Comprehensive Energy Audit + Clean Energy Technology Optimization Project

FINAL REPORT

Local Initiatives Support Corporation

Prepared with support from Massachusetts Clean Energy Center and Meister Consultants Group
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Section 1. Introduction

Deep energy efficiency retrofits and clean energy installations can offer significant benefits for multifamily affordable housing residents, owners, and property managers. These include lower building operating costs, long-term energy price stability, improved occupant comfort, and significant public health improvements.

However, to date, there has not been a clear way forward to help multifamily affordable housing partners make informed decisions to achieve clean energy savings. Through this project, LISC sought to define a pathway for scaling up deep energy efficiency retrofits and clean energy installations in multifamily affordable housing.

The Massachusetts Low-Income Energy Affordability Network (LEAN) Low-Income Multi Family (LIMF) energy program is one of the best – if not the best – ratepayer-funded utility energy efficiency program for low-income residents in the country. However, while the existing program does achieve energy savings through cost-effective measures, most affordable housing partners defer deep energy efficiency and clean energy measures until they have access to additional financial resources during the recapitalization/refinance and physical rehabilitation (“rehab”) process. Accordingly, the best opportunity to implement deep energy savings measures in affordable housing is during overall project rehab – which occurs on 15-20 year cycles.

While the recapitalization process represents a unique opportunity to achieve significant energy savings, it is neither an easy nor a straightforward process to integrate deep energy efficiency and clean energy measures into multifamily projects during recapitalization. Key barriers for owners include prioritizing potential rehab measures based on analysis of costs and benefits, juggling timing and funding constraints, and applying to and meeting the requirements of multiple funding partners. As the results of this Comprehensive Energy Audit and Clean Energy Technology Optimization project show, success requires investment in education, oversight, coordination among stakeholders, and technical resources to help owners ensure that energy measures are deployed effectively.

This report summarizes key findings from MassCEC and LISC’s initiative to improve the deployment of deep energy efficiency and renewable energy technologies in the multifamily affordable housing sector. In particular, the project was structured to achieve four key goals:

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2 From 2012 to 2015, LISC worked with owners statewide to retrofit 3,500 units, achieving on average 29% electric savings and 23% gas savings. Our experience underscored the deep energy savings that can be achieved at project recapitalization more so that in between capital cycles. Third-party savings analyses were conducted by WegoWise and Cadmus Group: [http://www.lisc.org/boston/our-work/green-retrofit-initiative/reports/](http://www.lisc.org/boston/our-work/green-retrofit-initiative/reports/).
3 For instance, owners must work with city/state subsidy providers, line up tax credit financing, and then coordinate with one of the state housing finance agencies (or commercial banks) on their permanent loan; with the LEAN program (or its market rate equivalent, MassSave) on cost-effective energy efficiency measures; and with DOER and MassCEC on appropriate clean energy technology integration. The burden is on the developer to make these timelines mesh within the recapitalization/rehab timeline itself, which is very challenging.
1. **Provide Technical Assistance to Owners.** Most owners do not plan for energy efficiency and clean energy measures early enough in the recapitalization/rehab planning cycle. To address this challenge, LISC (“the project team”) provided 24 participating affordable housing owners with free comprehensive (ASHRAE Level II) energy audits for buildings approaching recapitalization/rehab. Technical assistance also encompassed outreach and education services for owners, property managers, permanent lenders, and related stakeholders. LISC created summary sheets that categorized the types of energy efficiency and clean energy measures available and when they would be financed and installed. Recommended measures fell into one of four categories: (1) LEAN-eligible energy efficiency measures; (2) non-LEAN-eligible energy efficiency measures (due to a Benefit to Cost Ratio (BCR) of less than one); (3) non-LEAN-eligible clean energy measures; and (4) water, health, and safety measures (some of which may result in energy efficiency losses, such as ventilation systems, but which are critical for improved health and comfort of residents). The project team also provided follow-up technical support to owners and property managers, connecting them with the building science providers who performed their audit/analysis.

2. **Coordinate Stakeholders to Maximize Deployment of Available Resources.** A second goal of the project was to foster collaboration among stakeholders – including owners and property managers, permanent lenders, building science providers, utilities, LEAN program staff, and state housing, housing finance, and energy agencies – to ensure that energy savings opportunities identified were actually implemented. LISC engaged these stakeholders throughout the project, from the recruitment of eligible properties to the outlining of best practices in utilizing benchmarking tools (such as WegoWise) and comprehensive energy audits for underwriting of anticipated energy savings as part of that property’s permanent loan. This work built upon goals from the Commonwealth’s Three-Year Energy Efficiency Plan, wherein utilities and program administrators agreed to coordinate with housing finance agencies on projects approaching recapitalization/rehab by committing funds to enable the deepest energy savings possible.

3. **Analyze Root Causes and Optimize Underperforming Systems.** The project also focused on optimizing operation of clean energy technologies, ensuring that systems were installed, maintained, and operated correctly in order to achieve their lifetime energy savings potential. To this end, the project team conducted retrocommissioning analyses for 15 underperforming clean energy technology systems already in the field, including air source heat pump, ground source heat pump, combined heat and power (co-gen), solar photovoltaic (PV), and solar hot water systems. The project team analyzed conditions that led to the underperformance of installations, such as poor system design/installation, operational and maintenance constraints, or a combination of such factors. The project team also provided technical support to help owners optimize system performance in order to improve overall return on investment (ROI).

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4 ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) develops standards that advance better building systems, energy efficiency, indoor air quality, refrigeration and sustainability within the building industry ([https://www.ashrae.org/](https://www.ashrae.org/)). Their Level 2 energy audits are considered comprehensive energy audits as they provide more detailed energy calculations and financial analysis of proposed energy efficiency measures ([http://www.energyadvantage.com/blog/the-difference-between-ahsrae-level-1-2-3-energy-audits/](http://www.energyadvantage.com/blog/the-difference-between-ahsrae-level-1-2-3-energy-audits/)).

5 WegoWise is a utility tracking and measurement software company that supports owners in benchmarking, tracking retrofit savings, and identifying energy savings opportunities ([www.wegowise.com](http://www.wegowise.com)).
4. **Provide New Insights into the Pathway Forward.** The final goal of the project was to develop recommendations that can inform next steps across the broader community of practice. LISC convened multifamily affordable housing owners and property managers to discuss successes and failures related to integrating energy, water, and health measures in their properties. Key lessons learned from these dialogues – as well as findings from the 24 energy audits and 15 retrocommissioning analyses – have been summarized in this report, providing directional guidance to key leaders on next steps to transform energy use and consumption in the affordable housing sector.

