above code.

The six homes in the overall development received $24,500 awards from GAHI to finance the PV renewable energy systems, each with a capacity of 3.51 kW. Annual energy production from each system is expected to be approximately 4,200 kWh, enough electricity to satisfy 90% of the household electricity needs and save the homeowner about $714 per year at current rates.

The BRH project was one of five projects competing in the Massachusetts Zero Energy Challenge, which is sponsored by investor-owned utilities that are members of the Massachusetts New Homes with ENERGY STAR Program. The challenge enrolled five home builders to construct single-family homes with the goal of using little to no grid energy. (See section below for description of Wisdom Way Solar Village, which also participated in the challenge.) BRH shared two features with the four other developments in the challenge, one social and the other technical. From a social perspective, each participant demonstrated a strong commitment to building the highest performance house that it could. From a technical viewpoint, the very low infiltration rates of each home stand out as the most noteworthy building science achievement. All the houses are 96% tighter than the reference homes against which they were measured. This alone accounted for a nine-point improvement in the HERS Index. Each home represents a positive example for the many sectors of the residential building community that are now reaching for zero energy housing.

## 4.2.2 1460 Dorchester Avenue, Boston

### GAHI Partner: City of Boston Department of Neighborhood Development (DND)

1460 Dorchester Avenue, courtesy of DND

Completed in November 2008, 1460 Dorchester Avenue is a mixed-use, transit-oriented, multi-family development that contains a combination of 43 efficiency and 1-bedroom rental apartments and 7,000 square feet of community retail space. Strategically located near a newly renovated public transit station, 1460 Dorchester is the first new building in the Fields Corner area in more than 50 years, and the city hopes it will be a catalyst for additional economic development in the area. To this end, the project has included local improvement efforts such as a new and well-lit pedestrian walkway.

*Green Features*

Consistent with the city's requirements for affordable housing, 1460 Dorchester meets LEED for Homes Silver certifiable standards. It also meets the requirements of the Enterprise Foundation's Green Communities program. Among key green features are rigid insulation skin, cellulose insulation, ENERGY STAR–certified windows, and a white "cool" roof for a high-efficiency building envelope. It also features high-efficiency mechanical equipment (condensing boilers) appropriately sized for the single building development and Energy Recovery Ventilator (ERV) for ventilation.

The development's 10 PV systems (total of 34.2 kW) are expected to generate 37,044 kWh per year to support electricity for nine of the lowest income rental units and part of the development's common area, saving an estimated $6,300 per year at current rates. The system will support a total square footage of 12,357, which represents these nine units (total square footage of 4,515) and the common residential area (square footage of 7,842).

**Highlights**

*Building Characteristics*

- Single building, multi-story development of 43 rental units
- New construction
- 36,000 residential sq. ft.
- 7,000 sq. ft. of retail

*Green Features*

- LEED-H Silver certifiable
- 64 HERS rating
- 34.2 kW PV systems to power 9 units and residential common area
- Monthly production of 526-2,270 kWh (5 months of operation)
- To date produced 6,540 kWh

*Building Operations*

Since beginning output in January 2009, 1460 Dorchester's PV system has produced a total of 6,540 kWh of electricity (5 months of operation), ranging from 526 kWh to 2,270 kWh per month depending on the available sunlight. There are nine reporting systems at the development; the lowest monthly output for one of them was 55 kWh and the highest was 451 kWh. This figure includes the common area and residential output.

Data are not available on residential electricity consumption or the relative impacts of the PV system on the residential units at this time. In its first quarter of operation and occupancy, the development's common area consumed a range of 9,162 kWh (March 2009) to 14,070 kWh (November 2008), averaging 11,163 kWh per month.

## 4.2.3 Wisdom Way Solar Village – A Near Net Zero Energy Project

Wisdom Way, courtesy of Rural Development, Inc.

### GAHI Partner: **HAP**Housing

Wisdom Way Solar Village is a model project because of its near-zero energy performance achieved by using innovative super-insulated walls and triple-paned windows with energy production from rooftop PV systems and solar hot water heaters. The project's deep green energy features are nestled into a project design intended to create the sense of a traditional New England village. All the homes are built close together with land dedicated for open space and a community playground. "If the families that buy these homes and live in them are reasonably conservative in their energy use, they will not pay an electric bill over the course of a year," said Anne Perkins, the project developer.

The development was awarded third place in the Zero Energy Challenge in competition with four other single-family developments.

#### Highlights

*Building Characteristics*

- 10 duplex homes with 20 units
- Total of 17,486 sq. ft. with units ranging 1,100–1,500 sq. ft.
- New construction

*Green Features*

- Seeking LEED-H Platinum rating
- Double 2X4 walls, 12 inches of dense-blown cellulose (R-42)
- Triple-pane windows, U-value 0.18
- Sealed combustion gas-fired heaters in units, with fan to direct heated air to bedrooms
- Unit-based, exhaust-only ventilation system; meets ASHRAE 62.2 standards
- CFL lighting and ENERGY STAR appliances
- 2.8–3.4 kW PV systems

*Green Features*

The project team pushed itself from the outset to design and construct low-energy homes. Initial site planning oriented all the homes to the south to allow for passive and active solar, and created a landscaping plan that would not result in shading even as plants matured. The building construction techniques included an innovative, super-insulated, double wall construction with strict attention to detail in the air sealing. The exterior load-bearing walls are framed using 2X4s, 16 inches on center. Contractors then framed a second wall 5 inches inside the initial exterior wall, with Insulweb netting stapled to the inner studs. The 12-inch cavity between the two walls is filled with dense, pack-blown, cellulose insulation achieving a collective R-42. To complement the insulated walls, the designers specified triple-pane windows on non-south-facing walls to minimize heat loss (U-factor 0.18). To maximize solar gain on the southern walls, double-paned, low-e windows with a U-factor of 0.26 and solar heat gain coefficient of .36 were selected.

The remarkably low design heat loads of the buildings (less than 12,000 BTU per hour) are met by a small and efficient sealed-combustion, natural gas-fired heater on the first floor, which is about half the capacity of the smallest centralized furnace or boiler on the market, according to the project developer. Having the flexibility to use these smaller heating units allowed the development team to reduce the budget for heating systems by about $4,500, and to reallocate these funds to support the added costs of the super-insulated walls. To help equalize temperatures between the lower levels and upstairs bedrooms, the team installed a Panasonic Whisper Green fans to exhaust air from the ceilings of the first floors and distribute 20–25 CFM (cubic feet per minute) of warmed air to each bedroom.

To provide energy, each housing unit is outfitted with a PV array ranging 2.8–3.4 kW in power—enough, in the larger case, to supply up to 4,000 kWh annually that could support nearly 80% of the home's electricity

needs, based on conservative energy consumption estimates for single-family homes. Based on current average residential electric rates, that will save each homeowner $680 annually. Hot water is provided with solar-thermal collectors, augmented by an on-demand natural-gas system.

Ventilation is provided by an exhaust-only system. The primary bathroom's exhaust fan is programmed to run continuously to meet the whole house ventilation requirements of ASHRAE 62.2. The fan boosts for greater airflow when the bathroom and shower are in use.

The first completed duplex achieved the very low HERS scores of 7 and 15, as well as LEED Platinum status. The other duplexes are expected to achieve similar ratings when complete.

### *Early Lessons Learned*

HAP and its partners have learned several lessons when developing Wisdom Way Solar Village that are informing additional and future projects. These include:

- Super-insulated walls with extensive attention to detail on air sealing are an effective wall system. Inspection and testing of air sealing is critical.
- Solar thermal design and installation was more problematic than PV; the industry response was not as mature.
- It is possible to get close to a zero net energy home by implementing modest additional changes above and beyond code and standard building practices.
- Off-the-shelf technologies can achieve these goals, but some knowledge of how to put it all together is required—as is attention to detail.

## 4.2.4 Gulls Nest, Provincetown – An Innovative Building Reuse and High-Performing LEED Platinum Building

### GAHI Partner: Cape Light Compact

Gulls Nest, courtesy of CLC

Gulls Nest offers a unique way to look at how to repurpose an existing structure, in this case a dilapidated motel, to provide new, appealing, green, affordable units without expanding the infrastructure footprint. In the Cape Cod area of Massachusetts, this approach is particularly appealing because there is limited virgin land on which to build, and the reuse of land and/or structures is a key component of green building. This is now serving as a model for additional projects to convert old motels to affordable housing in other Cape Cod locations. Gulls Nest was a new partnership between CLC and local realtors (Anathan Benson LLC).

### *Green Features*

The first affordable housing development in the United States to achieve LEED for Homes Platinum status, Gulls Nest incorporated many important energy efficiency, green, and renewable energy features. Foremost among these is reuse of as much building material as possible from the existing structure, including wood and walls, which also reduced dumpster fees and overall construction costs (by an estimated $20,000). The 7,008-square foot development of mostly one-bedroom condominiums was built to achieve tight air sealing and aggressive insulation standards. It also features bamboo flooring; Rinnai On-Demand Hot Water; compact fluorescent lighting; stainless steel ENERGY STAR appliances; low-flow faucets, showerheads, and toilets; energy-efficient windows; vinyl siding (to look like cedar shingles while requiring less maintenance than

### Highlights

*Building Characteristics*

- 2-story development of 12 homeowner condo units converted from former motel
- 7,008 residential sq. ft.

*Green Features*

- LEED Platinum
- 58.5 HERS rating
- On-demand hot water
- CFL lighting
- ENERGY STAR appliances
- Aggressive insulation standards
- 17.5 kW PV system to power residential areas
- Monthly production of 759–2,342 kWh (10 months of operation)
- To date produced 15,856 kWh

wood); and noninvasive plants with rainwater capture. Each unit's heating demands were reduced due to the effective air sealing and insulation. The remaining heating demand is met via modest liquid propane heaters located on the ground floor, with open floor vents to the second floor and ceiling fans to help circulate heat.

The development also features a GAHI-funded 17.5 kW PV system estimated to produce 20,430 kWh annually. The goal is to create as much electricity as possible from the system to support the Gulls Nest units; as excess electricity is produced, it will be sold back to the main power grid.

Following construction, CLC worked with the developers and crafted an owner's manual to ensure the new homeowners understood the key features of their units and how to maximize their energy efficiency.

## 4.2.5 Whaler's Place, New Bedford – An Innovative Historic Mill Reuse With Solar PV

### GAHI Partner: WinnDevelopment

Whaler's Place is another interesting reuse of a property—a historic 1894 waterfront mill that housed a garment and textile factory in addition to a wholesale store—into beautiful and green affordable housing units. Such mills exist throughout Massachusetts and New England, and this project serves as a model for green renovation, with productive PV panels producing electricity to serve the common loads. The 75 new one- and two-bedroom apartments and townhouses provide housing for residents age 55 and older.

*Building Exterior*


Before

After

*Building Interior*

Before

After

Whaler's Place, courtesy of WinnDevelopment

### Project Team

As managers of 70,000 units of housing, most of which are affordable, Winn has a strong interest in developing and operating the properties as efficiently as possible. Its solar installations on properties like Whaler's Place are part of an aggressive greening effort put in place by WinnCompanies (WinnDevelopment's parent corporation). Other efforts have included LEED in

new construction and energy retrofits in existing buildings, including air sealing and insulation, lighting improvements, and water efficiency.

"By installing solar energy at Whaler's Place, we are preserving the long-term affordability of the development and allowing residents to reduce their carbon footprint," said Heather Clark, WinnDevelopment's director of green building.

### *Green Features*

This historic mill renovation project sought and secured permitting from the National Park Service (NPS) to install solar panels on the roof. The 156.75 kW system underwent extensive reviews by NPS that included development of a mock-up model to verify the solar panels would not alter the historic presentation of the buildings. The approval to install solar panels on this historic property paves the way for future such installations. According to Clark, "You don't have to be scared to undertake solar projects on historic buildings anymore." The system was designed to support the electrical load of the 112,820 square feet of common space.

