RETROFIT STANDARDIZATION INTERIM REPORT

a promising new approach to expanding residential energy efficiency.

PRATT CENTER FOR COMMUNITY DEVELOPMENT | 50 YEARS

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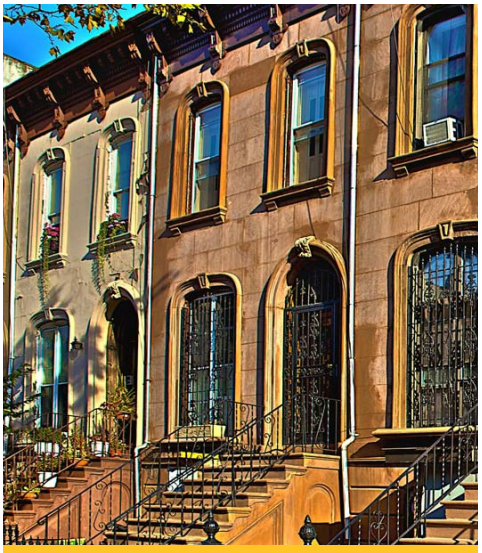
A. Overview

In 2012, the Pratt Center for Community Development launched the Retrofit Standardization Study to test a simplified, scalable approach to implementing energy efficiency upgrades in small residential buildings throughout New York City. Although these buildings are not New York City's most egregious energy wasters, they comprise two-thirds of the city's building stock and account for 17% of the city's carbon emissions. Retrofitting half of the city's 650,000 small homes would save homeowners at least $255 million annually, create over 2,500 jobs, improve indoor health and safety, and preserve the building stock. But achieving this requires a dramatic increase in retrofit implementation; no more than a few dozen small home retrofits are completed annually in New York City under the State's energy efficiency programs.



Brooklyn Rowhouses

To address this, we sought to capitalize on the redundancy in the building stock by developing a standard package of energy retrofit measures based on building typology. We hypothesize that this package can be applied to tens of thousands of small homes while mitigating the pervasive barriers to retrofit implementation, and that the overall standardization approach can simplify, expedite, and accelerate small home retrofits throughout the city. As part of the study we audited 24 similar buildings—two family, masonry, attached, gas heated homes— to develop a simple, cost-effective package of energy efficiency measures. The study identified a clear set of measures applicable to every building in the study's sample set. This starter retrofit package has an estimated average cost of only $3,312 with expected annual utility savings of 14% and a Savings to Investment Ratio (SIR) of 1.74. We also found that if additional conditional measures could be added to the package, it would raise energy savings in many homes to 21%.

Conducting a Blower Door Test

Pratt Center collaborated with the New York State Energy Research and Development Authority (NYSERDA), Con Edison, National Grid, Conservation Services Group, U.S. Department of Energy and several other industry stakeholders, to facilitate this study. Pratt Center contracted with Bright Power, a leading energy consulting firm, to conduct the energy audits, model savings, and develop a standard package of cost-effective energy efficiency measures.

This Interim Report describes the study's progress to date, and details our analysis from the last year and a half on a streamlined approach to catalyzing residential retrofits in New York City.

B. Study Background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The Retrofit Standardization Study emerged from insights gathered through Pratt Center's on-the-ground 2010-2012 Retrofit Block by Block initiative, which utilized community-based social marketing campaigns to catalyze retrofits in 1-4 family homes in New York City. Through partnerships with 4 community-based organizations, the initiative successfully enrolled over 740 low- and moderate-income homeowners into retrofit programs within 18 months, almost double the number that had enrolled in New York State's signature retrofit program in the eight years prior. While community-based organizations successfully generated unprecedented interest in energy efficiency, demonstrating the power of on-the-ground, grassroots outreach strategies, the Retrofit Block by Block initiative did not achieve the economies of scale that we had hoped for or expected. We found that hundreds of homeowners who enrolled in energy efficiency programs never took the next step of retaining a contractor to complete a mandatory energy audit, and that among those who did complete an audit, many did not follow through with a retrofit. In fact, as of August 2013, less than 10% of New York City homeowners who enrolled in State energy efficiency programs through community-based organizations implemented a retrofit after completing an energy audit. Through Block by Block we found that energy audits are a considerable hurdle and bottleneck for homeowners implementing retrofits. Specifically, the standard industry approach of implementing an individual energy audit in every home prior to a retrofit is an obstacle to scaling up building retrofits because it is:

- **Difficult to explain to homeowners:** most people do not know what an energy audit is, therefore it requires considerable time and resources to convince homeowners to do it.
- **Costly:** it takes most contractors a full day of labor to make an appointment, conduct the energy audit, write the audit report and explain the report. Therefore, it would require 650,000 days of labor to audit all of NYC's one- to four-family small homes under the current system. Even if contractors were paid the subsidized rate that NYSERDA covers through its Green Jobs Green NY (GJGNY) program, it would cost $224,000,000 to audit every New York City home before any energy-saving measures are implemented.
- **Confusing:** Once audit reports are delivered, many homeowners don't understand them or know how to interpret their data.
- **Unreliable:** although the Building Performance Institute's audit framework (the industry standard) is intended to ensure comparable and high-quality audit reports, Pratt Center's database of over 200 audits suggests that the audit reports are skewed to the experience and interests of the contractors and the items paid for by the incentive program under which they are executed.
- **Not tailored to NYC's communities:** the majority of small homes in New York City's low- and moderate-income communities are 2 – 4 units, as opposed to the single-family homes in other parts of the state. Under the State's incentive program, homes cannot undergo any subsidized retrofit upgrades unless all of the units are audited, and the time and effort required to schedule an audit with multiple tenants further complicates the audit process.

- **Inefficient and in many cases unnecessary:** by requiring every individual home to undergo a deep comprehensive audit, the traditional approach does not leverage building stock redundancies to achieve economies of scale; most of the city's residential communities have similar and at-times identical buildings with the same number of units, heating systems and ventilation systems. Through Block by Block we found that energy audits performed in similar homes in the same communities prescribe almost identical retrofit measures.

Pratt Center designed the Retrofit Standardization Study to test the hypothesis that homes of similar type—built around the same time period with similar materials and systems—require the same energy efficiency measures. The study further aimed to identify a standard package of cost-effective energy efficiency measures that could be applied to a housing type without an energy audit and without compromising energy savings. We hypothesize that a standard package would make it easier for homeowners to access retrofit financing and implement energy efficiency measures, and open the door to new approaches to expedite implementation across a large number of homes.

Pratt Center launched the Study in August 2012 in partnership with NYSERDA and under the guidance of an Advisory Group of expert industry stakeholders. As this report details, a package of cost-effective, energy efficiency measures was indeed developed and will be installed in ten homes as part of the second phase of the study to verify the projected energy savings of the measures.

C. Retrofit Standardization Study Advisory Group

At the outset of the study, Pratt Center and NYSERDA convened an Advisory Group of expert industry stakeholders including Con Edison, National Grid, U.S. Department of Energy, city agencies, community-based organizations, contractors and others to guide the project.

The Advisory Group's input was instrumental in finalizing the study's methodology. The most significant change made based on the group's feedback was the creation of a second phase of the study in which the standard package of retrofit measures will be implemented in a number of homes and evaluated 12 months later to document actual energy savings. Additionally, the Advisory Group provided guidance at key points in the study, including before homeowner recruitment, after the study's test phase, and after the energy analysis and development of the standard package, all the while validating the study's systematic, step-by-step approach and findings, described below.

Retrofit Standarization Advisory Group

Chairs: Adam Friedman, *Pratt Center* and **Frank Murray**, *NYSERDA*[1]

Nicole Henderson-Roy
Bedford Stuyvesant Restoration Corporation
Mike Brown
BrightHome Energy Solutions/Building Performance Contractors Association
Rachel Scheu
Elevate Energy
Anthony Ng
Center for Working Families
Rebecca Craft
Con Edison
Kyle Archie
Conservation Services Group
Tom Sahagian
Enterprise Communities
Colleen Flynn
Local Initiatives Support Corporation
Louis Rizzo
National Grid
Christopher Mahase
NYC Dept. of Housing Preservation and Development
Jessica Luk
NYC Energy Efficiency Corporation
Joan Glickman
U.S. Dept. of Energy

1 During Phase 1 of the Retrofit Standarization Study, Frank Murray was the President and CEO of NYSERDA. The current President and CEO is John Rhodes.

D. Phase 1 Approach

1. Building Type Selection

The Retrofit Standardization Study analyzed a single building type: 2-family, masonry homes. To determine the target building type, Pratt Center established three criteria:

- **Prevalence:** a building type that represents a large proportion of NYC's building stock.
- **Feasibility:** a building type in which we could complete the audits in a reasonable time frame.
- **Opportunity:** a building type that was expected to yield a high rate of return on retrofit investments and/or a neighborhood with need for affordable energy efficiency upgrades.