In summary, this report identifies barriers, opportunities, and recommendations that can enable LISC and its partners to increase access to deep energy retrofits and clean energy technologies in the affordable housing sector. These findings will provide a foundation on which the Massachusetts Clean Energy Center, Massachusetts Department of Energy Resources, Low-Income Energy Affordability Network, housing subsidy providers and lenders, and multifamily building owners and developers can build in order to transform the energy and buildings assets serving the Commonwealth’s low-income community.
Section 2. Methodology

The Comprehensive Energy Audit and Clean Energy Technology Optimization Project (“the Project”) was led by the Local Initiatives Support Corporation (LISC) in response to a Request for Proposals (“RFP”) issued by the Massachusetts Clean Energy Center (MassCEC). The RFP sought proposals to design, independently manage, and verify programs that deliver eligible clean and efficient energy technologies for the benefit of low-income residents.

The project required close collaboration across a range of energy and housing stakeholders in Massachusetts, including:

- **Multifamily affordable housing owners (nonprofit, for-profit, or public) and/or property managers**, who have properties approaching recapitalization/rehab or who have underperforming clean energy technologies.
- **Policymakers from the state energy and housing authorities**, including representatives from the Massachusetts Clean Energy Center (MassCEC), Massachusetts Department of Energy Resources (DOER), Mass Department of Housing and Community Development (DHCD), as well as Community Economic Development Assistance Corporation (CEDAC), Massachusetts Housing Partnership, MassDevelopment, and MassHousing.
- **Major building science providers**, including Bright Power, CLEAResult, New Ecology, and Sparhawk Group.
- **Energy market, policy, and technical experts**, including Meister Consultants Group and the Clean Energy Group.

Throughout the project, LISC served as project manager, owner’s agent, coordinator, and convener among all of the above stakeholders. LISC staff time to play this coordinating role was made possible in large part due to generous support from the Barr Foundation from the start of the project in August 2016 through July 2017, and MassHousing and Massachusetts Housing Partnership from July 2017 to June 2018. The following section provides a description of the five key tasks LISC engaged in to complete this project. For reference, the project outreach and selection process (from project start date to signed memorandums of understanding with selected owners) took approximately 3 months, while report turnaround times (from initial site visit to completed audit/analysis) averaged 4.5 months.

2.1 Developed Application and Recruited Eligible Project Applicants.

LISC first identified eligible building project applicants for the project’s energy audits and retrocommissioning analyses. A comprehensive and up-to-date list of multifamily properties approaching recapitalization/rehab within Massachusetts does not currently exist. Accordingly, LISC conducted outreach via a variety of channels, including outreach via building owners’ groups like CHAPA (Citizens Housing & Planning Association), MACDC (Massachusetts Association of Community Development Corporations), among other relevant stakeholders like CEDAC, Massachusetts Housing Partnership, MassDevelopment, and MassHousing.

In addition, LISC designed the project application to be simple and straightforward for potential applicants. For energy audits, applicants were asked to identify the building owner, physical description of the project, anticipated construction closing date, and permanent lender, whether a
capital needs assessment (CNA) and/or energy audit had already been completed, energy goals for the project, their preferred building science provider, and a commitment to implement all recommendations to the extent feasible. For retrocommissioning applicants, applicants were asked similar information, as well as the type of existing clean energy technology.

After reviewing initial applications, LISC requested additional technical information (e.g. major mechanical systems, estimated rehab costs, etc.) from candidates for the energy audits and retrocommissioning analyses. The report Appendix provides additional information on the initial and follow-up application materials. Applications exceeded program capacity two-fold.

2.2 Reviewed Applicants and Established Pricing with Building Science Firms.

LISC worked with the building science providers to establish pricing and deliverables for the comprehensive energy audits and retrocommissioning feasibility analyses. Upon receipt of applications, LISC provided the building science firms with relevant information for their review – including WegoWise data where available – and asked them to establish a not-to-exceed cost estimate for each of their potential audit/analysis projects. Where owners did not have a preference of building science provider, LISC requested not-to-exceed cost estimates from all four building science providers and enabled the owner to select a building science provider based on the resulting bids.

LISC also asked building science firms to rank projects based on their expert understanding of the energy savings potential in these projects. Several firms also added detailed comments to explain why they believed a certain project should or should not be selected for the program, which became a component of our selection criteria.

2.3 Selected Projects for Energy Audits and Retrocommissioning Analyses.

LISC then worked with a selection committee comprised of key stakeholders to assess energy audit and retrocommissioning analysis applicants and select the portfolio of projects for the program.

Comprehensive Energy Audits. To evaluate projects best suited for the comprehensive energy audit program, LISC engaged policymakers and market experts to develop comprehensive evaluation criteria and select projects. Evaluation criteria included:

- **Clear opportunity to achieve savings**, including projects that have high likelihood of achieving carbon savings and cost savings.
- **Owner capacity and willingness to navigate applicable utility energy efficiency programs and fully implement energy efficiency and clean energy recommendations**, including ability of owners to work toward obtaining LEAN funding commitment and to explore measures that LEAN could not fund, but which would provide additional energy savings.
- **Clarity on where the building stands in the overall recapitalization/rehab timeline process**, including a clear indication of how close the building is from construction closing.\(^6\)

\(^6\) Projects early in design development potentially provide the most opportunity to inform the scope of work. However, some projects may be 6-12 months away from construction closing and still provide a good opportunity to provide near-term...
- **Owner capacity and willingness to share project data, enroll in online benchmarking (WegoWise or similar), and participate in a case study upon request.**

Beyond the individual project characteristics, LISC also took into account the allocation of overall funds to serve a diversity of projects across the state and across a mix of for-profits, nonprofits, and housing authorities.

Altogether, 24 eligible projects were chosen to receive comprehensive energy audits. Audit pricing varied ranging from $6,500 at the low end up to $17,500 on the high end, depending on property size (properties ranged from 18 to 357 units, and from 1 to 28 buildings), type (high-rise, low-rise, etc.), system type (all-electric, gas heated, etc.) and complexity, among other factors. The average audit cost approximately $12,000.

**Retrocommissioning Feasibility Analyses.** LISC followed a similar process to select buildings for the retrocommissioning analyses. Key evaluation criteria included:

- **Clear opportunity to achieve carbon and cost savings**, which required a demonstrated indication that the existing technology was actually underperforming.
- **A range of project sizes.** While large, underperforming projects had the potential to deliver the greatest amount of savings, it was also important to demonstrate the potential of this approach to advance a mix of small, medium, and large projects.
- **Owner capacity and willingness to proceed**, including an assessment of whether the building owner could provide sufficient organization- or project- level cash flow to support implementation, and whether the organization was willing to invest resources for the identified solutions.
- **Willingness of owner to share project data and results**, including enrolling in WegoWise and participating in a future project case study. Notably, owners with dedicated sustainability staff had more capacity to provide a deeper (and thus more actionable) level of baseline data, which tended to result in higher project rankings.

Similar to the audit projects, LISC also took into account the allocation of overall funds to serve a diversity of projects across the state and across a mix of for-profits, nonprofits, and housing authorities to select projects for retrocommissioning analyses. LISC prioritized projects that enabled analysis across a variety of technologies (e.g. air source heat pumps, ground source heat pumps, combined heat and power (co-gen), solar photovoltaic (PV), and solar hot water).