## Highlights

*Building Characteristics*

- Historic mill renovation
- Conversion to 75 affordable housing units for the elderly
- Total of 12,645 residential sq. ft.

*Green Features*

- 156.75 kW PV system not visible from the street, receiving NPS approval for use in a historic building
- Use of third-party ownership for PV through WinnSolar LLP
- Innovative brick wall insulation and air sealing
- High-efficiency heating and cooling equipment
- Water-conserving toilets and showerheads

Complementing the PV installations were numerous energy and green building practices. Chief among these are innovative approaches to air sealing and insulating the interior brick exposed walls. The insulation techniques pioneered at Whaler's have helped inform WinnDevelopment's subsequent mill renovations by establishing a new baseline for performance. Additional green elements included ENERGY STAR appliances, high-efficiency water storage tanks, high-efficiency heating and air conditioning equipment, and water-conserving toilets and fixtures.

# 5.0 Summary and Next Steps for the Affordable Housing Sector

Trolley Square Development, courtesy of MassHousing

The experience of GAHI Partners provides valuable insights about ways that individuals and organizations working in the affordable housing sector can help "green" residential properties serving low- and moderate-income households with benefits accruing to residents and property owners. While the Partners have taken important first steps in greening affordable housing in Massachusetts, further actions are needed to extend the lessons from the GAHI program more broadly across this segment of the housing stock.

Greening the Nation's buildings, both residential and commercial, and greater reliance on renewable energy sources continues to garner growing interest and commitment across the country, particularly at the Federal level. As evidence, Federal investment in green buildings and renewable energy is increasing. For example:

- The U.S. Department of Housing and Urban Development (HUD) has received substantial funds from the American Recovery and Reinvestment Act of 2009 (ARRA) to support the greening of HUD-assisted, affordable, multi-family housing properties, and has established an Office of Sustainability.
- The U.S Department of Energy (DOE) received substantial funding for the Energy Efficiency and Conservation Block Grant program.

These and other Federal initiatives offer an opportunity to leverage Federal support to further extend the accomplishments of GAHI Partners.

The next steps identified below are drawn from the results of the Partners' work, and their feedback about ways members of the affordable housing sector can support the greening of this housing stock. These steps are organized by the major stakeholders in this sector.

### Owners of Existing Properties

- Monitor the energy/water usage and costs in your properties to identify priority areas for savings and evaluate recently upgraded buildings (e.g., New Ecology's Energy Tracker).
- Look for opportunities to drive down the electrical and heating loads by incorporating energy efficiency improvements into rehabilitation and capital improvements to the greatest extent feasible.
- For properties achieving substantial load reductions, consider renewable energy generation. But, carefully evaluate the building and the site to ensure this is technically feasible and financially viable.
- When evaluating renewable energy generation, consider third-party ownership.
- Look for opportunities to incorporate water conservation to the greatest extent feasible.
- Pursue available funding for green improvements—energy efficiency, renewable energy, and other green features.

### Property Developers (including community development corporations)

- Build your internal capacity to oversee development of buildings with green features (e.g., installing energy efficiency and indoor air quality measures, and learning how to assess renewable energy potential).

- Carefully evaluate property acquisitions regarding suitability for green features. Examine building energy and water use and the potential for renewable energy systems. (Note: An inexpensive property might not prove to be sustainable over the long term.)
- Strive to drive down electrical and heating loads by incorporating energy efficiency improvements into designs for new buildings and substantial rehabilitation projects to the greatest extent feasible.
- Plan new construction to maximize potential for renewable energy systems.
- Look for opportunities to incorporate water conservation to the greatest extent feasible.
- For project designs that achieve substantial load savings, consider renewable energy generation. Examine the feasibility of renewable energy generation early in the design stages (e.g., as part of site selection).
- When evaluating renewable energy generation, consider third-party ownership.
- Pursue available funding for green features—energy efficiency, renewable energy, and other green features.
- Once a building is placed in service, monitor the energy/water usage and costs (e.g., Energy Tracker is an option).
- Recognize that incorporating green features into residential projects likely will change your organization's operations and the types of projects you pursue.

### Affordable Housing Lenders/Funders

- Support a one-stop application process for financing and a consistent set of baseline green criteria so developers do not struggle to meet a variety of standards. (Note: Individual lenders/funders could require more aggressive measures beyond the baseline standards, but these should be distinguished from the baseline standards.)
- Affordable housing lenders/funders that finance or offer incentives for incorporating green features are encouraged to collect and analyze data on energy and water usage in their green buildings. Incorporate the responsibility to provide these data into the terms of the financing/funding. Share the results of the analysis with all members of the affordable housing sector.
- Offer monitoring and technical assistance to developers with less experience to help them avoid common mistakes and build their capacity.
- Assess the short and long-term costs and benefits of green features in the properties you finance.

### Residential Construction Contractors

- Get trained on how to properly install green features during rehabilitation or new construction.
- Gain experience by participating in programs that provide onsite assessments, such as ENERGY STAR for insulation installation.
- Be supportive of integrated design approaches to planning residential projects.
- Try green projects and find the technical assistance needed to ensure quality results. Building capacity for sound, efficient execution takes time. Be open to diagnostic testing and site evaluations to ensure designs are created correctly in the field. Experienced contractors should be open to mentoring others.

### Policymakers

- Link any subsidy or support for use of renewable technologies in buildings to also achieve energy efficiency improvements (i.e., don't put renewable energy on a "brown" building).

- Explore policy options to continue to provide subsidy or financial support or renewable energy in affordable housing.
- Facilitate electronic access to utility data for owners and lenders.

# Appendix 1: Initiative Advisory Committee Charge and Membership

MRET developed an Initiative Advisory Committee (IAC) for GAHI to provide guidance on the program's concepts, encourage broad knowledge of lessons learned, and provide input and direction on next steps for green affordable housing beyond GAHI. The committee's purpose and members are summarized below in its official charter from MRET.

## Name

The name of the Committee shall be the Green Affordable Housing Advisory Committee (the Advisory Committee or IAC).

## Purpose and Duties

The purpose of the Advisory Committee is to provide guidance, advice, and recommendations on matters related to greening affordable housing, including providing strategic advice on how best to catalyze the affordable housing financing, development, and builder communities to include more green design and renewable energy in developments. The Advisory Committee's initial focus will be on partnership grant programs in which MTC [now MRET] is engaging, and over time will help to improve and refine the direction of GAHI. More specifically, the Advisory Committee is intended to provide outside viewpoints and may make recommendations from time to time on matters including but not limited to:

1. Development of a green affordable housing strategy for the Commonwealth consistent with the [Renewable Energy Trust] Fund's statutory mandate to generate public benefits, including increasing the consumption and generation of renewable resources and expanding the renewable energy sector in Massachusetts.
2. Identification and evaluation of challenges and opportunities relative to increasing the quantity and quality of green affordable housing, including use of renewable energy technologies for distributed power generation.
3. Plans, reports, and similar statements of policy, developed by the Corporation and the Corporation's partners; and any research studies and surveys being considered by the Corporation and partners to review programmatic impact.
4. Development of standards and metrics to monitor progress and measure outcomes of the Initiative.
5. Qualified individuals to serve as points of expertise or on independent peer review panels to review matters of interest to the Initiative, including funding proposals to the Trust.

## Committee Members

- Tina Brooks, Housing Policy Chief, Massachusetts Executive Office of Housing and Economic Development
- Joy Conway, Senior Vice President, Business and Community Development, MassDevelopment
- Elliott Jacobson, Director, Action Energy, Inc.
- Joseph Kriesberg, President, Massachusetts Association of Community Development Corporations
- David MacLellan, Program Manager, Low-Income Electric & Gas Programs and Residential Gas Weatherization, NSTAR Residential Energy Efficiency Department
- Chris Norris, board member, Fair Housing Center of Greater Boston and Homeowner Options for Massachusetts Elders

- Betsy Pettit, A.I.A., President, Building Science Consulting
- David Parish, former Senior Vice President/Director of Housing and Community Investment, Federal Home Loan Bank of Boston
- Donna Sorgi, City of Boston

# Appendix 2: Partner Details

## Boston Community Capital

### Partner Description and Program Summary

Boston Community Capital (BCC) is a community development financial intermediary whose mission is to create and preserve healthy communities where low-income people live and work. For GAHI, BCC received $5 million for a 3-year contract, beginning in March 2007 and ending in March 2010. BCC partnered with the Massachusetts Housing Partnership (MassHousing) for its GAHI submission.

BCC offered a slightly different strategy for using GAHI funds to promote renewable energy in affordable housing. From the outset, BCC's primary goal for the GAHI funding was to develop a sustainable, market-based model for financing renewable energy systems (PV) in affordable housing (see section 4.1 for a detailed discussion of this alternative ownership approach). Through energy efficiency improvements and installation of PV systems for onsite energy generation, BCC sought to fix lower utility costs, thereby stabilizing building. BCC's plan included installation of 700–900 kW systems with the capacity to generate approximately 1 million kW annually in 6–12 developments to affect 500 affordable housing units. In starting the initiative, BCC developed a selection matrix to help target developments that demonstrated the greatest capacity for improved operating income, including those experiencing challenges in meeting operating income requirements, those with high utility consumption, and those with imminent upgrade (including roof) needs. BCC also sought to identify developments for which PV installations were the most feasible from the early stages.

### Accomplishments

Ultimately, BCC funded installation of PV systems totaling 918.3 kW in five large multi-family developments, affecting 1,008 units. Exhibit A-1 provides a snapshot of BCC key development-related accomplishments under GAHI.

**Exhibit A-1: BCC Accomplishments**

| Development | Total Installed Units | GAHI-Funded Installed Units | Unit Type(s) | Total System Capacity (kW) | Total Estimated System Production (kWh) (annually) | Total RE System Production to date (kWh)[21] | Span of RE System Production (months) |
|---|---|---|---|---|---|---|---|
| Mishawum Park | 337 | 337 | Multi-family | 391.3 | 396,594 | 85,809 | 2 |
| North Village | 132 | 132 | Multi-family | 156 | 168,900 | 29,022 | 2 |
| Riverview | 120 | 120 | Multi-family | 199 | 213,200 | 53,497 | 3 |
| Walden Square | 244 | 244 | Multi-family | 80 | 88,720 | 19,743 | 2 |
| Washington Elms | 175 | 175 | Multi-family | 92 | 102,436 | 19,662 | 2 |
| **TOTAL** | **1,008** | **1,008** | **n/a** | **918.3** | **969,850** | **207,732** | **n/a** |

A critical challenge faced by BCC during development and testing of its model has been the recent downturn in the U.S. economy. According to BCC, expiration of tax credits for renewable energy technology has made installing the technology in affordable housing less attractive to developers, thus affecting development and testing of its financing model.

[21] Data for renewable energy system production were collected up to June 30, 2009.

Participation in GAHI has triggered BCC's Energy Advantage Program and influenced its future approach to site selection. GAHI has made BCC more disciplined in avoiding poor or expensive sites for inclusion in its project pipeline.

Internally, BCC now offers its employees a $700 Green Benefit, which can be used to pursue green activities such as energy efficiency improvements for employee homes, help purchase a hybrid vehicle, purchase carbon credits to offset plane travel, etc. BCC itself now tracks its electricity and paper use in an effort to reduce usage.

### Challenges Faced

BCC has faced the following challenges while participating in the GAHI program:

- Legal work and negotiations with host properties took longer than expected.
- The downturn in the credit and tax equity markets in late 2008 and early 2009 affected BCC's access to tax investors and required changes to its financing and ownership structures, contributing to delays in development completion and renewable energy system installation.

