NEW YORK CITY HOUSING AUTHORITY

Comprehensive Modernization Consultation White Paper

A Critical Approach for Preserving New York City's Public Housing

Prepared by NYCHA's
Capital Projects Division

January 2022

NEW YORK CITY HOUSING AUTHORITY

LETTER FROM OUR LEADERSHIP

For more than 85 years, the New York City Housing Authority (NYCHA), the nation's largest public housing authority, has provided New Yorkers with a decent, affordable home and a pathway to opportunity. NYCHA properties are home to 1 in 22 New Yorkers, across over 177,000 apartments. With a housing stock that spans all five boroughs, NYCHA is a city within a city.

Yet, NYCHA is facing unprecedented challenges. Decades of federal underfunding have resulted in massive capital investment needs and deteriorating conditions in the Authority's apartments. Day-to-day maintenance and repairs can no longer keep up, while the limited capital funding that NYCHA does receive, which has historically been used to upgrade or replace single components and assets, is spread too thinly across more than 300 properties. At latest estimate, NYCHA requires at least $40 billion in capital funding to fully renovate the Authority's developments – funds that would address the root causes of systemic issues, such as leaks and mold, lead-based paint, heating and hot water, elevators, and pests and waste management.

For NYCHA to make best use of new funding, the Authority must adopt a new approach to investment: comprehensive modernization. Comprehensive modernization of a property entails undertaking major renovations across building exteriors, multiple building systems, building and apartment interiors, and holistic site and grounds improvements, through a single, integrated project. This approach will allow the Authority's developments to be renovated more quickly, at a higher quality, and with better value for money, while comprehensively addressing all compliance requirements and the broader needs of residents and community partners. A whole-of-development renovation approach – with extensive resident engagement and resident input from early on in each project – can bring NYCHA campuses into the 21st century and preserve them for the next generations of public housing residents.

To inform the Authority's approach to comprehensive modernization, beginning in 2019 NYCHA organized an initial series of consultative workshops with resident representatives, partners in the planning, design and construction industries, NYCHA staff from various departments and disciplines, and other stakeholders. This white paper synthesizes ideas and insights from this consultation process to support the first set of comprehensive modernization projects NYCHA will undertake. Through these projects, the insights presented here will be tested and further developed to inform NYCHA's vision for comprehensive modernization across our portfolio. The white paper will therefore serve as a critical resource for NYCHA, residents, funders, design and construction contractors, and other stakeholders, as we jointly plan and implement these projects.

Current and future NYCHA residents and our great city deserve more than a piecemeal, uncertain commitment to property modernization. The strategic approach laid out in this white paper represents a critical step towards truly preserving New York City's public housing.

In partnership,

Gregory Russ
Chair & Chief Executive Officer

J. Steven Lovci
Executive Vice President of Capital Projects

CONTENTS

EXECUTIVE SUMMARY

Introduction to Comprehensive Modernization

Over the last few decades the New York City Housing Authority (“NYCHA” or “the Authority”) has had to adopt a largely ‘stop-gap’ capital investment strategy whereby the most deteriorated components of buildings and grounds at a property are prioritized for replacement or upgrade. While NYCHA has made efforts to shape these investments into more integrated projects, the Authority is now aiming to shift towards a comprehensive modernization approach as new levels of capital funding may be secured. This approach moves away from a focus on individual component replacement or even integrated systems upgrades towards full renovation of each property through a holistic, fully integrated project over several years.

A shift to comprehensive modernization builds on ongoing consultations with residents of our properties as well as industry experts since early 2019, which culminated in a comprehensive modernization design charrette, or planning workshop. Drafted in collaboration with industry partners, resident representatives, and other stakeholders, this white paper synthesizes ideas and insights from this consultation process to support the first set of comprehensive modernization projects NYCHA will undertake under a newly constituted program.

Through this program, NYCHA is developing enhanced resident engagement, project delivery, design and construction methodologies to effectively modernize the Authority’s properties. This includes a model for early and extensive resident engagement before and throughout each project, as well as utilizing innovative project delivery methods that can reduce timelines and costs, improve quality and durability, and strengthen resident employment and minority and women-owned business (M/WBE) opportunities.