Altogether, 15 eligible projects were selected to receive support for retrocommissioning analyses (1 air source heat pump, 1 ground source heat pump, 6 co-gen, 4 solar PV, and 3 solar hot water). Similar to audit pricing, retrocommissioning pricing also depended on a number of factors, including property size, type, and system complexity; the average retrocommissioning feasibility analysis came in just under $9,500, with a low end of $6,500 to a high end of $16,500.

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7 $12,000 was the average audit cost based on auditors’ previously agreed upon not-to-exceed prices. Taking into account fully loaded costs (i.e. the total price to auditing firms), the average audit price was a little over $14,000.
2.4 Established Information Sharing Agreements with Building Owners and Contracts with Building Science Firms.

Following project selection, LISC established a memorandum of understanding (MOU) with each of the building owners, which detailed information-sharing commitments and other expectations for the program. An important component involved tracking all projects in WegoWise, a utility tracking and measurement software company that supports owners in benchmarking, tracking retrofit savings, and identifying energy savings opportunities. For owners with sufficient resources, LISC required payment for the cost of WegoWise Pro (standard level) pre-retrofit and for a minimum of one year of WegoWise Premium (customized service level) post-retrofit. In some cases, LISC provided gap funding to ensure the project was enrolled in WegoWise. Of the 38 total projects at project entry:

- 37% were not utilizing any type of benchmarking service.
- 32% were utilizing WegoWise Pro.
- 24% were utilizing WegoWise Premium.
- 8% were utilizing Bright Power’s EnergyScoreCards (another benchmarking service).

As part of the MOUs, owners committed to sharing WegoWise project accounts with LISC and MassCEC so that post-retrofit savings could be measured. For those projects already enrolled in another online benchmarking service (such as Bright Power’s EnergyScoreCards), LISC asked owners to provide LISC and MassCEC with access to their existing benchmarking account. WegoWise account costs averaged $800 per project, which ensured WegoWise Pro from start of grant through construction and WegoWise Premium for one year post-rehab/retrofit.

LISC also requested that owners receiving comprehensive energy audits enroll their respective properties into LEAN, Massachusetts’ utility energy efficiency program, to ensure that eligible owners would take full advantage of all available energy saving resources. Similarly, owners were asked to sign information releases so that LEAN program staff could share scope(s) of work for any electric and/or heating work already completed through the LEAN program at each property. These two components allowed LISC to provide policymakers with a much better understanding of which projects have maximized – and which have yet to fully utilize – the LEAN program. Of the 24 to-be-audited projects:

- 4% were not eligible for the LEAN program (project located in municipal light plant community\(^8\)).
- 42% had not yet applied to the LEAN program.
- 13% had received both electric and heating system work through the LEAN program.
- 38% had previously received electric-only work through the LEAN program.
- 4% had previously received heating-only work through the LEAN program.

Finally, LISC established contracts with each of the four building science firms. Building science providers were required to provide completed audit/analysis reports along with invoices in order to receive report payment (up to the previously agreed upon not-to-exceed project cost).

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2.5 Developed a Work Plan Based on Analyses Provided by Building Science Firms.

As the building science firms provided LISC with their comprehensive energy audit and retrocommissioning feasibility analysis report and summary sheet drafts, LISC reviewed, provided feedback, and suggested revisions. In some cases, LISC worked with firms to provide multiple rounds of feedback to finalize all 38 reports. Specifically, LISC noted where reports required general edits; recalculations for accuracy; inclusion of essential information such as Savings to Investment Ratios (SIR), available clean energy program incentives, and helpful supporting data/analysis within the appendix; and recommended formats for report standardization and review ease. Due in part to both the above in-depth review and capacity constraints of building science firms, while LISC had originally expected report delivery in 4-6 weeks, the average turnaround time from initial site visit to report completion exceeded 4 months for both audits and analyses.

Once reports and supporting materials were finalized, LISC held follow-up calls jointly with owners and their respective building science firms to review reports and ensure clarity on all recommendations. The calls also provided the opportunity for evaluating owners’ willingness and ability to move forward with the recommended measures, as well as their anticipated rehab/retrofit timeline. Where appropriate, LISC referred interested owners to our partners at the Clean Energy Group for potential feasibility analyses on solar plus battery storage system options, especially for properties with high electricity demand charges that had also been recommended for solar PV systems. Owners then developed expected timeline and rehab scope of work (for audit projects) or their action plan (for retrocommissioning projects).

For the retrocommissioning projects, LISC requested that owners provide contractor quotes for the recommended fixes, as well as a commitment letter from their organization stating that the owner would utilize any partial funding from MassCEC to implement the recommended solution(s). The retrocommissioning work plans were submitted to MassCEC for their review and approval of up to $10,000 per project (as needed) in match funding. LISC administered these matching grants and required owners to provide proof of implementation post-receipt.

2.6 Shared Results and Coordinated with Key Stakeholders.

Additionally, LISC created a secure online sharing portal to make all final reports and rehab scopes of work/action plans available to state housing, energy, and clean energy agencies. To ensure all comprehensive energy audits’ LEAN-eligible and cost-effective recommended measures could be implemented through the LEAN program, LISC convened several meetings with LEAN program staff to review each of the 24 audit reports and supporting materials in detail. The project team continues to support owners through the LEAN process and to act as a liaison between owners and LEAN program staff as needed.
Section 3. Key metrics and findings

3.1 Key Metrics

As shown in Table 1 below, the project served more units than expected and estimates significantly more carbon emissions reductions and LEAN-eligible project dollars to be leveraged. For instance, the 10,626 metric tons of carbon dioxide emissions reductions is equivalent to taking 2,275 passenger vehicles off the road for one year.9

In fact, the $26M+ expected to be leveraged through the LEAN program is only a portion of the maximum achievable potential ($77M) if all audit/analysis recommended measures were to be implemented. While LISC understands the variety of reasons why this full potential is not unlocked, it is important to note the deep savings available to the multifamily affordable housing sector at project recapitalization/rehab.

It is also important to note that this project was significantly more time intensive for the project team to administer than originally expected, which is partially captured in the higher program administration cost listed below. Please see Methodology section for details on where the project team invested additional time.

Finally, it should be stated that some data is not available at this point in the project, as most properties have not yet begun their planned construction. As a result, LISC has provided proxy data such as maximum achievable amounts and/or LEAN-eligible measure totals. Below are the key metrics that LISC and its partners tracked for the Comprehensive Energy Audit and Clean Energy Technology Optimization Project. Please refer to MassCEC LISC Data Input Sheet for additional details.