### Tools Developed

- PV Selection Tool

## Boston Department of Neighborhood Development

### Partner Description and Program Summary

The City of Boston Department of Neighborhood Development (DND) is the city agency responsible for providing housing services and programs to neighborhoods in Boston. DND has a history of administering Federal funding to carry out a wide range of housing, economic development, open space, environmental abatement, and other community development programs. DND received a $2 million MRET grant to participate in GAHI for 3 years. DND's GAHI contract began April 11, 2007, and will end in June 2010. John Feuerbach, Senior Development Officer for Housing, has been the lead administrator for DND's GAHI program since its inception.

At the outset, DND planned to use its GAHI funds to incorporate renewable energy, energy efficiency, green design, and healthy homes construction techniques into an affordable housing program consisting of large rental and ownership developments totaling approximately 200 units. Each development was anticipated to have 4–7 buildings and 20–60 units each. DND planned to have a total system capacity for all developments of 130–160 kW, generating an estimated 156,000–192,000 kWh annually. DND also expected to use some of its grant money to provide education and training on integrated design and technical issues involved with developing affordable housing with renewable energy and energy efficiency designs.

### Accomplishments

The Initiative funding was coupled with a related grant from a private foundation that supported the hiring of internal staff to investigate aspects of green building and helped DND refine its standards, including its ENERGY STAR requirements for buildings of more than four stories as part of its current Affordable Green Housing Program (see http://www.cityofboston.gov/dnd/D_Green_Housing.asp). DND lists the following goals for the affordable housing to be developed by the program:

- Results in low maintenance and energy costs for renters and homeowners through use of green technologies and materials
- Promotes the health and well-being of residents
- Minimizes environmental impacts of development by conserving water, energy, and other resources, and reduces greenhouse gas emissions

While the bulk of DND's activities focused on standards related to larger renovation and new construction projects, the GAHI funding also supported a smaller, single-family rehabilitation project to explore how to incorporate green features, including PV, into this type of project (e.g., energy efficiency, ENERGY STAR criteria, solar PV, and healthy homes considerations). As a result of this project, DND's Home Center, which supports these smaller projects, has also incorporated green features into its standards and such revisions are ongoing.

DND also cites the Initiative as the catalyst for supporting development of the city's solar program plan, now coordinated by Solar Boston, and as the stimulus for the city's integrated design plan, which includes solar readiness, nonsolar green features, energy efficiency, and healthy homes, with the goal of increasing solar energy in Boston to 25 MW by 2015. Solar Boston is the city's program under the Solar American Initiative of the U.S. Department of Energy to encourage broad adoption of solar energy. The Solar Boston partnership also includes MRET.

DND has completed construction and installed PV systems in three of five developments (1460 Dorchester, Sussex, Franklin Hill Phase 1A). All DND developments will be required to be at least LEED Silver certifiable.

In conjunction with GAHI, DND hosted a series of three developer trainings in mid-2007 on topics such as energy efficiency, integrated design, and indoor air quality, and a separate training on the ENERGY STAR program. Approximately 135 architects, developers, consultants, contractors, and renewable energy company representatives attended the trainings.

The following table provides several key metrics for each of DND's GAHI developments, and provides valuable data that can be used to compare DND's activities to date with its initial goals:

**Exhibit A-2: DND Accomplishments**

| Development | Total Installed Units | GAHI-Funded Installed Units | Unit Type(s) | Total System Capacity (kW) | Total Annual RE System Production (kWh)[22] | Span of RE System Production (months)[6] |
|---|---|---|---|---|---|---|
| 1460 Dorchester | 43 | 43 | Multi-family | 34.2 | 6,539 | 46 (9 systems combined) |
| Sussex Street | 1 | 1 | Single-family | 1.5 | Not Yet Available | Not Yet Available |
| Blessed Sacrament | 0 | 0 | Multi-family | 14 | Not Yet Available | Not Yet Available |
| Franklin Hill Phase 1A | 90 | 90 | Multi-family | 27.93 | 17,251 | 9 |
| Mount Pleasant | 0 | 0 | Multi-family | 40 | Not Yet Available | Not Yet Available |
| **TOTAL** | **134** | **134** | **n/a** | **117.63** | **23,790** | **n/a** |

DND's five active developments are composed of 210 units, all of which are GAHI funded. This is very close to its target of 200 units estimated at the beginning of the program. DND expected that most of its developments would be large rental and owner developments of 20–60 units each, and has pursued this goal for the most part: three of the five developments have 20–100 units (1460 Dorchester, Franklin Hill Phase

[22] Data for renewable energy system production were collected up to June 30, 2009.

1A, and Mount Pleasant). Furthermore, while DND has achieved its target of creating a mixture of ownership and rental units throughout its program, the vast majority of its units are rental (193, or 92%, of all DND units), with a much smaller number of ownership units (17, or about 8%, of all DND units). DND also achieved a mix of new and rehabilitation units throughout its program: 133 units are new construction (about 63% of all DND units) while 77 units are rehabilitation units (about 37% of all DND units).

DND set a target of 130–160 kW total system capacity for all developments at the outset of the program. To date, DND has reported a total of 117.63 kW for all developments, which is within a 10% difference from the low end of its original target.

As far as green designations, DND has exceeded program requirements by pursuing a variety of ratings and certifications for three of its developments. All DND developments will pursue a LEED Silver certifiable requirement. Mount Pleasant will pursue a LEED New Construction Gold rating. Franklin Hill Phase 1A is also participating in the NSTAR Construction Solutions program, which includes ENERGY STAR and Vermont Green Build certifications. Finally, the 1460 Dorchester Avenue development will pursue the Green Communities standard.

Of DND's $2 million MRET grant, it spent $903,182, or about 45%, through June 2009. Most of DND's spending went toward purchase of renewable energy systems for its developments: DND spent $840,011, or 93% of all expenditures, on renewable systems. The rest of DND's expenditures went toward purchase of energy efficiency measures for its five active developments.

### Challenges Faced

During its participation in GAHI, DND faced challenges associated with reduction in the market for Federal tax credits, resulting in construction and PV installation delays at the Blessed Sacrament and Mount Pleasant developments.

### Tools Developed

DND developed increased understanding relative to ENERGY STAR standards for multi-story, multi-family housing through its GAHI participation.

## Cape Light Compact

### Partner Description and Program Summary

CLC is a regional energy services organization serving Martha's Vineyard and Cape Cod. CLC received a $1.5 million MRET grant to participate in GAHI for 3 years. CLC's GAHI contract began November 14, 2006, and will end December 31, 2010.

At the outset, CLC planned to use its GAHI funding to provide financial incentives to building developers and home builders for advanced building performance. One of CLC's foremost goals in the program was to use its MRET funding to reduce the environmental footprint of new affordable and low-income housing units, and reduce energy costs for owners. Specifically, CLC planned to use its grant funds to purchase renewable technologies (solar thermal; PV; and small-scale, land-based wind and bio-based fuels) for new, single, duplex, and multi-family affordable and low-income units on Cape Cod and Martha's Vineyard. CLC originally planned to fund about seven developments composed of roughly 62 total units, and planned to install in each unit a PV system with a capacity of 1–10 kW. CLC estimated at the beginning of the program that the total system capacity for all systems would be approximately 124 kW.

## Accomplishments

CLC's Gull's Nest development has the first overall LEED Homes Platinum-rated affordable housing units in the Nation. CLC's Jenney Way development has the first single-family, detached, affordable housing units with a LEED Homes Platinum rating in the country. All CLC developments achieved or are pursuing a LEED rating. Finally, as the table below demonstrates, CLC will achieve or exceed its initial program targets for the number of units impacted and total installed system capacity.

**Exhibit A-3: CLC Accomplishments**

| Development | Total Installed Units | GAHI-Funded Installed Units | Unit Type(s) | Total System Capacity (kW) | Total Annual Estimated System Production (kWh) | Total RE System Production to Date (kWh)[23] | Span of RE System Production (months)[24] |
|---|---|---|---|---|---|---|---|
| State Road | 0 | 0 | Single-family | 40.8 | Not Yet Available | Not Yet Available | Not Yet Available |
| Asa Meigs | 0 | 0 | Single-family | 14 | Not Yet Available | Not Yet Available | Not Yet Available |
| Gomes Way | 0 | 0 | Single-family | 27.675 | Not Yet Available | Not Yet Available | Not Yet Available |
| Gull's Nest Condominiums | 12 | 12 | Multi-family | 17.5 | 20,430 | 15,856 | 10 |
| Jenney Way | 10 | 10 | Single-family | 6.08 | 5,857 | 4,815[2] | 46 (2 systems combined) |
| Main Street Extension | 0 | 0 | Multi-family | UNK | Not Yet Available | Not Yet Available | Not Yet Available |
| Shore Road | 0 | 0 | Single-family | 5.4 | Not Yet Available | Not Yet Available | Not Yet Available |
| **TOTAL** | **22** | **22** | **n/a** | **111.45** | **n/a** | **20,671** | **n/a** |

As the table demonstrates, CLC achieved its initial objectives in number of developments, number of units built, and total system capacity. CLC had seven active developments as of the May 2009 reporting period, with an additional development (11th St.) in the pipeline. No unit or renewable energy system data was available on this development as of this report, so that development has been excluded from this analysis. The seven active developments have a total of 62 units, equal to CLC's original target number. Of the 62 units, 22 have been built and 40 are in the pipeline to be built. Of the 62 units, 54 are GAHI-funded.

CLC set out initially to use its GAHI funding specifically on new construction, and the table shows the company has achieved this goal in six of its seven developments. Only one of CLC's developments, Gull's Nest, is unique in that it is a conversion development of a former motel into 12 homeowner affordable condominium units. Gull's Nest achieved a LEED Homes Platinum rating in 2008—the first affordable homes in the Nation to achieve that rating. For more information on Gull's Nest, see section 4.2.

The planned system capacity for all CLC developments was estimated at the outset of the program to be approximately 124 kW. The total system capacity for all systems is 111.45 kW, which is very close to the original goal.

Another notable aspect of CLC's GAHI program has been the green designations pursued in each of its developments. All seven developments achieved the ENERGY STAR Qualified Homes rating, as required by GAHI for all Partners and developments, but CLC exceeded this requirement by pursuing a LEED Homes rating in each of its seven developments. Four CLC developments are pursuing or have achieved a LEED Platinum rating (State Road, Gull's Nest, Jenney Way, and Main Street Extension). The Gomes Way development is pursuing a Gold rating, the Asa Meigs development is pursuing a Silver rating, and the Shore

[23] Data for renewable energy system production were collected up to June 30, 2009.
[24] Based on two reporting systems.

Road development is pursuing a Certified rating. The Jenney Way homes are the first single-family detached affordable homes in the country to achieve a LEED Homes Platinum rating.

Through June 2009, CLC had spent $462,364, or about 30%, of its $1.5 million MRET grant. Most of CLC's expenditures ($288,212, or 62%) have gone toward purchase and installation of renewable systems in its developments.

### Challenges Faced

CLC faced the following challenges during its participation in the GAHI program:

- Demand for funding from developers exceeded the amount CLC had available.
- Obtaining lifetime warranties for renewable energy systems as required by contract with MRET was difficult.

### Tools Developed

CLC developed the following tools with GAHI funding:

- CLC now offers a renewable energy assessment along with its home energy audit for customers considering renewable energy for their homes.
- CLC offers programs ranging from ENERGY STAR Homes to ENERGY STAR–qualified lighting and appliances to low-income residents on Cape Cod and Martha's Vineyard.
- CLC has begun a pilot to replace electric hot water with solar domestic hot water for year-round families of four or more.