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While the methodology of this study was designed to conduct analysis on a very specific building type, we envision that retrofit standardization can apply to most if not all small residential building types in New York City, capitalizing on the repetitive nature of the city's building stock.

To identify a building type that met our criteria, we utilized data from the NYC Department of City Planning's MapPluto dataset that includes information on year built, number of floors, number of residential units, attachment status, and building class. With this data, Pratt Center engaged in a detailed process to narrow down all of the city's buildings to a subset of buildings, which would be applicable to the study. These steps included:

a) Considering only residential buildings.

b) Considering only buildings with 2, 3 or 4 units to address many of the tenancy challenges that NYC homeowners have faced in the audit and financing phases of retrofit programs, while maintaining the study's focus on small homes.

c) Including only buildings constructed after 1860 and before 1929 (small homes built between these dates were usually near-identical and constructed in contiguous clusters thus making them ideal for this study).

d) Including buildings with fewer than five floors, to eliminate potential outliers.

We then analyzed the building clas data to further narrow this subset of 165,268 homes. We found that homes classified by the NYC Department of Finance[2] as B1 (Two Family Brick Dwellings), B2 (Two Family Wood Dwellings), B3 (Two Family Converted From One Family) and CO (Walk-Up Three Family) collectively accounted for over 80% of the subset, or 132,798 buildings. Next, we analyzed the attachment status of this remaining subset, focusing specifically on Brooklyn and Queens, which accounted for 83% of the homes classified as B1, B2, B3 and CO. The majority of these 110,426 homes were either attached or semi-attached and given construction patterns

2 The New York City Department of Finance classifies every parcel of land for tax purposes. However, these classifications, which were established decades ago, do not always reflect the buildings type today. Nonetheless, it is the best resource available to quickly classify NYC's building stock.

in the period between 1860 and 1929, were more likely to have similar building systems than detached homes. Accordingly, we then mapped the distribution of all attached and semi-attached homes classified as one of these four building classifications to identify the communities with the densest concentration of these homes. This was followed by an analysis of Area Median Income in these communities so as to ensure that the study's focus remained on areas with the greatest need for affordable energy efficiency upgrades.

Based on these analyses, we determined to focus on Bedford-Stuyvesant—a community with a large number of the housing type subset and the highest concentration of residents below Area Median Income (relative to other communities with numerous B1, B2, B3 and CO homes). We further examined the attachment status and contiguity of these homes on clusters of blocks.

From this analysis we determined to focus on attached buildings due to their greatest prevalence in Bedford Stuyvesant. We also determined that B2 buildings were too scattered for us to pursue as the study's building type, (although we believe a standard retrofit package could certainly be developed for two-family wood dwellings) and that two-family buildings were preferable to CO (a three-family building classification) because of the need to recruit fewer tenants to cooperate in the study in a short timeframe. Lastly, based on feedback from the Department of Finance, we learned that there is no substantive difference between homes classified as B1 and B3.

Therefore, in the end, we decided to focus on attached B1 and B3 homes, of which there are 48,796 buildings in the five boroughs, representing over 13% of all 2-4 family homes in New York City.

2. Homeowner Outreach

In collaboration with Bedford Stuyvesant Restoration Corporation, a community-based non-profit organization in Bedford Stuyvesant and a partner in Pratt Center's Retrofit Block by Block initiative, Pratt Center recruited homeowners of attached, masonry two-family homes to participate in the study and receive a free comprehensive energy audit. Participating homeowners received a $75 incentive in exchange for:

- Providing access to 12 months of pre-audit energy usage data, and if selected for the retrofit in Phase 2, a commitment to provide 12 months of post-retrofit energy usage data.
- Completion of a pre-audit survey, and if selected for the retrofit, one year post-retrofit survey.
- Allowing Bright Power, our technical consultant, to conduct a comprehensive energy audit of the entire home, including their tenant's residential unit. Audits available through NYSERDA's programs can cost a homeowner up to $400. However, the audit completed for this study was more comprehensive and valued at over $2,000 but was provided at no cost to the homeowner in exchange for their participation.
- Agreement to install the standard package if selected for Phase 2 of the study.

Over the course of several months, we employed several outreach techniques to contact homeowners in Bedford Stuyvesant as well as other nearby neighborhoods with concentrations of attached B1 and B3 homes including Park Slope, Prospect Heights, Fort Greene and Clinton Hill. Outreach methods included following up with homeowners that Bedford Stuyvesant Restoration Corporation was already in contact with, attending community events such as block parties, online postings on blogs and other websites, flyers at key community hubs, and door-to-door knocking. Almost 70 completed intake forms were collected; after an initial assessment 24 homeowners were selected and committed to participate in the first study phase.