In addition to delivering developments free of deferred maintenance and hazardous materials, comprehensive modernization will allow NYCHA to promote resident health, foster resident safety, enhance grounds and building accessibility, and increase energy conservation and climate change resiliency. Comprehensive modernization projects will also advance NYCHA’s goals of design and construction excellence, and value for money, ensuring that there is affordable, high-quality public housing stock for the current and next generations of residents, and contributing to resident employment opportunities and economic mobility.

Codes, Federal Requirements & Climate Adaptation

A thorough code analysis should be conducted for comprehensive modernization projects to fully understand any code requirements, substantial work triggers that may be activated, and other requirements, prior to full project scoping and design. Project scoping should also consider all federal requirements including those specified in the agreement NYCHA signed with the U.S. Department of Housing and Urban Development (“HUD”) and New York City (“the City”) in 2019 and various associated action plans agreed to remedy the deficient physical conditions in NYCHA developments, ensure that NYCHA complies with its obligations under federal law, reform the management structure of NYCHA, and facilitate ongoing cooperation.

Comprehensive modernization at NYCHA is taking place not only at a time of transformation for the Authority, but at a time of dramatic change in the global climate. To continue to provide livable housing for future generations, comprehensive modernization projects must consider the climate conditions and hazards that will be faced within the useful life of our buildings, including: extreme heat, continued cold snaps, extreme winds, rising groundwater levels and extreme rain. These hazards can directly impact buildings and residents, as well as supporting services and infrastructure through power outages, and disruptions to water supply, transportation system, and natural gas networks. NYCHA should draw on New York City’s Climate Resiliency Design Guidelines and NYCHA’s own experience from the Hurricane Sandy Disaster Recovery Program to ensure climate adaption is well-integrated in comprehensive modernization projects.

Resident Engagement & Impact

The Authority's approach to resident engagement for comprehensive modernization projects will build on policies, procedures and approaches initiated in recent years within NYCHA's Permanent Affordability Commitment Together (PACT) program and Capital Projects programs, as well as by other partners, to ensure these projects best meet resident's housing needs and contribute to their economic livelihoods. The engagement model should involve early engagement and partnership with residents, well in advance of design and construction activities, and throughout project planning, community visioning and design, and construction. A range of engagement models and tools from live meetings and design charettes through to online webinars, door-to-door communication efforts, resident surveys, signage, and post-construction evaluations should also be utilized.

Each comprehensive modernization project's outreach and engagement strategy should be tailored to the specific needs of the residents impacted and the surrounding community stakeholders. Independent technical advisors, stakeholder advisory groups, community construction liaisons, and community-based construction plans, are four approaches that will be explored in comprehensive modernization projects to support engagement. Wherever NYCHA can take input from residents in regards to design elements, procurement documents, contractor evaluation and selection, resident engagement, construction and relocation planning, format and timing of construction updates, it should be proactively included in the planning process. NYCHA anticipates developing additional engagement approaches, requirements, and guidance for the comprehensive modernizations based on resident input and project experience.

Modernization Strategies

The scope of a comprehensive modernization project should at a minimum typically include abatement of hazardous materials (lead, mold, and asbestos) where applicable, accessibility and security enhancements, envelope work to decrease air and moisture infiltration, upgrades to heating, hot water, ventilation and cooling systems, new kitchens and bathrooms, upgrades to electrical systems, replacement of piping in chase walls and plumbing systems, elevator replacements, improvement of waste management systems, new fire suppression systems and renovations to apartment interiors and common spaces. Where funding is available, projects could also include additional enhancements to apartment interiors and common areas, building exteriors and grounds, and decarbonization, energy and water efficiency investments.

Through the comprehensive modernization consultation process, modernization strategies and innovations for specific scope areas were explored more in depth and are detailed in this white paper. These include: grounds, entryways and accessibility; façades and building envelopes; roofs; indoor environments; heating, ventilation and cooling; and electrical systems.

Project Planning, Delivery Methods & Phasing

Historically, HUD recommends that Public Housing Authorities ("PHAs") conduct a statistical sampling of the portfolio to estimate the capital accrual and backlog needs. NYCHA performs Physical Needs Assessment ("PNA") every five years to estimate capital needs accrual and guide long-term capital planning as well as annual project budgeting and scoping. The methodology envisions addressing individual deficiencies and replacement of systems that have reached their expected useful life, and therefore may not be as meaningful for estimating capital needs in the context of integrated renovations or comprehensive modernization, nor application of new technologies with energy and operating efficiencies rather than replacement-in-kind.