## **HAP**Housing

### Partner Description and Program Summary

**HAP**Housing (formerly HAP, Inc.) is a private, nonprofit corporation providing a variety of housing services to tenants, rental property owners, homebuyers, and homeowners in Hampden and Hampshire counties in western Massachusetts. HAP has developed affordable housing for more than 20 years, and has experience providing services such as housing consumer education, rental services, housing counseling, homeless services, fair housing, lead-based paint abatement assistance, first-time homebuyer assistance, and foreclosure prevention. HAP, in partnership with Rural Development, Inc., received a $2 million MRET grant to participate in GAHI for 3 years. HAP's contract with MRET began January 1, 2007, and will end January 1, 2010. Craig Marden has led the administration of HAP's GAHI program since it began.

At the outset of the program, HAP planned to use its MRET grant to affect about 130 housing units (40 homeowner units and 90 rental units), through installation of renewable systems totaling about 125 kW of system capacity. One of HAP's primary objectives at the beginning of GAHI was to reduce electricity costs to homeowners by one-third or more, and reduce heating costs by 20–40% per unit.

At the core of HAP's program were grants to developers for advanced building performance, including installation of renewable energy systems. HAP provided rebate incentives for eligible affordable housing developers to install renewable energy systems in their developments, and increase the energy performance and health of the developments through superior building products and technology. Another major component of HAP's program was providing education to developers and technical services to projects,

including design assistance and performance certification. Finally, all new units built through HAP's program were required to meet the ENERGY STAR Qualified Homes standard.

## Accomplishments

HAP's Wisdom Way development (built by Rural Development, Inc.) will be near zero net energy and is pursuing a LEED-Homes Platinum rating. HAP's YWCA Supportive Housing LP development is pursuing a LEED-H Silver rating. HAP held five trainings for housing industry professionals in 2008 on topics such as solar thermal, PV, and high-performance HVAC systems.

**Exhibit A-4: HAP Accomplishments**

| Development | Total Installed Units | GAHI-Funded Installed Units | Unit Type(s) | Total System Capacity (kW) | Total Annual RE System Production (kWh)[25] | Span of RE System Production (months)[5] |
|---|---|---|---|---|---|---|
| DMR Housing | 0 | 0 | Single-family | Not Yet Available | 0 | 0 |
| Easthampton Housing Authority | 0 | 0 | Single-family | Not Yet Available | 0 | 0 |
| Laurel Road | 11 | 11 | Single-family | 29.7 | 45,674 | 189 (11 systems combined) |
| Pendleton Avenue | 0 | 0 | Single-family | 4.4 | 0 | 0 |
| YWCA Supportive Housing LP | 0 | 0 | Multi-family | 30 | 0 | 0 |
| Berkshire Veterans' Village | 0 | 0 | Multi-family | 40 | 0 | 0 |
| West Union Street | 0 | 0 | Single-family | 4.96 | 0 | 0 |
| Wisdom Way | 0 | 0 | Single-family | 41.04 | 0 | 0 |
| **TOTAL** | **11** | **11** | **n/a** | **150.1** | **45,674** | **n/a** |

HAP will ultimately impact 108 units. Ninety-seven of the 108 units are in the pipeline to be built after August 31, 2009, and construction has been completed on the remaining 11 units. While HAP will not meet its original target of impacting 130 units, it should be noted that HAP has had to replace some original developments with other developments that were not initially expected to be a part of the program. For example, HAP determined in its most recent reporting round (May 2009) that one of its developments, Spruce Green, would not proceed as part of the program because of delays that will prevent development from beginning until after GAHI is over. Thus, the seven units in that development originally included in HAP's target number are excluded from HAP's actual final total of impacted units.

Most of HAP's units—101 of 108, or 94%—will be funded by GAHI and benefit directly from the program.

Most of HAP's 108 units will be new construction, affordable, homeowner units. Specifically, 73 units, or 68%, will be new construction, affordable, homeowner units; 25 units, or 23%, will be new construction, market-rate, homeowner units; and 10, or 9%, will be new construction, affordable, rental units.

HAP's target at the outset of the program was to install approximately 125 kW of system capacity across all developments. While HAP is on track to install 150.1 kW of system capacity in eight developments, it should be noted that only one development had completed construction by August 31, 2009, while the remaining seven are in the pipeline. System capacities for those seven developments are thus pipeline estimates provided by HAP that could change after the systems are actually installed. Furthermore, because not all the

[25] Data for renewable energy system production were collected up to June 30, 2009.

developments that HAP originally planned to fund have been kept in the program, the 150.1 kW value is only a 20% difference from the original target.

As of June 30, 2009, one HAP development (Laurel Road) had renewable systems installed and was reporting data into the MRET Production Tracking System (PTS). Laurel Road has 11 units and 11 renewable energy systems that have been reporting monthly production data for an average of 17 months. The mean monthly output of these 11 systems has been 245 kWh/month, with a high output value of 497 kWh/month and a low monthly output of 50.5 kWh/month. The total system output for all 11 systems to June 30, 2009 was 4,152 kWh.

Through June 2009, HAP had spent $960,328, or 48%, of its $2 million MRET grant. Most of HAP's spending was on purchase and installation of renewable systems in its developments. HAP spent $615,304 on renewable systems, accounting for 64% of total expenditures.

HAP has created the Green Building Program Manager position to provide in-house expertise to other HAP staff. This position is 80% funded by MRET. When funding is depleted, a position dedicated to green building will no longer exist, but the individual will remain in the organization in a broader capacity and will be able to provide expertise and consultation across the organization. This person provides the organization substantial expertise in building performance testing and solar screening, knowing that is now also spreading to others in HAP and the region. HAP also plans to institute a formal green screening step as part of its funding decisionmaking process. In terms of property management, HAP has embraced the challenge of more aggressively tracking energy and water usage at its properties. The new facilities manager position explicitly includes job elements related to green building performance. HAP also undertook an energy audit for its own building, suggesting changes in operations such as more efficient waste reuse and recycling.

### Challenges Faced

HAP faced push-back from nonprofit developers of affordable housing regarding mortgage covenants during its GAHI participation to date.

### Tools Developed

HAP developed the following tools with GAHI funding:

- An ongoing education series is moving to integrate energy efficiency and green building techniques into buildings that are powered with renewable energy.
- The Google Sketch Up Model, developed with funds from the Citizens Housing and Planning Association (CHAPA), is an interactive architectural model that will be used to educate developers, architects, and contractors on how building assemblies are properly constructed. The model specifically addresses best building practices specific to insulation, air barriers, and drainage planes.
- The Green Specification Template is a resource for projects going forward.

## Joint Management Committee

### Partner Description and Program Summary

JMC is the sponsor of the Massachusetts New Homes with ENERGY STAR Program. The Committee comprises various utility companies and energy efficiency service providers in Massachusetts, including NSTAR Gas & Electric, National Grid Gas & Electric, Western Massachusetts Electric, Unitil,

Cape Light Compact, Bay State Gas, Berkshire Gas, New England Gas, and the Massachusetts Technology Collaborative.

JMC is unique in that utilities and providers work together under one umbrella to unify and promote multiple energy efficiency programs, as well as create innovative pilot programs to move the residential new construction market toward greater energy efficiency.

The GAHI partnership administered by JMC was awarded $1.5 million for design and construction of small PV systems for affordable housing developments throughout Massachusetts. The ENERGY STAR program was able to provide GAHI with an existing green building standard and direct access to one- and two-family, low-rise, residential housing developments.

Under the administration of ICF, the JMC partnership was charged with delivering, at a minimum, approximately 55 kW of installations composed of 10–15 developments.

## Accomplishments

By June 30, 2009, JMC had installed 43 renewable systems in 16 of its 19 developments, producing a total of 158,180 kWh. JMC has completed or will complete construction on 79 of its 91 units, or 89%, by August 31, 2009.

**Exhibit A-5: JMC Accomplishments**

| Development | Total Installed Units | GAHI-Funded Installed Units | Unit Type(s) | Total System Capacity (kW) | Total Annual Estimated System Production (kWh) | Total RE System Production To Date (kWh)[26] | Span of RE System Production (months)[8] |
|---|---|---|---|---|---|---|---|
| Petty Plain | 1 | 1 | Single-family | 3.3 | 3,946 | Not Yet Available | Not Yet Available |
| Wisdom Way | 1 | 1 | Single-family | 3.04 | 3,205 | 3,155 | 10 |
| L Street | 1 | 1 | Single-family | 2.52 | 3,031 | 1,325 | 4 |
| 58 7th Street | 6 | 6 | Multi-family | 6.9 | 11,330 | 2,742 | 4 |
| 95-97 Pine Street | 0 | 0 | Multi-family | 10 | 10,964 | Not Yet Available | Not Yet Available |
| Alder Street | 2 | 2 | Single-family | 7.02 | 8,404 | 4,146 | 10 (2 systems combined) |
| Baboci Residence | 1 | 1 | Single-family | 3.42 | 4,517 | 1,476 | 8 |
| Coppersmith Way | 6 | 6 | Single-family | 19.44 | 23,666 | 29,022 | 75 (6 systems combined) |
| Ed Clark Road | 3 | 3 | Single-family | 9.68 | 11,766 | 20,295.10 | 66 (3 systems combined) |
| Eutaw Street | 2 | 2 | Single-family | 7.02 | 8,404 | 4,015 | 10 (2 systems combined) |
| Gomes Way | 0 | 0 | Single-family | 7.38 | 7,468 | Not Yet Available | Not Yet Available |
| Grove Street | 0 | 0 | Single-family | 3.6 | 4,492 | Not Yet Available | Not Yet Available |
| Hyde-Blakemore Condominiums | 2 | 2 | Multi-family | 5.76 | 6,960 | 5,425 | 22 (2 systems combined) |
| Kilby Hollis | 10 | 10 | Single-family | 28.8 | 33,650 | 31,847.60 | 120 (10 systems combined) |
| Melvin Street | 0 | 0 | Single-family | 6.84 | 7,778 | Not Yet Available | Not Yet Available |
| Old Stage Road | 2 | 2 | Single-family | 5.98 | 6,987 | 15,840.50 | 54 (2 systems combined) |
| Scarito Homes | 10 | 10 | Multi-family | 24 | 24,520 | 36,408.10 | 180 (10 systems combined) |
| Stanley Street | 0 | 0 | Single-family | 7.84 | 9,277 | 2,483 | 12 (2 systems combined) |
| Turnpike Road | 1 | 1 | Single-family | 3.3 | 3,946 | Not Yet Available | Not Yet Available |
| **TOTAL** | **48** | **48** | **n/a** | **165.84** | **194,311** | **158,180** | **n/a** |

Through June 2009, JMC had spent $1,169,326 of its MRET grant award, or about 78% of its total GAHI program budget. Most of JMC's expenditures—$785,612, or 67%—went toward purchase of renewable systems in developments. About 32% of JMC's expenditures went toward program administration ($377,430), and $6,284 was spent on marketing the GAHI program to potential developers.

[26] Data for renewable energy system production were collected up to June 30, 2009.

### Challenges Faced

JMC faced the following challenges during its participation in the GAHI program:

- The slow housing market continued to keep new project signings at arm's length. While there was sufficient interest from several builders, State and Federal funding commitments remained unconfirmed, thus hampering the ability of interested developers to sign on to the JMC GAHI program.
- A late December 2008 ice storm delayed utility inspections of two completed systems, and nonspecific construction delays prevented completion of four systems.

### Tools Developed

JMC developed the following tools with GAHI funding:

- Excel spreadsheets were distributed to all Massachusetts New Homes with ENERGY STAR program raters to help them accurately model the "as built" PV systems of the projects they are rating for the JMC partnership to:
  - Calculate comparative energy load and savings data
  - Accurately model REM rate renewable energy system entries
  - Properly assess and qualify a home for PV installation
- A survey of the 2008 completed JMC-GAHI funded projects showed unacceptable errors in the reported HERS Index. On average, HERS indices were three points lower as a result of incorrect PV system REM rate inputs.