<table>
<thead>
<tr>
<th>METRIC</th>
<th>ORIGINALLY EXPECTED FOR CURRENT GRANT PERIOD</th>
<th>CURRENT GRANT PERIOD (maximum achievable unless otherwise specified)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program Delivery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Program administration and customer</td>
<td>$60,000</td>
<td>$88,682</td>
</tr>
<tr>
<td>Program development and future program/policy</td>
<td>$20,000</td>
<td>$20,000</td>
</tr>
<tr>
<td>Technology cost</td>
<td>$470,000</td>
<td>$451,729.60</td>
</tr>
<tr>
<td>Installation cost</td>
<td>$50,000</td>
<td>$39,588.40</td>
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<tr>
<td>Operation &amp; Maintenance Costs</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Total cost</td>
<td>$600,000</td>
<td>$600,000</td>
</tr>
<tr>
<td>Program Impact</td>
<td></td>
<td></td>
</tr>
<tr>
<td>External dollars leveraged ($)</td>
<td>$13,300,000</td>
<td>$26,185,706 (LEAN-eligible measures for 24 audits combined)</td>
</tr>
</tbody>
</table>

### Table 1: Program Metrics: Expected v. Maximum Achievable

<table>
<thead>
<tr>
<th>Units/Homes Served</th>
<th>3,390 units</th>
<th>4,407 units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed Capacity (kW)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>GHG Emissions Reductions (lbs. CO$_2$e)</td>
<td>3,000 metric tons</td>
<td>23,420,331 lbs. CO$_2$e (equivalent to 10,626 metric tons)$^{10}$</td>
</tr>
<tr>
<td>Lifetime Energy Savings (total) (MMBtu)</td>
<td>1,945,664kWh/yr; 51,530MMBtu/yr</td>
<td>2,596,126 MMBtu</td>
</tr>
<tr>
<td>Lifetime Energy Savings (per/unit) (MMBtu)</td>
<td>963 kWh/unit/yr; 27MMBtu/unit/yr$^{11}$</td>
<td>863 MMBtu/unit (Audit); 20 MMBtu/unit (Retrofit)</td>
</tr>
</tbody>
</table>

#### 3.2 Audit Findings

In the project team’s review of the 24 funded comprehensive energy audit reports, supporting materials, and resulting planned rehab scopes of work where applicable; as well as through the participant follow-up process, the project team identified the following themes and challenges: predictability and knowledge of programs; challenges to implement various technologies, specifically solar systems; the conflict between cost and carbon savings; owner familiarity and concern with certain recommended energy efficient and clean energy technologies; the importance of well-timed audits; and varying report content and calculation standards.

**Predictability and Knowledge of Programs.** During this project, the project team encountered several instances where energy efficiency program (e.g. LEAN) and clean energy program (e.g. DOER’s transition from Solar Renewable Energy Credit (SREC II) to its upcoming Solar Massachusetts Renewable Target (SMART)) funding/incentive guidelines were unclear. For instance, one owner believed that the LEAN program would be able to fund air source heat pumps at their large electrically-heated building approaching recapitalization/rehab, but found out that LEAN’s Benefit to Cost Ratio (BCR) could not support that installation. See section below for more details on SREC to SMART transition impact for owners.

In a few cases, owners were unaware of the LEAN program, and several were unfamiliar with the currently available clean energy technology incentives, suggesting an opportunity for increased communication and education/outreach for all available programs by all stakeholders.

**Challenges to Implement Solar Systems.** These audits unearthed several interested findings related to the challenges of installing solar systems. A quarter of the properties expressed interest in moving forward with on-site solar systems, while the remaining 75% were unsure or uninterested.

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$^{11}$ Please note that this section was originally informed by building science firms who provided estimated annual (rather than lifetime) energy savings in kWh/year and MMBtu/year. Thus, it is difficult to compare with maximum achievable lifetime energy savings seen in 38 projects.
One owner already had a solar virtual net metering (SVNM) contract for their portfolio and was therefore not interested in an on-site solar PV system as it would “cannibalize” the SVNM savings. A second owner already had a solar PV and thermal system on the audited property so another system was neither feasible nor needed.

Two owners had had negative experiences with existing on-site solar systems – one because of the amount of system maintenance necessary and the other due to an incorrectly installed solar PV system that had created dangerous conditions (i.e. falling snow and ice) for its residents. As a result, one was only engaging in solar virtual net metering contracts across its portfolio, while the other owner was willing to reconsider an on-site system given additional analysis.

Owners also experienced some technical limitations – for instance, several owners were simply not good candidates for solar due to limited roof space and shading; and one owner had concerns about their building structures not being able to hold the panel weight. Relatedly, two owners were in all likelihood not moving forward given their location in a historical district and the resultant limiting aesthetic regulations.

Cost was also a factor, both upfront and in terms of payback period. For instance, two owners could not afford system installation costs. Similarly, there was some hesitance related to changing incentive levels: for instance, one owner with a promising property for a solar installation was unsure about and waiting to move forward due to uncertainty around the upcoming switch from the SREC II program to the SMART program. Another owner was interested generally but wanted more analysis performed before making a final decision.

Six owners did express interest in installing on-site solar PV systems. Of this group, one owner was planning on moving forward with a solar system (potentially with battery storage), four owners were creating “solar-ready” roofs in the hope that related grant funding would come available, and one owner was planning on installing solar plus battery storage if their property’s planned switchover to air source heat pumps came to fruition.

**Cost Savings versus Carbon Savings.** Owners participating in the project naturally prioritized audit recommendations that projected higher cost savings over those that reduced more carbon emissions, but were less cost-effective (e.g. conversion to hydronic heating systems; conversion from electric resistance heating to variable refrigerant flow (VRF) HVAC systems; air source heat pumps; deep air sealing and insulation, etc.). The notable exception to this cost-savings-first rule was in the case of health-related recommendations such as increasing ventilation to ensure resident well-being. In these cases, even where there were associated energy (and thus cost) penalties, the vast majority of owners expressed their intent to move forward with the measures in question.

**Owner Familiarity and Concern with Technologies.** In addition to owners’ tendency to prioritize the more cost-effective measures, owners were generally cautious about moving forward with technologies they were less familiar with that would require additional training for maintenance staff, such as learning how to operate high-efficiency condensing boilers. One owner shared putting in as many non-condensing boilers as possible to ensure that their technicians would be able to continue maintaining familiar systems. However, once an owner had on-site familiarity with a technology (such
as condensing boilers or low-flow toilets), they were much more likely to include it in a future rehab scope of work.

Owners also raised some concerns about potential added maintenance time for some of these newer, more efficient technologies – for instance, the actual or perceived incremental time needed to maintain 100 air source heat pumps rather than up-keeping one central boiler. Across the board, owners prioritized buildings that would be efficient and require as little maintenance as possible.

**Importance of Well-Timed Audits.** Time – or lack thereof – was a major factor influencing the ability of participating owners to fully consider audit recommendations. Because LISC allowed owners to participate at different phases of their project approaching recapitalization/rehab, audits were sometimes too late in the planning process to be fully informative of the rehab scope of work, whereas others were completed early enough to allow adequate planning time to incorporate the audit into the planned rehab scope of work. On the other hand, a few audits were provided so far in advance of the planned rehab that anything outside of LEAN was simply not yet considered by the owner. In these cases, the owner was usually working on another project in their portfolio closer to recapitalization/rehabilitation. Recommendations from audits performed approximately 1.5 years in advance appeared to have the greatest likelihood of being integrated into the planned scope of work.