By re-envisioning the PNA and NYCHA's capital needs information more broadly, the Authority should aim to move to a more holistic, life-cycle planning model for comprehensive modernizations. This approach will inform project scoping and prioritization as well as selection of appropriate procurement and project delivery methods to maximize the effectiveness of the comprehensive modernization project delivery, including Design-Bid-Build, Design-Build and its variants, and Construction Manager at Risk (if NYCHA is granted authorization to utilize this method in the future).

Phasing of design, pre-construction, and construction work within each project also impacts the effectiveness of the project delivery, including the overall project duration and cost, residents' day-to-day lives during construction and when residents may not be able to access certain areas of a property or building or remain in their units, as well as property staff's access to parts of the property and buildings during construction. In particular, temporary moves of residents to facilitate construction work is anticipated to be the most challenging component of comprehensive modernization projects.

NYCHA's goal is to minimize temporary resident moves in number and duration as much as possible, and maximize work being done with residents-in-place. Where such moves are required, NYCHA should consider various available solutions: moves within the resident's development or to other NYCHA developments, short-term moves to hotels or use of private accommodation within the neighborhood, use of temporary modular housing, and new building construction. Each comprehensive modernization project will have unique characteristics that impact the mix of solutions available, and each family's circumstances and composition will need to be considered in selecting appropriate solutions.

01 INTRODUCTION

1.1 Background & Context

HUD Agreement

On January 31, 2019, the U.S. Department of Housing and Urban Development ("HUD"), the New York City Housing Authority ("NYCHA" or "the Authority"), and New York City ("the City") signed an agreement ("HUD Agreement") to remedy the deficient physical conditions in NYCHA developments, ensure that NYCHA complies with its obligations under federal law, reform the management structure of NYCHA, and facilitate cooperation and coordination between HUD, NYCHA, and the City during the term of this agreement. Under the HUD Agreement, the City will provide a total of $2.2 billion dollars in incremental funding over the next 10 years for capital investments to address issues related to lead-based paint, leaks & mold, elevators, heat and hot water, and pests and waste management.

NYCHA estimates that renovation of all of NYCHA's 177,000+ apartments increases the capital needs to $40 billion, before considering additional energy and water efficiency as well as climate change resiliency investments.

Category	Cost	Types of renovations
Mold	$15.2B	Piping systems, roofs and façades, kitchens & baths, ventilation systems
Lead abatement	$1.6B	Lead removal, enclosure, and/or encapsulation
Heating systems	$6.6B	Heating system replacements
Elevator systems	$2.5B	Elevator cab replacements, mechanical equipment
Pests & waste	$0.6B	Waste yards, interior compactors, exterior equipment
Other basic repairs	$2.2B	Gas risers, security cameras, lobbies, doors and entrances, & more
All other items	$10.9B	Common areas, landscaping, external cladding, windows, apartment reconfigurations, & more
TOTAL	**$40B**	

A Blueprint for Change

In July of 2020, NYCHA launched A Blueprint for Change ("the Blueprint"). One component of the Blueprint is the Authority's strategy for raising capital funds to holistically address all elements of compliance and basic housing quality standards at NYCHA properties. An important piece of this stabilization strategy is the creation of a new public entity – the Public Housing Preservation Trust ("Trust") – to enable raising of the capital funds needed as well as effective delivery of large-scale renovation projects at NYCHA developments.

While the proposed legislation for the Trust is still being deliberated on by the New York State Legislature, the Blueprint also marks a shift from a component-based capital investment approach to a comprehensive modernization approach. Given the Authority's prolonged capital funding deficit, over the last few decades NYCHA has had to adopt a largely 'stop-gap' capital investment strategy whereby the most deteriorated components of buildings and grounds at a property are prioritized for replacement or upgrade. Projects have fallen into four main areas: (1) building envelope projects including exteriors like roofs, masonry, and windows; (2) building systems such as heating, elevators, plumbing, gas riser, underground steam and water distribution lines, waste compactors; (3) apartment and building interior renovations, and (4) grounds and other exterior site security and site improvements.

NYCHA has made every effort to leverage all recent funding to complete more holistic projects; for example, when upgrading a heating plant at a development, ancillary work such as repairing the underground distribution of heating service is identified and adding in remote monitoring systems and temperature sensors is considered. The comprehensive modernization approach moves away from a focus on individual component replacement or even integrated systems upgrades towards full renovation of a property through a holistic, fully integrated project over several years.