Many homeowners who were initially interested in participating in the study withdrew their application for one of several reasons, including:

- **Some homeowners did not want to ask their tenants to submit their utility bills.**
- **Some homeowners did not want to take off from work for the audit because it yielded no clear home upgrades or energy efficiency benefits.**

These challenges illustrate the overall problem with conducting an energy audit in residential retrofit programs and further demonstrate the need for a simpler standard package and streamlined approach.

3. Comprehensive Energy Audits

Pratt Center contracted with Bright Power, an energy management consulting firm, to conduct and analyze the energy audits for the study. During our previous Retrofit Block by Block work, we found that energy audit recommendations were often skewed toward the specialty of the firm conducting the audit, resulting in costly retrofit packages that included measures with minimal projected energy savings. Therefore, it was imperative that we retain an auditing firm that was not biased toward any potential recommended measures and that would not be performing the retrofits. In addition, the same Bright Power staff audited all the buildings in the study to ensure a similar analysis of each home.

Before undertaking all 24 audits, we developed a "test phase" consisting of the first four buildings to be audited. We used these first test audits to evaluate our initial assumptions and determine if the standardization approach appeared feasible based on just a small number of homes. All four homes were gas heated; three had radiator-based heating systems, and one had a forced air system. Bright Power used TREAT, an energy modeling software accepted by NYSERDA for its residential energy efficiency programs, to analyze these four homes. They identified clear overlaps in energy usage, recommended energy measures, projected savings, and savings to investment ratios—supporting our hypothesis that retrofit standardization is possible.

A major ancillary benefit to an energy audit is the review of several health and safety components including checking for gas leaks and measuring carbon monoxide (CO) levels in the mechanical rooms. During the health and safety reviews of the four test phase audits, Bright Power identified one minor gas leak and two homes that had higher than recommended CO levels in the flues of their combustion equipment, one of which spilled into the mechanical room. With 50% of the test phase homes having some type of notable health and safety issue, we decided at this stage that we would include health and safety protocols in the preliminary standard retrofit package, such as the installation of CO detectors outside the mechanical room and a recommendation for homeowners to fine tune their boiler system to ensure proper combustion and therefore acceptable CO levels.

Additionally, all four test phase homes had old, non-functioning coal chutes in the mechanical rooms, which were designed to transport coal from delivery trucks on the street to the basement furnaces. While these chutes provide fresh air access required for the combustion equipment they are also a source of uncontrolled air infiltration, and it was noted that a measure would likely need to be included in the standard package that addressed adequate fresh air access.

Unsealed Basement Coal Chute

Despite the clear overlap in applicable, cost-effective measures during the test phase, we determined to restrict eligibility for the remaining audits to gas heated homes with radiators because of the unique nature of evaluating and improving forced air equipment and distribution ductwork. We also determined to further narrow the criteria for participation to homes that did not have central air conditioning and that had flat roofs—two elements that were likely to skew energy use and the cost of improving the attic cavity. These additional elements helped to ensure that the buildings had similar enough systems and characteristics.

The remaining 20 homes were audited using the same approach as the first four. Twenty-two homes were ultimately included in the final analysis as it was determined after the audit that two audited homes did not meet the study criteria.

4. Development of the Standard Measure Package

After all the audits were completed, Bright Power modeled energy savings using TREAT software and aligned the model with actual energy usage from utility bills to ensure projected savings were not overestimated. Over 20 energy measures were evaluated individually for whether or not the measure would positively impact energy use, applicability, and cost-effectiveness, defined as having a savings-to-investment ratio (SIR) of 1.0 or more, for the sample set. These measures included:

- **Reduce air infiltration**
- **Insulate and seal roof cavity (R 37)**
- **Dense pack roof cavity (R 24)**
- **Insulate and seal shed walls**
- **Isolate shed from residence**
- **Insulate and seal roof hatch**
- **Replace double pane windows**
- **Insulate and seal basement ceiling**
- **Insulate and seal basement walls (or mechanical room)**
- **Insulate and seal exterior walls**
- **Install smart thermostat**
- **Insulate exposed heating pipes**
- **Tune/balance heating system**
- **Insulate exposed Domestic Hot Water (DHW) pipes**
- **Reduce DHW supply temperature**
- **Install low-flow showerheads and faucet aerators**
- **Replace incandescent bulbs**
- **Replace inefficient window A/Cs**
- **Install A/C controls**
- **Replace inefficient refrigerators**
- **Install smart strips**