**Audit Content and Calculation Standards.** For this project, LISC utilized four different building science firms, all of whom followed ASHRAE Level II energy auditing standards. However, there were some discrepancies in what was included in each audit. While these discrepancies can be confusing to owners, they can also limit the ability of permanent lenders to underwrite projected savings in a standardized way. The following variances in content were observed across audit reports:

- **Blower door testing** for none/some/all buildings.
- **Consideration of some, but not all, clean energy technologies** (for instance, not considering solar hot water because of its actual or perceived operational challenges).
- **A scan for healthy housing opportunities** for none/some/all buildings.
- **“Bundling” of recommended measures** to increase cost-effectiveness through LEAN program.\(^\text{12}\)

Additionally, Savings to Investment Ratios (SIR) varied across reports based on different assumptions for the following SIR base calculation components:

- **Cost of recommended measures** (i.e. whether pricing was based on listed prices or more competitive bulk prices).
- **Expected useful life (EUL).**
- **Discount rates.**

Finally, auditors had discretion to deem measures as “LEAN-Eligible” or “Not LEAN-Eligible” based on their experience with likelihood of funding versus a standard benchmark of $SIR\geq1$ as “LEAN-Eligible”

\(^{12}\) “Bundling” is where measures (under the same utility – so electric measures with electric and gas with gas) are allowed to have their Savings to Investment Ratios (SIR) averaged so that even if some of the measures individually are not cost-effective, combined with other cost-effective measures they can pencil out collectively. The project team noted some “cross-bundling” of recommended measures (i.e. bundling across electric and gas measures), which the LEAN program is unable to consider; other firms did not provide any bundling analysis.
and SIR<1 as “Not LEAN-Eligible”.\textsuperscript{13} This was confusing to building owners who were looking for funding clarity rather than probability.

Please see MassCEC Performance Dashboard for additional details at the project level.

### 3.3 Retrocommissioning Findings

In LISC’s review of the 15 funded retrocommissioning feasibility analysis reports, supporting materials, and supporting owners in the resulting action plans where applicable, the project team found that there was not one single theme or reason for the underperformance of each clean energy technology type. In fact, some systems experienced multiple types of underperformance (i.e. system design/installation, operation/maintenance, and/or other issues).

This project included 15 clean energy technologies – consisting of 1 air source heat pump, 1 ground source heat pump, 6 combined heat and power (co-gen), 4 solar photovoltaic (PV), and 3 solar hot water systems – that were submitted and selected due to actual or perceived underperformance. The relatively small sample size may not be representative of the wider universe of existing clean energy technologies across Massachusetts’ varied typologies of multifamily affordable housing stock. The relatively small size of the analysis pool also makes it difficult to extrapolate to the wider population.

Nonetheless, it is notable that of the 15 clean energy technology projects, the most frequent system selected based on optimization consideration (40% of the total) was combined heat and power, or co-gen, systems. It is unclear whether this disproportionately high number is due to the prevalence of co-gen in the affordable housing sector, the relative lack of other clean energy technologies, the systemic underperformance of co-gen systems (as currently configured), or a combination of the above. And while biomass boilers were considered an eligible clean energy technology for optimization, no owners applied for a biomass boiler specific retrocommissioning feasibility analysis.

**Sources of Underperforming Clean Energy Technologies.** Of the possible reasons for clean energy technology system underperformance, the project team found that over half (60%) of all clean energy technologies analyzed experienced poor system design/installation. Similarly, 60% of all the clean energy technologies experienced operations or maintenance issues. Within the project’s smaller sample size, both co-gen systems and solar hot water systems were more likely than not (67%) to experience operational/maintenance issues; with solar PV systems encountering an even higher level (75%) of operational/maintenance issues. Other issues encountered included legal and reporting

\textsuperscript{13} Some auditors bucketed “LEAN-Eligible” items as any measure whose SIR equaled or exceeded 1. However, some auditors were more conservative with their estimates of LEAN eligibility, keeping bundled measures whose SIR exceeded 1 still in the “Capital Upgrades” section of the report based on their experience that LEAN Benefit to Cost Ratio (BCR) was often more stringent than their own SIR calculations. In the words of one auditing firm: “We are happy to make a note...that air source heat pumps, showerheads, aerators, and DHW equipment together have an SIR greater than 1.0…but we can’t state that this will make them eligible for LEAN funding. LEAN will evaluate air source heat pumps on different terms than we have done here, and we can’t speak for them when it comes to what would pass and what would not. Our conversations with them about this building indicate that they have looked at this building once already and concluded it would not pass, but that they would be willing to look again. Stating that [the owner] should consider applying for LEAN funding is as far as [the comprehensive energy auditing firm] can go.”
roadblocks. The table below provides additional details on sources by type of underperformance and technology.

<table>
<thead>
<tr>
<th>Type of Clean Energy Technology</th>
<th>Design/Installation Issues (%/#)</th>
<th>System Design/Installation Comments</th>
<th>Operation/Maintenance Issues (%/#)</th>
<th>Operation/Maintenance Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air source heat pump system</td>
<td>100% (1 of 1)</td>
<td>• Installed too close to building ceiling so units pull in already cooled air, resulting in lower efficiency.</td>
<td>0% (0 of 1)</td>
<td>N/A</td>
</tr>
<tr>
<td>Combined heat and power system</td>
<td>33% (2 of 6)</td>
<td>• Reversed piping leading to non-delivery of DHW from boilers and pump over-operating. • Back-drafting on flue is potentially dangerous installation condition.</td>
<td>67% (4 of 6)</td>
<td>• Some DHW storage tanks valved off. • Staff need additional training and communication with co-gen contract company personnel. • Engine is run at output power set-point, or turned off, rather than modulating output power to match thermal load. • DHW and space heating thermal loads less than originally predicted. Run hours inconsistent: pumps run unnecessarily in warm weather. Gas meters not reading. Filters need cleaning.</td>
</tr>
<tr>
<td>Ground source heat pump system</td>
<td>100% (1 of 1)</td>
<td>• Rubber gasket flow-setters degraded resulting in too much flow. Subpar heat exchangers (need titanium plate heat exchangers and pre-filtering with automatic cleaning feature). Program needs to be changed so heat pumps don’t shut down on errors. Need expansion tank and three-way valve to allow temperature blending. Heat exchanger isolation valves installed/programmed backwards.</td>
<td>0% (0 of 1)</td>
<td>N/A</td>
</tr>
<tr>
<td>Solar PV system</td>
<td>50% (2 of 4)</td>
<td>• Damaged panels likely from incorrect panel tilt installation and resulting snow and ice build-up. • Site staff shut off system due to noise complaints from adjacent resident.</td>
<td>75% (3 of 4)</td>
<td>• Site staff shut off system due to noise complaints from adjacent resident. • Burned out surge protector was not noticed and replaced. • Broken panels in system and some obstructive plant growth.</td>
</tr>
</tbody>
</table>

14 One solar PV system’s panel installer had merged with another business and it was unclear whether the panel warranty still held. Two systems were found to be in good working order — however, a faulty surge protector had unplugged its monitoring system, and as a result the owner had not received its projected Solar Renewable Energy Credits for the previous year.