NYCHA-CCOP Joint Letter

To advance the shift to this approach, in September 2021, NYCHA and the Citywide Council of Presidents (CCOP) of Residents Associations signed and publicly issued a joint letter urging the United States Congress to fully fund NYCHA's public housing infrastructure, modernization and capital projects for the first time in 40 years against the backdrop of the $40 billion deficit. The letter outlines the establishment of a transparent set of criteria for determining the order of how infrastructure and property renovations can proceed through a comprehensive modernization approach, and a Site Restoration List based on these criteria to determine how NYCHA will sequence property renovations if NYCHA receives the full or a partial allocation of federal funds. This agreement between NYCHA and CCOP also agrees a process for revisions to this list annually with consensus between CCOP, the Resident Advisory Board ("RAB"), and the NYCHA Board.

Comprehensive Modernization Program

The resident engagement, project delivery, design and construction methodologies to effectively modernize the Authority's properties are now being developed and implemented through NYCHA's newly constituted Comprehensive Modernization program. The program will ensure early and extensive resident engagement and partnership before and throughout each project. The program also aims to utilize innovative project delivery methods that can reduce timelines and costs, improve quality and durability, and strengthen resident employment and minority and women-owned business (M/WBE) opportunities.

In addition to delivering developments free of deferred maintenance and hazardous materials, comprehensive modernization will move past compliance and stabilization to support NYCHA's goals of promoting resident health, fostering resident safety, enhancing grounds and building accessibility, and increasing energy conservation and climate change resiliency. The Program will also further NYCHA's goals of design and construction excellence, and value for money, ensuring that there is affordable, high-quality public housing stock for the current and next generations of residents, and contributing to resident employment opportunities and economic mobility.

The scope of a comprehensive modernization project should at a minimum typically include abatement of hazardous materials (lead, mold, and asbestos) where applicable, accessibility and security enhancements, envelope work (façade and roof) to decrease air and moisture infiltration, upgrades to heating, hot water, ventilation and cooling systems, new kitchens and bathrooms, upgrades to electrical systems, replacement of piping in chase walls and plumbing systems, elevator replacements, improvement of waste management systems, new fire suppression systems and renovations to apartment interiors and common spaces. Where funding is available, projects could also include additional enhancements to apartment interiors and common areas, building exteriors and grounds, and decarbonization, energy and water efficiency investments.

Comprehensive Modernization Consultation

Since early 2019, NYCHA has held ongoing consultations with residents of our properties as well as industry experts to develop ideas for the design and implementation of a comprehensive modernization program. These consultations culminated in a comprehensive modernization design charrette, or planning workshop, including NYCHA resident associations, NYCHA staff from various departments and disciplines, and representatives from the American Council of Engineering Companies (ACEC), the American Institute of Architects (AIA), and Construction Management Association of America (CMAA).

This white paper synthesizes ideas and insights from this consultation process to support the first set of comprehensive modernization projects NYCHA will undertake, and was drafted in collaboration with industry partners, resident representatives, and other stakeholders. The white paper outlines important factors to be considered in planning and implementing the first set of comprehensive modernization projects. The insights presented here will be tested and further developed to inform NYCHA's vision for comprehensive modernization across our portfolio. The white paper will therefore serve as a critical resource for NYCHA, residents, funders, design and construction contractors, and other stakeholders, as we jointly plan and implement these projects.

1.2 Goals of Comprehensive Modernization

The specific goals of comprehensive modernization further explored in this White Paper include:

01. **Compliance:** Bring NYCHA buildings into compliance with all local, state, and federal laws and regulations, including the HUD Agreement, and the need to adapt to climate change.

02. **Resident Engagement:** Involve Tenant Associations and individual tenants from the beginning even before funding, contracts, or projects are in place, to foster buy-in and mutual trust, ensure resident priorities and concerns are integrated into projects from inception. Engage and partner with residents in prioritization of scope, design requirements and preferences, and construction and temporary planning. Assist residents to secure advisory and social support services. Promote collaboration for the continual improvement of building systems and maintenance processes.

03. **Grounds, Building Exteriors & Interiors:** Transform sites, buildings, and units to accommodate the full range of users, including those with limited mobility and an aging population. Control the movement of heat, air, and moisture, thus improving the thermal properties and indoor air quality of the buildings and diminishing mold. Improve the attractiveness, functionality, and durability of NYCHA apartments and common spaces. Use healthy, long-lasting, low-impact materials and products.