E. Study Findings

The analysis of the 22 audited buildings identified a clear set of cost-effective energy measures that were applicable in 100% of the sample set[3]. These measures form the Starter Package, named to reflect relatively simple energy efficiency measures that can enable homeowners to begin to save energy in this building type. Additional measures, specifically insulation of the basement and/or the roof cavity, prove cost-effective only in some of the homes where there is either no existing insulation of this type or the existing insulation is significantly compromised. In the instances when it is both applicable and cost-effective to implement these conditional measures, we recommend adding them to the Starter Package.

3 Similar to the analysis on the individual energy measure level, the package analysis also used applicability and cost-effective screening. Applicability is defined as the package overall having an opportunity to reduce energy use. Cost-effectiveness is defined as having an SIR of 1.0 or more.

The Starter Package with or without the conditional measures also includes a number of health and safety (H&S) and operations and maintenance (O&M) best practices. The allowable H&S/O&M costs increase when the conditional measures are added, reflecting NYSERDA's programmatic guidelines to restrict these costs to 15% of the total package cost. Prior to any work, it is required that homewowners' boilers and hot water heaters are tested for acceptable CO levels. If they exceed acceptable levels, homeowners need to have them tuned to ensure proper combustion and safety.

The Starter Package (see Table 1) is predominantly an interior and basement air sealing package. It assumes a 22% air infiltration reduction and insulation only in the roof hatch.

Opportunity for Air Sealing

Table 1: Starter Package

STANDARD MEASURES

- Reduce overall building infiltration by air sealing throughout main residence and basement.
- Insulate push-up roof hatch
- Insulate exposed heating and domestic hot water pipes in basement
- Install engineered low-flow showerheads and faucet aerators
- Replace incandescent bulbs with LED screw-in equivalent bulbs
- Improve fresh air access for combustion equipment
- Install CO detectors outside boiler rooms
- Reduce DHW supply temperature

Upfront Cost:	$3,313.12 (Incl. H&S/O&M Measures up to $450)
Lifetime Savings:	$5,773.91
Simple Payback:	7.05 years
% annual utility savings:	13.9%
SIR:	1.74
# of Buildings with Package Applicable	22
% of Buildings with Package Applicable	100%
# of Buildings with Package Applicable & Cost-Effective	22
% of Buildings with Package Applicable & Cost-Effective	100%

If a building does not have basement insulation and that basement is un-conditioned (i.e. not heated or cooled) then we recommed insulating the basement ceiling (see Table 2). This increases the cost of the retrofit, but also increases the savings to 17%.

Table 2: Starter Package Plus Basement Insulation

STANDARD MEASURES

- Reduce overall building infiltration by air sealing throughout main residence and basement.
- Insulate push-up roof hatch
- Insulate exposed heating and domestic hot water pipes in basement
- Install engineered low-flow showerheads and faucet aerators
- Replace incandescent bulbs with LED screw-in equivalent bulbs
- Insulate basement ceiling
- Improve fresh air access for combustion equipment
- Install CO detectors outside boiler rooms
- Reduce DHW supply temperature

Upfront Cost:	$6,265.03 (Incl. H&S/O&M Measures up to $750)
Lifetime Savings:	$7,953.63
Simple Payback:	10.78 years
% annual utility savings:	17.2%
SIR:	1.27
# of Buildings with Package Applicable	18
% of Buildings with Package Applicable	82%
# of Buildings with Package Applicable & Cost-Effective	11
% of Buildings with Package Applicable & Cost-Effective	67%

Similarly, if a home has no roof insulation, or if existing insulation is severely compromised, we recommend also installing roof cavity insulation (see Table 3). Once the roof cavity is entered for insulation purposes, there are additional opportunities for air sealing. As such, in these instances we assume that building infiltration will be reduced by 30%. Here too, costs and savings both increase.