## Massachusetts Department of Housing & Community Development

### Partner Description and Program Summary

DHCD is the Commonwealth of Massachusetts's affordable housing agency. DHCD received $1.5 million from MRET for a 3-year contract beginning in May 2008 and ending in May 2011.

DHCD's primary objective at the outset of the program was to provide additional funding to affordable housing developers as an incentive to bring green building design into their projects. DHCD sought to use its grant funding to help tackle the extra expenses required to include energy conservation and generation in new buildings. DHCD projected that GAHI would impact approximately 50–80 units in 8–12 developments, with a total of 80–120 kW of installed system capacity. The developments DHCD planned to fund at the beginning of the program were homeowner developments and affordable, first-time homebuyer projects.

### Accomplishments

Ultimately, DHCD funded installation of 63.5 kW PV systems in three multi-family developments, affecting 50 units. Exhibit A-6 provides a snapshot of key accomplishments for DHCD's developments.

**Exhibit A-6: DHCD Accomplishments**

| Development | Total Installed Units | GAHI-Funded Installed Units | Unit Type(s) | Total System Capacity (kW) | Total Annual Estimated System Production (kWh) | Total RE System Production To Date (kWh)[27] | Span of RE System Production (months)[7] |
|---|---|---|---|---|---|---|---|
| 823 Main Street | 10 | 10 | Multi-family | 19.5 | 24,102 | 0 | 0 |
| 89 Oxbow | 16 | 16 | Multi-family | 19 | 21,134 | 5,004 | 4 each for 15 systems. One system did not report data. |
| Print Shop | 24 | 24 | Multi-family | 25 | 74,534 | 0 | 0 |
| Orchard Park | 0 | 0 | Single-family | 74.62 | UNK | 0 | 0 |
| **TOTAL** | **50** | **50** | **n/a** | **138** | **119,770** | **5,004** | **n/a** |

DHCD has completed construction of its three developments. The department met its target number of units and total installed system capacity. Its three developments consist of a total of 50 units and 63.5 kW of renewable energy system capacity. One of DHCD's developments, 89 Oxbow, has installed 16 renewable energy systems that produced 5,005 kWh through June 30, 2009. The 823 Main Street and Print Shop developments were built to a LEED Homes Silver standard.

Of DHCD's $1.5 million MRET grant, $655,998, or about 44%, had been spent through June 2009. Most of DHCD's expenditures were on renewable systems in its three developments ($518,116, or 79% of total expenditures). Its remaining expenditures went toward purchase of energy efficiency measures ($137,882, or 21% of total expenditures).

The agency also is working with one of its architects to develop a list of recommended green building materials, and is considering development of a guidebook for developers. DHCD also manages extensive public housing stock, and for this portfolio is actively pursuing ways to increase energy efficiency and reduce costs through green features and renewable energy at 50,000 units that are in need of upgrades.

### Challenges Faced

DHCD faced the following challenges during its participation in the GAHI program:

- DHCD had to replace the program coordinator halfway through program.
- DHCD had to seek a fourth development that it did not originally intend to pursue so it could expend all GAHI funds (the fourth project is still under review).

### Tools Developed

None reported.

## MassHousing

### Partner Description and Program Summary

MassHousing is a State affordable housing lender that uses bond financing and other sources of funds to finance developers of housing affordable to low- and moderate-income residents. It sells federally authorized, tax-exempt, and taxable bonds to individual and corporate investors, which raises private capital for

[27] Data for renewable energy system production were collected up to June 30, 2009.

mortgages that MassHousing then loans to eligible borrowers at rates below those of conventional lenders. Investors in MassHousing bonds receive returns on their investments that are supported by the monthly mortgage payments made by borrowers.

For GAHI, MassHousing received an $8.5 million grant for a 4-year contract, beginning in June 2006 and ending in June 2010.

The MassHousing program was designed to award feasibility grants up to $30,000 per project to study technical and financial feasibility of placing renewable energy systems in a proposed affordable housing development, design grants up to $50,000 per project to prepare design and pricing information for construction of renewable energy systems, and construction grants up to $500,000 per project to fund direct construction costs of renewable energy systems. All units must be certified as ENERGY STAR Homes or meet or exceed an equivalent energy or green standard. In addition, many MassHousing developments sought to meet Enterprise Green Communities standards. MassHousing projected that its GAHI developments would have about 340 units of housing, and its grant would help fund installation of renewable energy systems totaling about 740 kW.[28]

## Accomplishments

MassHousing has completed construction of eight developments and produced 573 total units. It has installed four renewable energy systems in four developments with a total installed system capacity of 186 kW. Through June 30, 2009, these four systems had produced 118,259 kWh of energy.

**Exhibit A-7: MassHousing Accomplishments**

| Development | Total Installed Units | GAHI-Funded Installed Units | Unit Type(s) | Total System Capacity (kW) | Total Annual Estimated System Production (kWh) | Total RE System Production To Date (kWh)[29] | Span of RE System Production (months) |
|---|---|---|---|---|---|---|---|
| 113 Spencer | 48 | 0 | Multi-family | 44.08 | 48,654 | Not Yet Available | Not Yet Available |
| 225 Centre Street (part of Jackson Square) | 0 | 0 | Multi-family | 47.88 | 59,664 | Not Yet Available | Not Yet Available |
| Centre Wise Lamartine | 0 | 0 | Multi-family | 35 | 45,000 | Not Yet Available | Not Yet Available |
| Ashmont – The Carruth Building | 74 | 0 | Multi-family | 50 | 54,746 | 33,231 | 10 |
| Bliss School Apartments | 40 | 0 | Multi-family | 38 | 43,725 | Not Yet Available | Not Yet Available |
| Bridle Path Apartments | 104 | 0 | Multi-family | 43 | 48,850 | Not Yet Available | Not Yet Available |
| Cabot Street Homes | 0 | 0 | Multi-family | 26.22 | 30,222 | Not Yet Available | Not Yet Available |
| Centre-Creighton (Bldg M) Blessed Sacrament | 0 | 0 | Multi-family | 51.24 | 52,900 | Not Yet Available | Not Yet Available |
| Fairweather Apartments | 0 | 0 | Multi-family | Not Yet Available | Not Yet Available | Not Yet Available | Not Yet Available |
| Franklin Hill 2-A | 0 | 0 | Multi-family | 48 | 64,700 | Not Yet Available | Not Yet Available |

[28] MassHousing targets are based on internal MRET approval documents.
[29] Data for renewable energy system production were collected up to June 30, 2009.

| Development | Total Installed Units | GAHI-Funded Installed Units | Unit Type(s) | Total System Capacity (kW) | Total Annual Estimated System Production (kWh) | Total RE System Production To Date (kWh)[29] | Span of RE System Production (months) |
|---|---|---|---|---|---|---|---|
| Hope House | 102 | 102 | Multi-family | 31.44 | 36,550 | 37,13 | 1 |
| Kasanof Bakery | 0 | 0 | Multi-family | 50 | 54,300 | Not Yet Available | Not Yet Available |
| Shillman House | 0 | 0 | Multi-family | 50 | 51,600 | Not Yet Available | Not Yet Available |
| St. Polycarp Village Apartments | 24 | 0 | Multi-family | 39.65 | Not Yet Available | Not Yet Available | Not Yet Available |
| Trolley Square | 32 | 32 | Multi-family | 44.04 | 44,532 | 63,591 | 23 |
| Visiting Nurse Association Senior Living Community | 99 | 99 | Multi-family | 60.2 | 62,165 | 17,724 | 3 |
| Sean Brooks House | 0 | 0 | Multi-family | 38.6 | 47,728 | Not Yet Available | Not Yet Available |
| **TOTAL** | **523** | **233** | **n/a** | **697.35** | **745,336** | **118,259** | **n/a** |

Of MassHousing's $8.5 million MRET grant, $4,257,147, or about 50%, had been spent through June 2009. All of MassHousing's expenditures went toward purchase and installation of renewable systems in developments.

### Challenges Faced

MassHousing faced the following challenges during its participation in GAHI:

- Delay in signing partnership agreement early in program adversely impacted approved developments.
- Unpaid feasibility studies prevented nonprofits from proceeding to design phase early in program.

### Tools Developed

None noted.

## WinnDevelopment

### Partner Description and Program Summary

WinnDevelopment is the largest affordable housing developer in Massachusetts. It owns and manages 5,200 units in Massachusetts and 65,000 units nationwide. For GAHI, Winn received a $2.5 million grant for a 3-year contract, beginning in November 2006 and now ending in February 2010. Winn partnered with greenGoat and Powerhouse Enterprises for its GAHI submission.

Winn's primary goal at the outset of the program was to create a model for including energy efficiency measures and renewable energy technology in affordable housing by studying two affordable "test" properties that would represent three different building types—townhouse, apartment style, and historic mill. Winn projected that its MRET grant would impact 300 units, and that it would install renewable systems with approximately 140 kW total system capacity in its developments, generating a projected 150,000 kWh annually. Winn was also interested from the start of the program in providing training for staff and affordable

housing professionals and developers, and set a target of providing eight different training meetings reaching a total of 300 people.

Initially, the GAHI funds supported a new position within Winn to review green features in its affordable housing portfolio. This position has now expanded to a permanent Director of Green Building and a program manager, as well as a standing Green Committee composed of all company executives. The Green Committee undertakes a formal review of green features as part of quarterly asset management reviews.

## Accomplishments

Ultimately, Winn funded installation of 281.63 kW PV systems in three large and medium-sized multi-family developments, affecting 399 units.

**Exhibit A-8: Winn Accomplishments**

| Development | Total Installed Units | GAHI-Funded Installed Units | Unit Type(s) | Total System Capacity (kW) | Total Annual Estimated System Production (kWh) | Total RE System Production to date (kWh)[30] | Span of RE System Production (months)[4] |
|---|---|---|---|---|---|---|---|
| Bowdoin Apartments | 226 | 226 | Multi-family | 77 | 99,981 | 221,035 | 29 |
| Stony Brook Village | 98 | 98 | Multi-family | 47.88 | 49,125 | 19,153 | 12 (2 systems combined) |
| Whalers | 75 | 75 | Multi-family | 156.75 | 190,275 | 54,235 | 6 |
| **TOTAL** | **399** | **399** | **n/a** | **281.63** | **339,381** | **294,423** | **n/a** |

Winn has completed construction and renewable energy system installation in all three of its developments. Two of the developments (Bowdoin Apartments and Stony Brook Village) are apartment-style multi-family developments, and the third (Whalers) is a conversion development of a historic mill property. Winn created 399 units that directly benefit from GAHI, surpassing its target of impacting 300 units. Furthermore, Winn installed 282.63 kW system capacity in its three developments, exceeding its initial target estimate of 140 kW total installed system capacity. This was achieved at the Whalers and Stony Brook developments, each of which had renewable systems installed that exceeded the sizes set forth in the program agreement. This was accomplished by leveraging tax credits through a PPA. The PPA structure allows the leverage of renewable energy tax credits and increased system size. The PPA also protects properties from the long-term costs associated with operating and maintaining the systems, allowing affordable properties to benefit from renewables with none of the maintenance risk.

Of its $2.5 million GAHI award, Winn had spent $2,427,999, or 97%, up to June 2009. Most of Winn's expenditures have been on renewables systems and energy efficiency measures: about 73.8% on renewables, 12.6% on energy efficiency, and 13.5% on administration and training costs.

[30] Data for renewable energy system production were collected up to June 30, 2009.

## Challenges Faced

Winn faced the following challenges during its participation in GAHI:

- Installation of renewable systems was delayed due to issues with utility interconnection.
- There were last minute contractor changes.
- Wireless technology for tracking production data at Bowdoin was problematic, causing data collection issues at the property.