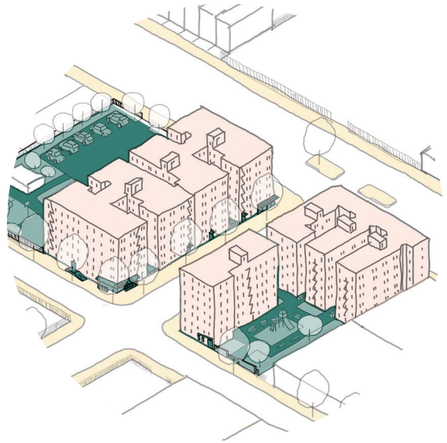
04. **HVAC & Electrical:** Utilize new, efficient technologies that decentralize mechanical systems and provide year-round climate control, thereby: (1) distributing risk from outages; (2) providing residents greater knowledge of and control over their living environments; (3) streamlining maintenance considerations; and (4) reducing maintenance costs. Introduce leading decarbonization technologies. Retrofit NYCHA buildings for sub-metered electrification for the twenty-first century, increasing the power supply capacity of every building and each unit to the extent that is financially feasible.

05. **Project Planning, Delivery Methods & Phasing:** Evaluate capital needs of a property in an integrated way, with holistic life-cycle planning. Utilize more efficient project delivery methods that can also increase quality of work and value for money, and support scaling of the program to a large number of sites over time. Ensure robust phasing of design, pre-construction, and construction work for effective project delivery and minimize disruption to residents' day-to-day lives during construction.

1.3 Building Typologies

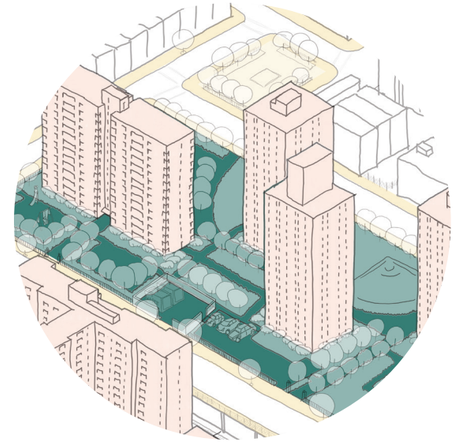
As a large-scale design and construction program, comprehensive modernization must address site-specific interventions and construction methods across the multiple typologies in NYCHA's public housing portfolio. The four different building typologies are overviewed below.

Pre-War Buildings (or "Walk-Ups)
Originally constructed as individual buildings, they became campuses under NYCHA. Building façades are parallel to the street and placed along the property line or minimally set back. Buildings are generally six floors or fewer and usually match the height of the surrounding neighborhood. Entries and lobbies face the street and are either located at the sidewalk level or raised a few feet and reachable by stairway (stoops) and ramp. Community facilities are sometimes found at the ground floor level. Lot coverage is high, often up to 80 percent. Open spaces are limited to the rear yard, which can be used as either service areas (often waste management) or common space for residents.

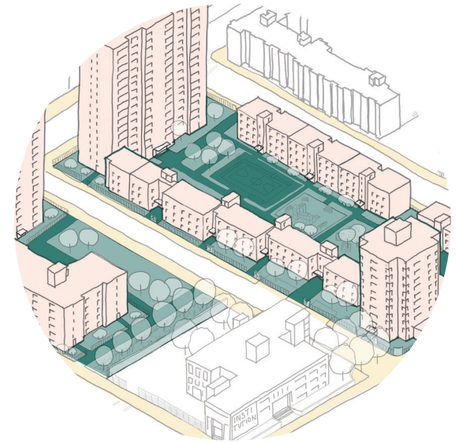


Early Tower-in-the-Park Buildings (or "Mid-rise Campus")
These campuses are typically multiple blocks to form superblocks and interrupt the original street grid. The building façades are usually set back from the street and can be either parallel or at an angle. Buildings are generally six floors or fewer and usually match the height of the surrounding neighborhood. Lobbies often face away from the street towards the interior of the campus and are accessed through pathways extending from the sidewalk. Some campuses have ground-floor retail or community facilities facing the street. Given the size of the overall campus, building lot coverage is low (20–30 percent) providing vast open spaces. Buildings are set back from the street creating residual open spaces that are typically fenced off and landscaped. Larger landscaped open spaces are located at the center of the campus where active uses (such as playgrounds and sports courts) take place.