15 One co-gen system had maintenance issues that were resolved in advance of our retrocommissioning feasibility analysis being completed and thus was not included in Table 1’s overall savings analysis.
Electric system tripping. Likely circuit fault led to system stagnation. Glycol needs to be replaced. No monitoring system to alert owner of issues. Too much collector capacity for storage capacity so system experiences many days of stagnation. Needs drain-back design.

Controls, pumps, & monitoring sensors may be faulty, contributing to sub-optimal performance. Likely circuit fault led to system stagnation. Glycol needs to be replaced. No monitoring system to alert owner of issues.

### Table 2: Underperforming Clean Energy Technologies: Rates and Sources

**Costs to Optimize Clean Energy Technology Systems.** While both retrocommissioning and ongoing commissioning can result in significant energy savings, both often cost more money than operators (owners, property managers, and/or third party energy service firms) expect. Building in ongoing operating and maintenance costs, including technician training for the equipment in question, appears to be a best practice to ensure long-term system performance. Below are estimated or actual (where available) cost averages to optimize the 15 clean energy technology systems studied.\(^{16}\)

- Notably, both the air source heat pump and ground source heat pump systems saw retrocommissioning costs of almost $100,000 apiece.
- Average cost for the three co-gen systems’ identified fixes came in just above $50,000.
- Average cost for the two solar PV systems’ identified fixes was much lower at $4,000.
- Average cost for the solar hot water system’s identified fix was just under $3,000.

**Paybacks to Optimize Clean Energy Technology Systems.** Paybacks varied widely based on type of technology and reason(s) for underperformance. Owners were willing to invest in system optimization if they expected long-term cost savings. It is important to note that the vast majority of retrocommissioning reports did not include Savings to Investment Ratios (SIR), but rather only provided Simple Payback Periods. This simple payback number is less useful to an owner who wants to know their return on investment based on the estimated useful life left of the system. For instance, a recommended measure with a simple payback period of 17 years would be cost-effective for an owner to fix if the measure’s estimated useful life is 20 years, but not if its estimated useful life is only 15 years. The following table lists estimated payback periods for each clean energy technology analyzed, along with planned owner actions.

<table>
<thead>
<tr>
<th>Clean Energy Technology Type</th>
<th>Number Analyzed</th>
<th>Simple Payback Period (years)</th>
<th>Owner Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air source heat pump system</td>
<td>1</td>
<td>7 years</td>
<td>Owner is moving forward with recommended fixes (partially supported by MassCEC retrocommissioning grant).</td>
</tr>
<tr>
<td>Combined heat and power system</td>
<td>5 applicable</td>
<td>3.4 years, 4.2 years, 9 years, 10.7 years, and 20 years</td>
<td>Two owners (with 4.2 and 9 year paybacks) plan on moving forward with recommended fixes (one is partially supported by MassCEC retrocommissioning grant).</td>
</tr>
</tbody>
</table>

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\(^{16}\) Some of these costs were one-time recommended fixes, while others included funding for ongoing (e.g. 5 year) monitoring contracts.
<table>
<thead>
<tr>
<th>Clean Energy Technologies</th>
<th>Optimization Paybacks and Planned Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ground source heat pump system</strong></td>
<td>26 years (bundled) Owner is moving forward with recommended fixes (partially supported by MassCEC retrocommissioning grant).</td>
</tr>
<tr>
<td><strong>Solar PV system</strong></td>
<td>0 years, TBD (may be under warranty), 0.7 years, and 5 years All payback times 5 years or less. All owners are (planning on) moving forward with recommended fixes (one is fully supported by MassCEC retrocommissioning grant).</td>
</tr>
<tr>
<td><strong>Solar hot water system</strong></td>
<td>0.3 years, 5.5 years, and 33 years Wide variation in payback time (from &lt;1 year to 30+ years). Both owners who had fixes with sub-6 year payback times are (planning on) moving forward with recommended fixes (both fully supported by MassCEC retrocommissioning grants); owner with long payback unlikely to move forward.</td>
</tr>
</tbody>
</table>

**Challenges to Optimize Clean Energy Technology Systems.** Owners are willing to invest in optimizing clean energy technologies when they have identified the issues, have access to funding, and the payback makes sense. Specifically:

- **Access to Funding:** Some owners had replacement reserves available, which allowed them to implement recommended solutions and optimize systems. Additionally, owners who provided proof of need and intent to implement solution(s) received retrocommissioning support grants from MassCEC, which fully or partially supported implementation of recommended measures depending on the overall cost. Conversely, owners without upfront capital tended to hold back on measure implementation.

- **Return on Investment:** Some owners decided that the payback time was too long and/or that the return on investment (ROI) was too long for them to move forward. Similarly, one building science firm recommended wholesale replacement (rather than retrocommissioning) of a particular co-gen system due to its advanced age and wear. As noted above, the lack of Savings to Investment Ratios (SIR) in several of the retrocommissioning reports made it difficult for owners to understand which measures were cost-effective over the remaining life of the measure.

- **Opportunity for Improved Alignment:** Lastly, co-gen systems should be optimized for system performance rather than run-time. Some companies encountered during this project provided third-party energy services with run-time-centric contracts. LISC sees this as an important gap to address for future contracts that affordable housing owners may make with third party energy service firms.

Please see MassCEC Performance Dashboard for additional details at the project level.
Section 4. Recommendations

1. Mandate or Incentivize ASHRAE Level II Energy Audits or IPNAs.

**Background:** This project has demonstrated the additional value of comprehensive (ASHRAE Level II) energy audits over ASHRAE Level 1/1.5 energy assessments to fully inform comprehensive energy savings strategies for projects approaching recapitalization/rehab. Additionally, comprehensive energy audits are a necessary minimum for permanent lenders to be able to underwrite the projected energy and water savings.

**Pathway:** LISC recommends that DHCD mandate or incentivize ASHRAE Level II energy audits via the Qualified Allocation Plan (QAP) for all multifamily affordable housing projects seeking state subsidy. Based on LISC’s understanding of the critical importance of well-timed audits, comprehensive energy audits (and/or integrated physical needs assessments) should be conducted at least 1.5 years before project recapitalization/rehab begins. While cost concerns can put any measure at risk of elimination, timely audits enable owners to strategically incorporate a greater percentage of the audit’s recommended measures into their project planning process, thus minimizing the potential for these measures to be eliminated (or not considered) due to looming deadlines.