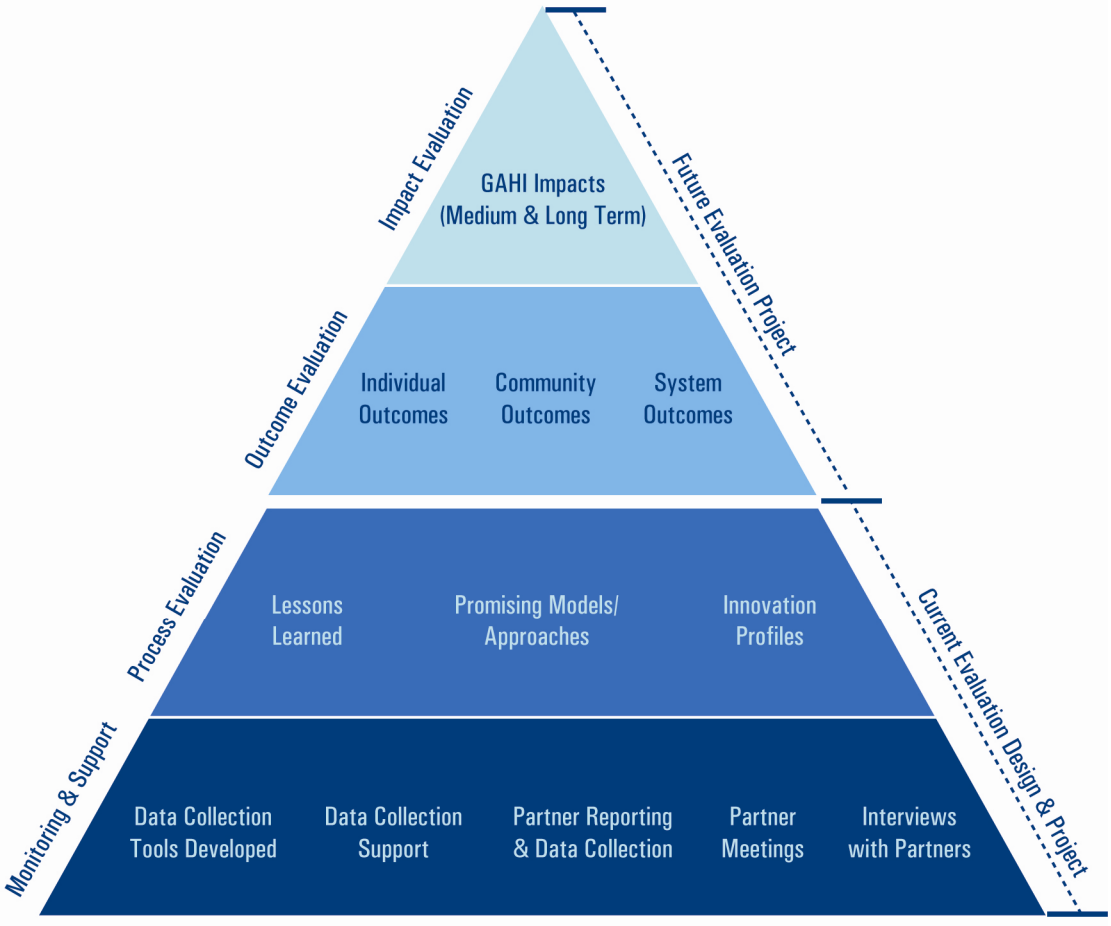
## Tools Developed

- "Energy Scorecard" that can be utilized by homeowners (Winn is in the process of finalizing this scorecard)
- PV site selection and assessment tool (see appendix 5)
- Energy audit tool for use with developments across the Winn portfolio

# Appendix 3: Monitoring and Evaluation Model and Evaluation Questions

The initial concept for GAHI's monitoring and evaluation incorporated a multilevel nested design primarily focused on monitoring and shorter term evaluation results, as shown by exhibit A-9 below.

**Exhibit A-9: Multilevel Evaluation Design**




As mentioned in section 1, the GAHI evaluation design originally included 10 core questions designed to cover the process, outcome, and impact evaluation components for both the short and long term with GAHI. Due to delays in Partner development, many of these questions cannot be addressed at this point in the process. As a result, this report focuses to a greatly limited degree on only five of the original 10 questions as described in section 1. The 10 core evaluation questions include the following:

## Exhibit A-10: Core Evaluation Questions for GAHI

| Evaluation Question | Current Data Status: Some data available | Current Data Status: Future data needed |
|---|---|---|
| 1. What changes has the Initiative achieved in terms of renewable energy capacity and generation in the affordable housing sector? | • | |
| 2. What changes has the Initiative achieved in terms of reducing consumption of energy from fossil fuel sources by the affordable housing sector? | | • |
| 3. What are the key outcomes of the Initiative for affordable housing properties, occupants, and owners (e.g., energy cost savings, improved building performance)? | | • |
| 4. To what extent did the Partners' activities contribute to permanent, self-sustaining change in use of renewable energy and other green building practices in the affordable housing sector? | • | |
| 5. What do the Partners' experiences show about the relative costs and benefits of renewable energy and other green housing practices in affordable housing? | | • |
| 6. To what extent were the Initiative's Partners able to leverage other resources to support incorporating renewable energy and other green housing practices in affordable housing projects? | | • |
| 7. To what extent did the Partners address renewable energy and other green housing practices from an integrated design approach? | | • |
| 8. What are the lessons from the experience of the Partners' about ways that renewable energy and other green housing practices can be successfully incorporated into affordable housing programs and projects? | • | |
| 9. What are the definitions of "green housing" used by the Partners and how do they compare with other common definitions used by key actors? | • | |
| 10. To what extent did the Initiative reduce adverse environmental impacts that stem from consumption of energy from fossil fuel sources? | • | |

# Appendix 4: Description of Green Designations Sought/Achieved by GAHI Partners

GAHI Partners sought and achieved a variety of green designations. The designations include ENERGY STAR Qualified Homes, LEED, Green Communities, NAHB Green Designations, 20% above ASHRAE standard, NYSERDA Existing Multi-Family Energy Conservation Standards, and the NSTAR Construction Solutions program.

## ENERGY STAR Qualified Home

To earn the ENERGY STAR Qualified Home designation, a home must meet the following three criteria: (1) meet the appropriate Home Energy Rating System (HERS) Index, (2) be verified and field-tested in accordance with Residential Energy Services Network (RESNET) Standards by a RESNET-accredited provider, and (3) meet all applicable codes. Home Energy Raters are trained to evaluate construction techniques, take key measurements, and perform inspections and testing procedures to verify a home's efficient performance. Raters help builders choose energy-efficient features for their ENERGY STAR qualified homes in two ways: (1) with a traditional Home Energy Rating, whereby a rater simulates a home's energy use with specialized computer software that allows him or her to identify the most effective upgrades to meet ENERGY STAR performance guidelines, or (2) with a Builder Option Package, whereby the builder and rater use a set of climate-specific construction specifications that consistently meet ENERGY STAR guidelines. Home Energy Raters conduct field verifications through onsite inspections and testing of homes, which ensures that energy-saving measures are consistent with ENERGY STAR guidelines. The process usually includes a blower door test (to test the leakiness of a house), a duct blaster test (to test the leakiness of the duct system), and completion of a thermal bypass checklist (a visual inspection of common construction areas where air can flow through or around insulation).

Any home three stories or fewer can earn the ENERGY STAR label if it has been verified to meet EPA's guidelines, including single-family, attached, and low-rise multi-family homes; manufactured homes; systems-built homes (e.g., modular construction); log homes; concrete homes; and even existing retrofitted homes.

For more information about ENERGY STAR Qualified Homes, go to:
http://www.energystar.gov/index.cfm?c=new_homes.hm_index

## LEED (Leadership in Energy and Environmental Design)

LEED is an internationally recognized green building certification system providing third-party verification that a building or community was designed and built using strategies aimed at improving performance across many metrics: energy savings, water efficiency, $CO_2$ emissions reduction, improved indoor environmental quality, and stewardship of resources and sensitivity to their impacts. LEED can be applied to any building type and lifecycle phase. LEED certification is obtained after submitting an application documenting compliance with the requirements of the rating system as well as paying registration and certification fees. Certification is granted solely by the Green Building Council responsible for issuing the LEED system used on the project. Buildings can qualify for four levels of LEED certification depending on the number of base points they earned. There are 100 possible base points plus an additional 6 points for Innovation in Design and 4 points for Regional Priority. The levels of LEED certification are:

- Certified – 40–49 points
- Silver – 50–59 points
- Gold – 60–79 points
- Platinum – 80 points and above

Points are distributed among the following categories:

- Sustainable Sites – 26 possible points for discouraging development on previously undeveloped land; minimizing a building's impact on ecosystems and waterways; encouraging regionally appropriate landscaping; rewarding smart transportation choices; controlling storm water runoff; and reducing erosion, light pollution, heat island effect, and construction-related pollution.
- Water Efficiency – 10 possible points for encouraging smarter use of water, inside and out. Water reduction is typically achieved through more efficient appliances, fixtures, and fittings inside and water-wise landscaping outside.
- Energy and Atmosphere – 35 possible points for encouraging a wide variety of energy strategies: commissioning; energy use monitoring; efficient design and construction; efficient appliances, systems, and lighting; renewable and clean sources of energy, generated onsite or off; and other innovative strategies.
- Materials and Resources – 14 possible points for encouraging selection of sustainably grown, harvested, produced, and transported products and materials; reduction of waste and reuse and recycling; and it takes into account the reduction of waste at a product's source.
- Indoor Environmental Quality – 15 possible points for promoting strategies that can improve indoor air quality, such as outdoor air delivery monitoring, increased ventilation, indoor air quality management plan, low-emitting materials, indoor chemical and pollutant source control, controllability of systems, as well as providing access to natural daylight and views and improving acoustics.
- Innovation in Design – 6 possible points for projects that use new and innovative technologies and strategies to improve a building's performance well beyond what is required by other LEED credits or in green building considerations that are not specifically addressed elsewhere in LEED. It rewards projects for including a LEED Accredited Professional on the team to ensure a holistic, integrated approach to the design and construction phase.
- Regional Priority – 4 possible points for addressing environmental concerns that are locally most important.

LEED also has some prerequisites that receive no points but are required to receive certification. These include construction activity pollution prevention, water use reduction, fundamental commissioning of building energy systems, minimum energy performance, fundamental refrigerant management, storage and collection of recyclables, minimum indoor air quality performance, and environmental tobacco smoke control.

For more information about LEED, go to the US Green Building Council's Web site at http://www.usgbc.org/DisplayPage.aspx?CategoryID=19.

## Green Communities

Green Communities homes are built according to the Green Communities Criteria, a national framework for healthy, efficient, environmentally smart, affordable homes. The criteria were developed collaboratively by Enterprise Community Partners, Inc. and leading national organizations and experts to provide a clear, cost-effective framework for all kinds of affordable housing: new construction and rehabilitation in multi-family as well as single-family buildings. Green projects must meet a minimum number of Green Communities criteria that include integrated design, site, location, and neighborhood fabric; site improvements; water conservation; energy efficiency; materials beneficial to the environment; healthy living environment; and operations and maintenance. The criteria are aligned with the LEED Green Building Rating System.