Tower-in-the-Park Buildings (or "High-rise Campus")
Campuses typically extend multiple blocks to form superblocks and interrupt the original street grid. Often, multiple campuses form larger clusters covering large swaths of a neighborhood and can be read as one campus. Buildings are set back from the street and can be either parallel or at an angle to it. Building height varies within a campus or from one campus to another, ranging from 6 to 30 stories. Lobbies face either the street or the center of the campus. They have a network of pathways that also lead to other buildings on the campus, shared service areas, and amenities (such as playgrounds, sports courts, and community centers). Given the size of the overall campus, building lot coverage is low (20-30 percent) providing vast open space. Open areas between the sidewalks and the buildings are typically fenced off and landscaped or used for parking and service areas. Larger landscaped open spaces located at the interior of a campus host active uses (playgrounds, sports courts) or large landscaped open spaces.



Scattered Site Buildings
Campuses rarely extend over more than one block and do not interrupt the street grid. Building façades are parallel or aligned to the street. Building heights vary within a campus, or from one campus to another. Taller buildings (around 20 stories high) usually front on wider streets while lower height buildings (three to four stories high) front the side streets or interior of the blocks. Entries and lobbies generally face the street and are either located at the sidewalk level or raised a few feet, accessible through stairs and a ramp. When building entrances are inward facing, they can be reached through pathways that cross the campus. Building lot coverages vary. When buildings are set back, the residual spaces between the buildings and the sidewalk are fenced off and landscaped to preserve privacy for ground floor apartments. The open spaces in the center of the campus are often activated with programs. Sometimes open spaces with direct access to streets are used for parking or service areas.



Since the majority of NYCHA campuses to fall within a comprehensive modernization program will be mid or high-rise Tower-in-the-Park configuration, designers and construction contractors will utilize many strategies that are primarily applicable to that typology. However, all NYCHA typologies found in the portfolio will need to be addressed, and solutions will be tailored for each specific type. It is important that the design and construction methodologies adopted provide a scalable solution for the larger portfolio.

1.4 Assessment Tools

Each comprehensive modernization project will require an assessment of a site's unique opportunities and challenges. The constitutive components of holistic modernization will differ across the NYCHA portfolio according to a range of variables including, but not limited to, the following: building typology, site and building existing conditions, compliance requirements, resident priorities and demographics, neighborhood and local community, funding availability, needs and constraints related to temporary resident moves during construction, building performance goals and expectations, energy and resource efficiency priorities, climate hazard (heat, rainstorm, and flood) preparedness, service outage readiness, and maintenance requirements.

In order to assist stakeholders in the planning for a particular site, seven assessment areas and related tools were identified which can be used to evaluate potential improvements, to pinpoint divergent and co-beneficial opportunities, and to prioritize the components of each modernization. These seven areas of focus will also inform the entire program.

01. **Resident experience and impact:** Residents of NYCHA buildings are the essential constituency of comprehensive modernization. Accordingly, site-specific plans should address resident engagement, participation, and impact before, during, and after capital project delivery. Through NYCHA's established resident outreach processes, residents' ideas and priorities should be integrated into the scope of comprehensive modernization project, and each improvement should be considered from the vantage of residents, whose buy-in and behavior will determine whether the capital project and modernization efforts succeed in the long-term.

02. **Funding availability and need:** Each site will have a budget and a unique set of "must-do" improvements, which often also build on recent investments. NYCHA staff and consultants should weigh the costs and benefits of each possible improvement so that the goals of comprehensive modernization are achieved to the highest possible degree on the available budget.

03. **Operations and maintenance:** New building systems will require NYCHA residents to learn new tools and NYCHA staff to integrate new Standard Operating Procedures. Preparing for these altered relationships will require foresight on the part of those developing comprehensive modernization plans. Building upgrades should be functional and easy to use, should require minimal in-unit access in case of repair, and should be cost-effective over the long-term. When evaluating systems, life-cycle costs that include operational costs should be used.