Based on the project’s finding that ASHRAE Level II energy audits can vary by building science provider (e.g. discrepancies in content and Savings to Investment (SIR) calculation assumptions), housing subsidy providers, permanent lenders, DOER, and MassCEC should provide DHCD with guidance on what an ASHRAE Level II energy audit should and should not contain for multifamily affordable housing properties.

**Alternative Pathway:** As an alternative and more comprehensive audit, LISC recommends that DHCD encourage Integrated Physical Needs Assessments (IPNAs) as a preferred option to ASHRAE Level II energy audits when multifamily affordable housing projects are approaching a major recapitalization and physical rehabilitation and seeking state subsidy. IPNAs are physical needs assessments that include energy, water, and health assessments, including identification of deficiencies, recommended improvements (scope of work), and associated construction costs for those improvements. Combining a physical needs assessment (PNA) and comprehensive energy audit in one, this merged report reduces duplication of efforts; reaches economies of scale in planning capital improvements and energy efficiency work simultaneously; and helps to leverage and coordinate financing sources. Additionally, an IPNA layers on a holistic health lens, identifying housing-based health issues that can be addressed during rehab or through operations and maintenance.

While a combined physical needs assessment and comprehensive energy audit may create some complications (e.g. ensuring IPNA teams include qualified members for all report components), lessons can be drawn from LISC’s colleagues in New York who have worked alongside New York City
Department of Housing Preservation and Development (HPD) staff to launch this tool for multifamily properties receiving city or state financing for property recapitalization/rehab.\(^\text{17}\)

Additionally, LISC recommends that resiliency measures be incorporated into ASHRAE Level II energy audits and IPNAs. These may include recommendations that are specific to backup energy needs like solar plus storage, but also items that relate to property protection, adaptation, and community.

**Impact:** Economic (cost savings). Institutional (capacity, coordination, and timing). This recommendation would maximize potential energy and water savings opportunities in affordable housing projects statewide that are approaching recapitalization/rehab.

### 2. Ensure Suite of Highly Qualified Auditing Firms Available with LEAN Assessment Capacity.

**Background:** Just as important as having projects approaching recapitalization/rehab receive comprehensive energy audits or integrated physical needs assessments is ensuring that owners receive these audits in a timely manner. While the final audit reports LISC received were of high quality, several took 4-6 months to deliver. If ASHRAE Level II energy audits are mandated or incentivized in DHCD’s next Qualified Allocation Plan (QAP), it will be critical to ensure firms are well-positioned to provide audits on a tight turnaround for owners with properties approaching recapitalization/rehab.

**Pathway:** LISC is interested in working with the state housing, energy, and clean energy agencies to develop an RFQ to prequalify auditors/assessors based on product quality, price, and internal capacity criteria. A prequalified auditor list will provide owners with the flexibility to work with the firm of their choice, while ensuring that owners who may be new to audits can easily find qualified firms to provide them with a valuable product that informs and fully leverages their project’s energy and water savings potential.

**Additional Pathway:** Any firms that apply for prequalification to perform ASHRAE Level II energy audits should as a prerequisite also apply for and receive LEAN approved auditor status so they can also offer LEAN energy site visits and scoping assessments. This would allow all pre-qualified firms to support owners through the entire recapitalization/rehab process. Currently, there is a notable gap in the existing structure, which requires an auditing firm to provide their proprietary ASHRAE Level II energy audit report to a competitor who then references that product to help determine energy efficiency (LEAN) program funding for the property. To avoid duplication of efforts and ensure alignment of the comprehensive energy audit and energy efficiency (LEAN) program funding assessment, qualified auditing firms should go through the qualified contractor process for the energy efficiency (LEAN) program so that they can utilize their own product and as a result provide the most thorough LEAN assessment for the property. This cross-qualification process will increase clarity around LEAN’s Benefit to Cost Ratio (BCR) for prequalified building science firms, who will be able to more accurately predict LEAN-eligibility status in their audits. Further, owners will gain a clearer understanding of which

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measures will likely be funded through the LEAN program versus which measures will likely fall outside of LEAN funding eligibility.

**Impact:** Institutional (capacity, coordination, and timing). DHCD can help owners make informed decisions by utilizing a qualified list of firms that have been vetted by the critical organizations from which they seek energy incentives, housing subsidy, and permanent financing.

3. **Encourage Early and Close Coordination between Recapitalizing Projects and LEAN Program.**

**Background:** The project team found that ASHRAE Level II energy audits informed and maximized the ultimate LEAN program scope of work for the selected projects. Further, audits that were completed well in advance of project recapitalization provided a reference document for LEAN program staff to base their LEAN assessments and funding decisions on earlier in their annual funding cycle, thus widening the window of opportunity for an owner to coordinate with LEAN staff and receive maximum program benefit as a result. The additional time also allows for LEAN staff, city/state subsidy providers, and state housing finance agencies (such as Massachusetts Housing Partnership and MassHousing) to more easily and closely coordinate to ensure maximum LEAN program participation by the state housing finance agencies’ borrowers.

**Pathway:** Based on the above, one promising path forward is creating a requirement within DHCD’s Qualified Allocation Plan – or QAP, the scoring criteria that determines how competitive state housing subsidy is allocated – that all developers seeking state housing subsidy for projects approaching recapitalization/rehab must apply to their applicable energy efficiency program (LEAN, MassSave, or their municipal equivalent).

**Additional Pathway:** During this project, LISC convened property owners, building science firms, and LEAN program staff to walk through the details of finalized audit/retrocommissioning report recommendations. Moving forward, the formalization of this review process in the form of a green design charrette, also known as integrated design kickoff meeting, could be led by the respective building science firm. With a comprehensive energy audit and physical needs assessment or integrated physical needs assessment in hand, these green design charrettes provide an additional venue for coordination within the project development team that allows for a more thoughtful approach to integrating energy efficiency, clean energy, water, and healthy housing recommendations into a project’s overall rehab scope of work.

**Impact:** Economic (cost savings). Institutional (capacity, coordination, and timing). This recommendation would help maximize potential energy and water savings opportunities and increase coordination among partners.

4. **Analyze Pipeline of Recapitalization Opportunities with Subsidy Providers, LEAN Staff, and Permanent Lenders.**

**Background:** LISC analyzed 24 projects approaching recapitalization over the course of this project. However, there is a larger universe of recapitalizing affordable housing projects for which DHCD provided housing recapitalization subsidy and housing finance agencies (e.g. MassHousing and
Massachusetts Housing Partnership) provide permanent loans. While LEAN has provided significant energy efficiency resources to the sector, it is unclear whether all projects approaching recapitalization have been served by the LEAN program.

**Pathway:** LISC recommends a retrospective scan of all recapitalized projects within the past 10 years to see whether they received LEAN program funding and with MassCEC and DOER to see whether they incorporated clean energy technologies. This scan would help to identify key trends and gaps in program coverage. The state housing finance agencies, energy, and clean energy agencies can use the findings of the scan to ensure that all projects, but especially those approaching recapitalization and likely receiving additional state housing subsidy for preservation and/or clean energy technology investment, take advantage of all available energy efficiency and clean energy funding. This ensures that no cost-effective energy savings opportunities are left on the table.