Projects seeking to achieve the Green Communities standard must comply with all mandatory provisions, which include:

- Green Development Plan
- Proximity to Existing Development (except for rehabs or infill sites)
- Protecting Environmental Resources: New Construction (except for rehabs or infill sites)
- Proximity to Services: New Construction (except for rehabs or infill sites)
- Compact Development: New Construction (except for rehabs)
- Sidewalks and Pathways
- Environmental Remediation
- Erosion and Sedimentation Control
- Landscaping
- Water-Conserving Appliances and Fixtures
- Efficient Irrigation (mandatory if irrigation is necessary)
- Efficient Energy Use
- ENERGY STAR Appliances
- Efficient Lighting
- Electricity Meter (some exceptions)
- Low/No VOC Paints and Primers
- Low/No VOC Adhesives and Sealants
- Urea Formaldehyde-Free Composite Wood
- Green Label Certified Floor Coverings
- Exhaust Fans: Bathroom
- Exhaust Fans: Kitchen: New Construction & Substantial Rehab
- Ventilation: New Construction & Substantial Rehab
- HVAC Sizing
- Water Heaters
- Materials in Wet Areas
- Basement and Concrete Slabs
- Water Drainage
- Garage Isolation
- Clothes Dryer Exhaust
- Integrated Pest Management
- Lead-Safe Work Practices
- Combustion Equipment
- Building Maintenance Manual
- Occupant's Manual
- Homeowner and New Resident Orientation

In addition, new construction projects must earn 35 points from the Optional Criteria, while moderate rehabilitation projects must earn 30 points from the Optional Criteria to be eligible for financial projects included under Green Communities. Optional Criteria include:

- Passive Solar Heating/Cooling (4)
- Grayfield, Brownfield, or Adaptive Reuse Site (10)
- Compact Development (5)
- Connections to Surrounding Neighborhoods (5)
- Transportation Choices (12)
- Surface Water Management (5)
- Storm Drain Labels (2)
- Water-Conserving Appliances and Fixtures (5)
- Additional Reductions in Energy Use (Optional)
- Renewable Energy (15)
- PV-Ready (2)
- Construction Waste Management (5)
- Recycled Content Material (14)
- Certified, Salvaged, and Engineered Wood (5)
- Water-Permeable Walkways (5)
- Water-Permeable Parking Areas (5)
- Reduce Heat-Island Effect: Roofing (5)
- Reduce Heat-Island Effect: Paving (5)
- Reduce Heat-Island Effect: Plantings (5)
- Exhaust Fans – Kitchen: Moderate Rehab (5)
- Ventilation: Moderate Rehab (10)
- Healthy Flooring Materials (5)
- Smoke-Free Building (2)

For more information about Green Communities, go to: www.greencommunitiesonline.org.

## NAHB Green Home Building Guidelines

The National Association of Home Builders (NAHB) Model Green Home Building Guidelines were written by builders, researchers, environmental experts, and designers to provide guidance for builders engaged or interested in green building products and practices for residential design, development, and construction. The guidelines offer three levels of certification:

- Bronze – 237 points
- Silver – 311 points
- Gold – 395 points

The guidelines cover seven areas:

- Lot Design, Preparation, and Development: Minimize environmental impact; protect, restore, and enhance the natural features and environmental qualities of the site; and minimize environmental intrusion during onsite construction. (Bronze – 8, Silver – 10, Gold – 12)
- Resource Efficiency: Reduce the quantity of materials used and waste generated, enhance durability and reduce maintenance, reuse materials, use recycled content materials and renewable materials, recycle waste materials during construction, and use resource-efficient materials. (Bronze – 44, Silver – 60, Gold – 77)
- Energy Efficiency: Meet minimum energy efficiency requirements, follow the performance path or the prescriptive path. (Bronze – 37, Silver – 62, Gold – 100)
- Water Efficiency: Water-efficient appliances and practices. (Bronze – 6, Silver – 13, Gold – 19)
- Indoor Environmental Quality: Minimize potential sources of pollutants, manage potential pollutants generated in the home and moisture (vapor, rainwater, plumbing, HVAC). (Bronze – 32, Silver – 54, Gold – 72)
- Operation, Maintenance, and Homeowner Education: Provide home manual and education to owners/occupants on use and care of the home. (Bronze – 7, Silver – 7, Gold – 9)
- Global Impact: Use low VOC sealants, choose low- or no-VOC indoor paints, note manufacturers' operations and practices. (Bronze –- 3, Silver – 5, Gold – 6)

For more information about the NAHB Green Home Building Guidelines, go to http://www.nahbgreen.org/Guidelines/nahbguidelines.aspx.

## 20% Above ASHRAE 62.2

The ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers) 62.2 Standard for Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings defines the roles and minimum requirements for mechanical and natural ventilation systems and the building envelope intended to provide acceptable indoor air quality in low-rise buildings. The standard applies to single-family homes and multi-family structures of three stories or fewer above grade, including manufactured and modular homes. The standard considers the chemical, biological, and physical containments that can affect air quality.

# Appendix 5: WinnSolar RFP and Borrego Solar/PV Selection Tool

WinnDevelopment created the following solar RFPs to guide selection of PV installers for its properties. Borrego Solar's PV selection tool also is provided as a tool and information that can be adapted as appropriate.

## Appendix 4: Sample Solar PV and Solar Hot Water RFP

<on owner's letterhead>

<date>

<vendor[1]>

Dear <vendor representative name>:

<Property Owner Name> is considering installing <technology … solar PV and/or solar hot water>. I have posted building plans and other information on the site to our web site at http://www.sitenamehere.com. Please indicate your interest in submitting a proposal for the work.

We are seeking a proposal that would provide a turn-key cost estimate for the project as described, an estimate of energy production capabilities, and information on your firm. The ultimate scope of the project will be determined based on expected savings and pre-qualified rebates available.

We would like to begin installing <describe time frame for installation>.

Please let me know if you have questions about the properties or our goals. If you would like to visit the properties, please give me a call for a tour.

Sincerely,

[1] **Who to hire?** In the case study that formed the basis for this document, the property owner sent solicitations to Zapotec Energy and GroSolar for the PV portion. We solicited Clean Energy for the solar hot water portion. Additional vendor names can be obtained from the case studies available on the MTC site. In our case, it was important on the PV portion to know whether the vendor had panels available or needed to order them. In the latter case, the back order time lag was six months, so this became a critical question.

## <Property Owner Name>

**Under Consideration for Renewables and Energy Reduction**

Contact: <property representative>, <phone>, <email>, <fax>

## <Property Name>

| | |
|---|---|
| Address: | <property address> |
| Property Description: | **<#>** <garden-style, high rise, townhouse, or other style> apartments in **<#>** buildings on a **<X s.f.>** site |
| Construction Type: | <list framing style, original build date, and construction type: refit, gut rehab, etc.> |
| Utilities and addresses: | <list utility provider and address(es) assigned to meter and on utility bill> |
| Roof Type: | <describe roof pitch and orientation … due south? South by southwest? If several buildings are being considered, describe orientation of each> |
| Roof Material: | <asphalt shingles, EPDM, rubber or PVC membrane, slate, etc and whether the roof is warranteed … years remaining in that agreement> |
| Roof Age: | <when was the last roof replacement? Attach any documents describing the structural strength, load bearing attributes of the roof here> |
| Obstructions[2]: | <describe shading in morning, mid-day, afternoon from trees, nearby buildings, and roof top mechanical equipment> |
| Utilities Owner Pays[3]: | 1. Common area electricity- Common areas include <#> management office; <#> community room; <#> maintenance room; <#> storage areas scattered throughout the property; common entrance ways that serve on average <#> apartments; <#> laundry rooms; and outdoor lighting<br>2. <modify to suit, depending on metering, who pays what> Heat and hot water in all apartments |

Technologies that <property owner> seeks to install:

1. Photovoltaic panels for common area electricity production
2. Solar hot water heating only if compatible with existing boilers and hot water heaters.

---

[2] It might be helpful to photograph the roof in question at 10am, 12pm, 2pm, 4pm in the summer months and attach those photos. Many times, owners forget to consider nearby trees when thinking about "obstructions".

[3] Note to RFP writer: prior to completing an RFP, the owner should have a clear idea of which meters would benefit most from PV supplement. Submetering a PV panel is impractical and costly; better to focus on the high-kilowatt-hour meters, like offices, community rooms, and computer rooms.

Metering: There is <#> electric room and <#> boiler room in each building. The house meter (the meter which records only energy usage paid by the Owner) for each building is located in the <describe location> room.

Mechanical Room: <For PV: describe potential location of inverter boxes (each is approximately the size of a large backpack). For solar hot water: describe potential location of storage tank, which can be LARGE, depending on the capacity needed. >

Breaker Boxes: <comment on the ability to add more breakers in the existing breaker boxes>

Chases: <comment on size of existing chases and whether additional electrical conduit and/or plumbing for solar hot water can be added, or whether an additional chase will need to be included in the scope>

Hot Water: <describe make, model, and capacity of boilers and hot water heaters in each building. >

**<Property Name>: Estimated Heating and Cooling Loads, Common Areas Only** (<source>)

| Bldg # | Heating and Cooling (BTUs) | 15% safety (BTUs) | Heating and Cooling (kWh) | Hot Water Only (kWh) |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7, 8, 9 | | | | |
| 10 | | | | |
| 11, 13, 15 | | | | |
| 12 | | | | |
| 14 | | | | |
| **Total** | | | | |

<insert a photo of the roof in question, labeled as to orientation, e.g. "camera pointing due north"> <second photo for second roof, other site features, or photo of mechanical room>

Enclosed[4] (<property name>) -
- Site Plan with compass
- Structural assessment of the roof
- Roof Plan
- Elevations
- Mechanical Equipment/Boiler/Electric Room Plans

[4] We suggest posting relevant documents on the web site and writing the URL in the cover letter. Alternatively, documents might be distributed via CD.

# Borrego Solar/PV Selection Tool

*SITE EVALUATION WORKSHEET*

Project Name: _____ Date: _____
Address: _____ Energy Consultant: _____

Was house hard to find from online map? (If so, note how to find it so those after you don't get lost.)

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- ○ Photo of Building From Street (helps those after you find house)
- ○ Meter (note meter number)
- ○ Main Panel (including labels on panel)
- ○ Main Panel With Dead Front Removed
- ○ Photo of Potential Space for Breaker
- ○ Grounding Electrode (rod/ufer/cold water pipe)
- ○ Zoomed-out view of proposed inverter/equipment location wall. Show where equipment will go. If there is a gas meter near by, make sure to include in photo.
- ○ Roof Faces (locations of panels) (along any linear dimension)
- ○ Photos of Pathfinder or Solmetric Shots
- ○ Shading Issues (trees/chimneys/parapet/other)
- ○ Immediate Area Around Service Entrance
- ○ Attic Photos
- ○ Conduit Run – AC + DC
- ○ Anything Unexpected/Unusual (possible code violations)

## QUESTIONS TO ASK AT SITE EVALUATION

Is the residence under the jurisdiction of a homeowners association (HOA) or other potential design review board?

○ YES ○ NO

Is the customer aware of any pre-existing code violations? Unpermitted remodels, structures, electrical work?

○ YES ○ NO

Code violations, if noticed by an inspector, must be corrected within 30 days.

Does customer have any drawings of the property or building?

○ YES ○ NO

If there is any construction work going on, there will be construction site plans. In that case you **must** get a copy. Actual CAD files should be obtainable if you ask the right person nicely (we'd like to not waste our time re-doing work.)

Are there dogs, gates, or other access issues the crew should know about? ○ YES ○ NO

### *ROOF MATERIAL:*

Comp Shingle/Flat Concrete Tile/S Tile/Other _____

How many layers? ○ 1 ○ 2 ○ 3

What is the age of the roof? _____

What is the condition (Is it sagging?) _____

Extent of existing warranty? _____

Is the building being re-roofed? ○ YES ○ NO

## ROOF MOUNT

Height of Building From Ground (highest): _____

Orientation: _____ Roof Pitch: _____

Ladder Access Requirement for Installation Crew: single-story/two-story ladder

Attic Access? ○ YES ○ NO

Exposed Rafters? ○ YES ○ NO

Vaulted Ceiling? ○ YES ○ NO

Are there fire sprinklers in the roof? ○ YES ○ NO

**Structural:**

Rafters: Size (2"x4," 2"x6," etc.)