Roof Hatch Without Insulation

Uninsulated Basement Ceiling

Table 3: Starter Package Plus Roof Insulation

STANDARD MEASURES

- Reduce overall building infiltration by air sealing throughout main residence and basement.
- Insulate push-up roof hatch
- Insulate exposed heating and domestic hot water pipes in basement
- Install engineered low-flow showerheads and faucet aerators
- Replace incandescent bulbs with LED screw-in equivalent bulbs
- Insulate roof cavity (R46)
- Improve fresh air access for combustion equipment
- Install CO detectors outside boiler rooms
- Reduce DHW supply temperature

Upfront Cost:	$7,985.16 (Incl. H&S/O&M Measures up to $750)
Lifetime Savings:	$8,131.29
Simple Payback:	13.06 years
% annual utility savings:	18.0%
SIR:	1.02
# of Buildings with Package Applicable	19
% of Buildings with Package Applicable	86%
# of Buildings with Package Applicable & Cost-Effective	7
% of Buildings with Package Applicable & Cost-Effective	32%

In the instances where a building does not have any or functioning roof and basement insulation, we recommend installing both types of insulation (see Table 4). The higher air sealing costs and savings stemming from entering the roof cavity are included in these instances. If the Starter Package plus both types of insulation are installed, savings increase to 21%.

Roof Cavity With Poor Insulation

Basement Pipes Without Insulation

Table 4: Starter Package Plus Basement and Roof Insulation

STANDARD MEASURES

- Reduce overall building infiltration by air sealing throughout main residence and basement.
- Insulate push-up roof hatch
- Insulate exposed heating and domestic hot water pipes in basement
- Install engineered low-flow showerheads and faucet aerators
- Replace incandescent bulbs with LED screw-in equivalent bulbs
- Insulate roof cavity (R46)
- Insulate basement ceiling
- Improve fresh air access for combustion equipment
- Install CO detectors outside boiler rooms
- Reduce DHW supply temperature

Upfront Cost:	$10,637.07 (Incl. H&S/O&M Measures up to $750)
Lifetime Savings:	$10,311.00
Simple Payback:	14.72 years
% annual utility savings:	21.3 %
SIR:	1.0
# of Buildings with Package Applicable	17
% of Buildings with Package Applicable	77%
# of Buildings with Package Applicable & Cost-Effective	7
% of Buildings with Package Applicable & Cost-Effective	41%

As Tables 1-4 indicate, the identification of a Starter Package comprised of a standard set of energy efficiency measures that applied to and was cost-effective in 100% of our sample set was a clear validation of the study's hypothesis and demonstrates the potential to apply retrofit standardization to city's 49,000 attached 2 family masonry homes, and potentially to also all 650,000 one to four family homes. By eliminating audits, this standardized approach can make it easier for homeowners to access retrofit financing, easier for CBOs to ramp-up retrofits in their communities, and more profitable for small businesses to implement energy efficiency, while generating more retrofit jobs for local residents. If successful, retrofit standardization could be applied to more building types to capitalize on the building stock redundancies of urban and suburban communities.

F. Next Steps

Based on the Advisory Group's guidance and Pratt Center's recognition that confirmed actual savings are even more reliable than projections from high-quality energy audits, we modified the original study methodology to add a second phase through which we will implement the standard package in ten homes – most of which were audited during the first phase. To this end, Pratt Center will be selecting a number of homes to receive the Starter Package as well as the Starter Package plus one or both conditional measures when warranted. Pratt Center will continue to work with Bright Power to develop contractor guidelines and will contract with BrightHome Energy Solutions, a NYSERDA approved Home Performance Contractor, to install the retrofits. In-field data, specifically test-in and test out blower door tests that will measure air infiltration levels, as well as a planned contractor focus group, will help the team further refine the package.

Additionally, one year after the retrofits, we will interview homeowners from the second phase and review their utility bills to assess the savings and impacts of the standard package retrofit. A final report will be released after the one year post-retrofit savings have been assessed.

In the meantime, NYSERDA has indicated strong interest to test this standardized approach citywide and pilot the Starter Package in two-family homes across the five boroughs. Pratt Center will continue to work closely with NYSERDA and the Advisory Group on demonstrating the value and impact of a standardized approach to scaling up retrofits in New York City.

G. Conclusion

The results from Phase 1 are very encouraging. As we hypothesized, the redundancy in the building stock creates an opportunity to achieve economies of scale in the retrofit market. Finding such economies of scale is absolutely essential if we are to meaningfully reduce greenhouse gas emissions from our residential building stock. Utilizing the successful community-based outreach and marketing strategies we identified in our Block by Block work to promote a standard set of measures such as the Starter Package is an effective strategy to reduce energy consumption and costs for many low-income communities in New York City, New York State, and hopefully the United States. Cities were built in waves, block by block, and we need to leverage these similarities to retrofit our cities for the future.

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