**Impact:** Economic (cost savings). Institutional (capacity, coordination, and timing). This recommendation would maximize potential energy savings opportunities.

**5. Develop Clean Energy Roadmap.**

**Background:** During this project, LISC has observed several instances of owners considering but ultimately not incorporating clean energy technologies into property rehabilitation due to a multitude of reasons, including uncertainty over technology performance and lack of financing. To encourage the widespread adoption of appropriate clean energy technologies for this sector, it is essential to first understand the suite of barriers to adoption of clean energy technologies for owners. The utilities and housing finance agencies worked to create an energy efficiency roadmap\(^{18}\) that focuses on helping affordable housing owners with properties approaching recapitalization to maximize/leverage use of the LEAN program. There is great potential for the development of a similar “clean energy roadmap” that helps owners proactively understand applicable clean energy technologies for their portfolios, and work to incorporate them strategically. This project also highlighted the importance of generating a vetted installer list for clean energy technologies, and ensuring a commitment from these prequalified vendors to include long-term monitoring and ongoing commissioning within their contracts as an industry standard.

**Pathway:** MassCEC should cross-reference DHCD’s list of affordable housing properties that recently received state housing preservation and/or new construction subsidy with MassCEC's records of its recent clean energy investments to learn which rehabbing/new properties did not incorporate any clean energy technologies. Based on this understanding, MassCEC and LISC should collaboratively reach out to these owners to better understand why they did not move forward with clean energy technologies (for example, why they chose to do a solar-ready roof but not a solar PV/thermal system). This will inform the creation of a clean energy roadmap, as well as technical assistance and additional resources/investments tailored to the needs of owners. For example, owners may need help deciding when it makes sense to pursue solar PV (i.e. solar PV ownership or leasing (power purchase agreements), solar hot water, and/or battery storage based on their portfolio’s unique characteristics (i.e. roof size and condition, solar exposure, energy usage, demand charges, etc.) as well as

owner/property manager capacity. There are other decisions to be made along these lines as well, depending on the clean energy technology in question, that a clean energy roadmap resource could help answer.

As part of this roadmap, MassCEC and DOER should work toward creation of a prequalified clean energy technology vendor list through a Request for Qualifications (RFQ) process. Once the clean energy roadmap and prequalified vendor list is in place, a next step would be broad outreach and education to the affordable housing sector to ensure owners and property managers understand how to access (and build a more informed business case for adopting) all applicable clean energy technology options.

**Impact:** Technical (maintaining systems). Institutional (capacity, coordination, and timing). This recommendation would leverage and maximize energy savings opportunities. It would also make it easier for owners to incorporate clean energy technologies into their housing portfolios, and to ensure optimal performance of clean energy technologies.

6. Explore Opportunities to Underwrite Projected Savings.

**Background:** Through this project, the goal was to ensure owners with properties approaching recapitalization and rehabilitation did the following: (1) maximize all available energy efficiency savings (e.g. LEAN program); (2) include in their planned rehab scope of work deeper (non-LEAN eligible) efficiency measures that would result in long-term energy and water savings; and (3) incorporate appropriate clean energy technologies into their project.

As the LEAN program is required to calculate measure eligibility based on Benefit to Cost Ratio (BCR) rather than a more inclusive Savings to Investment Ratio (SIR), LISC found multiple measures that were originally thought to be LEAN-eligible, but were ultimately deemed not eligible for LEAN funding by the program administrators. Further, the LEAN program cannot provide non-energy (water savings only) measures such as toilet replacements. These two program parameters resulted in many of the 24 audits’ recommended measures falling outside of LEAN. Combined with tight rehab budgets, many of the owners LISC worked with were faced with the prospect of value engineering these non-LEAN eligible technologies and clean energy technologies out of their planned rehab scope of work completely, despite the carbon reductions and long-term energy savings they could provide.

**Pathway:** Underwriting projected energy and water savings into a project’s first mortgage can remedy the above “value engineering” problem, as it uses those projected savings as a funding stream for measures that would otherwise be cut. Based on LISC’s experience in this project, the project team recommends the introduction and standardization of underwriting projected energy and water savings among the state housing finance agencies and other permanent lenders. Leaders in the field Community Preservation Corporation (CPC) recommend underwriting at least 50% of a project’s projected energy and water savings. Long-term, LISC sees underwriting 75% of the projected energy and water savings as an aggressive but achievable goal.

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However, it is essential that permanent lenders first see that projects’ projected energy and water savings actually materialize so they are confident to start underwriting these savings. MassCEC, DOER, permanent lenders, and related stakeholder should analyze post-retrofit data from these 38 projects to better understand what level of energy/water savings actually resulted from specific measures, and then synthesize these data into standardized underwriting criteria for high performance affordable housing. Ideally, LISC could explore setting up a repository of shared retrofit project data from the 17 states and cities that already have benchmarking incentives or requirements in their Qualified Allocation Plans such as California, New York (and NYC), Pennsylvania, and Rhode Island.

In summary, these three components will be integral to standardizing the process of underwriting energy and water savings:

- **Comprehensive (ASHRAE Level II) energy audit or integrated physical needs assessment (IPNA).**
- **Benchmarking** (in an online platform such as WegoWise, Bright Power’s EnergyScoreCards, etc.). Benchmarking for the life of the loan ensures that projected energy and water savings are realized and the building is performing as expected.
- **Ongoing commissioning and maintenance staff training.**

Permanent lenders should be closely involved in the above process, reviewing audits/IPNAs and ensuring borrowers’ maintenance staff are trained and comfortable with all building equipment and systems. Equally, owners and/or property managers can provide incentive mechanisms for maintenance staff to engage in ongoing training, monitoring, and maintenance of new technologies.

**Impact:** Economic (cost savings). Institutional (capacity, coordination, and timing). This recommendation would reduce the need for public subsidy dollars, while any efficiency savings beyond the conservative underwriting projections create additional, ongoing cash flow for the owner. This recommendation would also encourage closer communication and coordination amongst the permanent lender, building owner, and state housing agency.

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Section 5. Conclusion

The multifamily affordable housing sector in Massachusetts holds deep energy efficiency and clean energy savings opportunity as evidenced by the over 10,000 metric tons of potential carbon dioxide emissions savings identified through these 38 projects. This is equivalent to 1,600 homes’ energy use for one year.

Thanks to generous support from MassCEC and DOER, LISC will continue to scale this work over the next 2-3 years, offering comprehensive energy audits to up to 60 additional projects approaching recapitalization/rehabilitation.

The project team will carry forward lessons learned from this current project, which include the critical importance of early timing; predictable incentive programs for energy efficiency and clean energy technologies; and close coordination among key stakeholders.

Working collaboratively with housing and energy stakeholders, LISC is confident that the affordable housing sector can collectively move the needle toward achieving deep de-carbonization goals and more comfortable and affordable homes for residents.