Spacing (16" O.C., 24" O.C., 32" O.C., etc.)

Span (horizontal distance between supported points of rafter)

## PLANS + DIMENSIONS

Draw the following on the aerial provided by inside sales: The proposed location of the array, the conduit run, inverters, and disconnects. Show location of existing main service panel and gas meter.

Draw a site plan showing the above details if aerial photograph from inside sales is an insufficient base.

Dimensions of Roof Face Being Mounted To:

- Perimeter dimensions
- Vents (distance from ridge or eve) (horizontal + vertical)
- Vents (diameter and height)
- Height or width of trapezoid and rhombuses

## ELECTRICAL EQUIPMENT

Main Panel Manufacturer: _____

Service Voltage: _____

Rating of Main Panel (BUSSING): 100/125/150/200/225/400

Rating of Main Breaker? _____

Space for Breaker? ○ YES ○ NO

Can breakers be combined to create space? ○ YES ○ NO

Can utility disconnect switch be located within 10' of the meter and in a clear line of sight? ○ YES ○ NO

## APPROXIMATE CONDUIT RUN LENGTH

Distance from panels to inverter: _____

Distance from inverter to main panel: _____

## GROUNDING

Grounding Electrode – Ground Rod /Ufer Ground/Cold Water Pipe

Exposed? ○ YES ○ NO

Accessible? ○ YES ○ NO

## GROUND MOUNT

Ground Slopes (north-south and east-west): _____

**Soil Type:**

○ Normal ○ Clay ○ Some Rock
○ Very Rocky ○ Other

**Distance From Property Lines:**

Jurisdictional Setback Requirements (if known): _____

Ask customer if he/she has a septic system and knows of any underground utilities under the property: _____

## ADDITIONAL NOTES

Information such as special requests from the customer or anything that we promised the customer we would/wouldn't do:

_____

_____

_____

_____

_____

_____

_____

# Appendix 6: Summary of Green and Energy Efficiency Measures in GAHI Developments

The table below includes the features reported by the five Partners that were required through their agreements with MRET to allocate up to 30% of their GAHI funds to energy efficiency. In addition, MassHousing, while not required to fund energy efficiency features with its GAHI grant, pursued Green Communities certification for several of its projects and therefore is also included in this matrix. JMC's agreement with MRET focused entirely on installation of PV systems. BCC will address energy conservation measures in the future.

All Partners indicated they would not continue to install PV systems without a subsidy or grant like that provided by GAHI because of the high upfront costs and longer timeframe for return on investment.

| Summary of Green and Energy Efficiency Measures in GAHI Developments | | | | | | |
|---|---|---|---|---|---|---|
| | CLC | DND | DHCD | HAP | Winn | MassHousing |
| Total Number GAHI Developments | 8 | 6 | 3 | 8 | 3 | 17 |
| Integrated Project Planning | | | | | | |
| Integrated Project Team | ● | ● | ● | ● | ● | |
| Building Orientation (for PV) | ● | ● | ● | ● | ● | ● |
| Other: Green Charette | | ● | ● | | | |
| Durability Management | | | | | | |
| Durability Planning | ● | | ● | ● | | |
| Durability Management | ● | | ● | | | |
| Third-Party Durability Management Verification | ● | | ● | | | |
| Location | | | | | | |
| Edge Development | | | ● | | | |
| Infill | ● | ● | ● | ● | | |
| Previously Developed | ● | ● | ● | | ● | |
| Walkable Neighborhoods | | ● | ● | ● | | ● |
| Smart Site Location (passive heating/cooling) | | ● | ● | | | ● |
| Smart Site Location (brownfield, adaptive reuse site) | | ● | ● | | | |
| Public Transportation Proximity | ● | ● | ● | ● | ● | ● |
| Site Stewardship | | | | | | |
| Erosion Controls During Construction | ● | ● | ● | ● | | ● |
| Minimize Disturbed Area of Site | ● | ● | ● | | | |
| Exterior Water Conservation | | | | | | |
| Rainwater Harvesting System | ● | ● | ● | | | |
| Graywater Reuse System | | | | | | |
| Use of Municipal Recycled Water System | | | | | ● | |
| High-Efficiency Irrigation System | | | ● | | | ● |
| Interior Water Efficiency | | | | | | |

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|---|---|---|---|---|---|---|
| | CLC | DND | DHCD | HAP | Winn | MassHousing |
| High-Efficiency Water Fixtures/Fittings | ● | ● | ● | ● | ● | ● |
| Efficient Toilets (low flow) | ● | ● | ● | ● | ● | ● |
| Low-Flow Faucets/Showerheads | ● | ● | ● | ● | ● | ● |
| Efficient Laundries | | ● | ● | | ● | |
| Other: Dual Flush Toilets, others | | | | ● | | |
| Materials & Resources | | | | | | |
| Material-Efficient Framing | ● | ● | ● | ● | | |
| Detailed Framing Documents | | ● | ● | | | |
| FSC Certified Tropical Wood | ● | | | | | |
| Reclaimed Wood | ● | | | | | |
| Construction Waste Management Planning | | ● | ● | ● | ● | ● |
| Construction Waste Reduction | ● | ● | ● | | | |
| Indoor Contaminant Control During Construction | | ● | ● | | | ● |
| Recycled Content in Carpet or Other Materials | | ● | ● | | ● | ● |
| Low VOC Carpets | | ● | | | | ● |
| No Carpeting | | ● | ● | ● | | ● |
| FSC Certified Shingles | ● | | | | | |
| Non-Toxic, Low, or No VOC Paints and Primers | | ● | ● | ● | ● | ● |
| Non-Toxic, Low, or No VOC Adhesives and Sealants | | ● | ● | ● | ● | ● |
| Other Environmentally Preferred Products: bio-based tile, zero formaldehyde cabinetry | | ● | | | | |
| Other: Roof Is White | | ● | | | ● | |
| Indoor Environmental Quality | | | | | | |
| Combustion Venting | ● | ● | ● | ● | ● | |
| Enhanced Combustion Venting | ● | ● | ● | | | |
| Moisture Control | | ● | ● | | | ● |
| Outdoor Air Ventilation – Meet ASHRAE 62.2 whole house | ● | ● | ● | ● | | ● |
| Local Exhaust – Meet ASHRAE 62.2 | ● | | ● | ● | | |
| Room-by-Room Load Calculations – Manual J&D for sizing | | ● | ● | | | |
| Return Air Flow/Room-by-Room Controls | | ● | | | | |
| Automatic Exhaust-Only Fans | | ● | ● | ● | | ● |
| Multiple Zones | | ● | | | ● | |
| Air Filtering – MERV 8 | | | ● | | | |
| Enhanced Air Filtering > MERV 8 | | ● | | | | |
| Indoor Contaminant Control Central Vacuum, others | | ● | | | | |
| Radon-Resistant Construction Zone 1 | | | ● | | | |
| No HVAC in Garage | ● | | ● | | | |

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|---|---|---|---|---|---|---|
| | CLC | DND | DHCD | HAP | Winn | MassHousing |
| Garage Isolation | | | | | | ● |
| Enhanced Garage Isolation – Detached, Fan, etc. | | | | | | |
| Carbon Monoxide Alarms | ● | ● | ● | ● | | ● |
| Water Drainage – Flashing, etc. | | ● | ● | | | ● |
| Integrated Pest Management | | ● | ● | | | ● |
| Smoke-Free Building(s) | | ● | ● | | | |
| Other: No Garage | ● | ● | ● | ● | | |
| Energy Efficiency – Mechanical and Standards | | | | | | |
| Programmable Thermostats | | ● | ● | ● | | |
| Energy Recovery Ventilator | | ● | | | | |
| High-Efficiency Boilers and/or Mini-Boilers | | ● | ● | ● | ● | |
| High-Efficiency Heat Pumps | | ● | | | | |
| Attic Whole-House Fan in Place of Central A/C | | | ● | | | |
| High-Efficiency Gas Furnace(s) | | ● | ● | | | |
| High-Efficiency Condensers | | ● | ● | | | |
| Energy-Efficient Motors | | ● | ● | | ● | |
| Co-Generation System | | | | | | |
| Efficient Hot Water Distribution | | ● | | | ● | |
| On-Demand Hot Water | ● | ● | ● | ● | | |
| Pipe Insulation | ● | ● | | ● | ● | |
| Solar Hot Water | | ● | | ● | | |
| Geothermal Wells | | | | | | |
| High-SEER Rooftop Units | | ● | ● | | | |
| Refrigerant Charge Test | | ● | | | ● | |
| Photovoltaic | ● | ● | ● | ● | ● | ● |
| Individual or Submetered for Electricity | | ● | ● | | | |
| Ongoing Component Maintenance Procedures | | ● | ● | ● | | |
| Insulation & Building Shell | | | | | | |
| High-Efficiency Building Envelope/Reduced Envelope Leakage | ● | ● | ● | ● | ● | |
| ENERGY STAR–Compliant Insulation | ● | ● | ● | ● | | |
| Cellulose Insulation | | ● | ● | ● | | |
| Rigid Insulation Skin | | ● | ● | | | |
| Super Insulation (R-31 Walls, R-50 Ceilings, R-27 Floors) | ● | | | ● | | |
| R-19 Exterior Walls Only | | ● | ● | ● | | |
| R-49 Insulation | | | | ● | | |
| Icynene Insulation Upgrades | | ● | ● | | | |

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|---|---|---|---|---|---|---|
| | CLC | DND | DHCD | HAP | Winn | MassHousing |
| Low-Infiltration/High-Insulation Walls and Roofs | | ● | ● | ● | ● | |
| Insulated Slab | | ● | ● | ● | | |
| Improved Roof Insulation on Existing Structure(s) | | ● | | | ● | |
| 12" Thick Double Walls | | | | ● | | |
| 2x6 Construction | | ● | ● | ● | | |
| Other: Rainscreen Terra Cotta | | ● | | | | |
| Lighting | | | | | | |
| ENERGY STAR Lighting | ● | ● | ● | ● | ● | ● |
| LED Lighting Fixtures | ● | | ● | | | |
| Efficient Outdoor Lighting | ● | ● | ● | | | ● |
| Landscaping/Surface Water Management | | | | | | |
| Noninvasive Plants | ● | ● | ● | ● | ● | |
| Limited Conventional Turf | ● | ● | ● | | | |
| Drought-Tolerant Plants | ● | ● | ● | | ● | |
| Reduced Irrigation Demand | | ● | ● | | | ● |
| Permeable Lot or Pavers | | ● | | | | |
| Permanent Erosion Controls | | ● | ● | | | |
| Management of Runoff From Roof | | ● | ● | | ● | |
| Nontoxic Pest Control Feature(s) | ● | ● | ● | | ● | |
| Compact Development Feature(s) | ● | ● | ● | | | ● |
| Windows | | | | | | |
| ENERGY STAR–Certified Windows | ● | ● | ● | ● | ● | |
| High-Performance Windows | ● | ● | ● | ● | ● | |
| Triple-Glazed Windows for N, E, and W | | | | ● | | |
| Double-Glazed Windows for N, E, and W | | ● | ● | ● | | |
| Double-Glazed Windows on S for Solar Heat Gain | ● | ● | | ● | | |
| Appliances | | | | | | |
| ENERGY STAR Appliances | ● | ● | ● | ● | ● | ● |
| Water-Efficient Clothes Washer | | ● | ● | | ● | ● |
| Occupant Education | | | | | | |
| Education of Occupant | ● | ● | ● | ● | | ● |
| Education of Building Manager | | ● | ● | | ● | ● |
| Occupant Operational Manual/Guide | ● | ● | ● | ● | | ● |
| Building Manager Manual/Guide | | ● | ● | | ● | ● |
| Post-Occupancy Performance-Related Surveys | | ● | ● | | | |