04. **Energy usage, sustainability, and resiliency:** The pursuit of comprehensive modernization aligns with the Authority's existing legal obligations and goals. Local Law 97 directs the Authority to "make efforts to reduce greenhouse gas emissions by 40% by the year 2030 and 80% by the year 2050 (80X50), relative to such emissions for calendar year 2005." Moreover, the Agency is determined to mitigate risk from, and prepare for, future floods, storms, heat events, and service outages. Strategies to address these concerns are detailed at length in the NYCHA Climate Mitigation Roadmap, the Sustainability Agenda Update, the Authority's Climate Adaptation Plan and in this document.

05. **Embodied carbon footprint:** As New York City's largest landlord, the Authority is committed to reducing embodied as well as operational carbon emissions. In developing a comprehensive modernization project, NYCHA staff and consultants should identify embodied carbon "hot spots" in building materials and should seek to reduce overall emissions to the extent that is financially and technologically feasible. Agency staff and consultants may utilize off-the-shelf analyses, such as Environmental Product Declarations ("EDPs"), as well as bespoke evaluations, such as Whole Building Life Cycle Assessments ("WBLCAs").

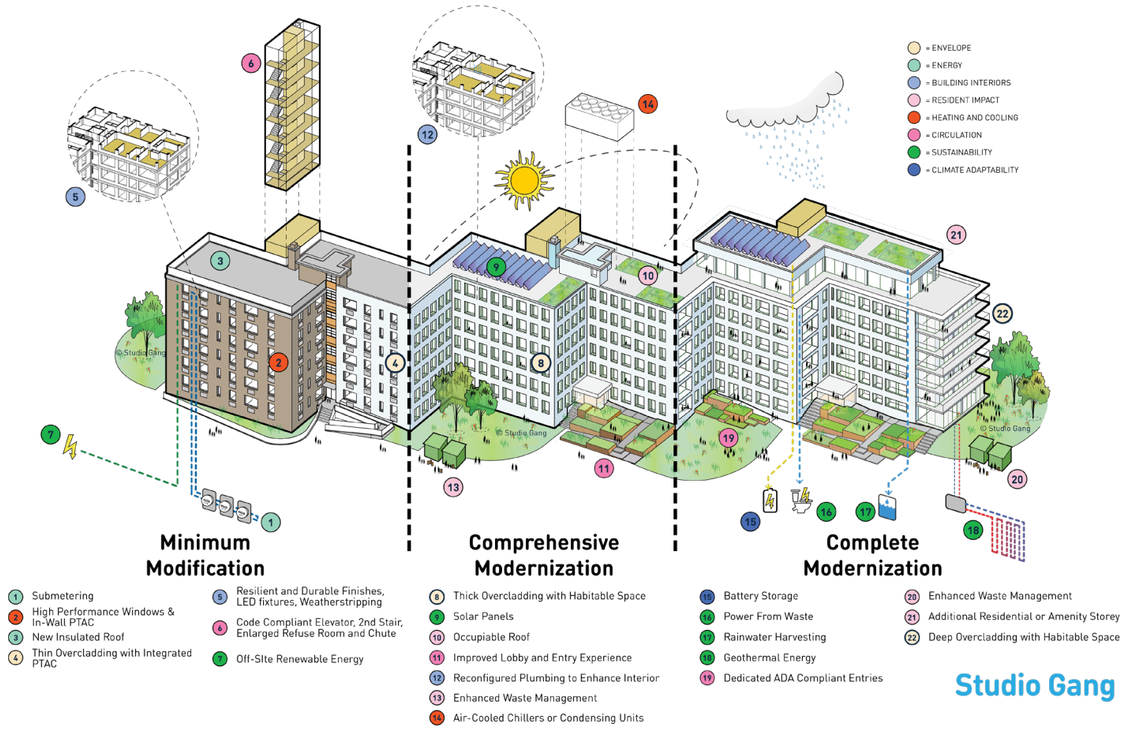
06. **Long-term performance and adaptability:** Comprehensive modernization plans should address concerns that may arise over the lifecycle of each building within a site. This includes risks from climate change, changes to resident demographics, and operational carbon output, among other topics. For example, at buildings where there is substantial risk of flooding, NYCHA staff and consultants should consider the permanent relocation of first-floor units as well as elevating all critical infrastructure. Additionally, for buildings with aging residents, comprehensive modernization plans should speak to long-term accessibility needs while understanding the restraints of the existing structures.

07. **Phasing and capital delivery:** Scaling a comprehensive modernization program will require use of improved vendor outreach and procurement approaches as well as more flexible project delivery methods, including NYCHA's recently granted Design-Build authority from New York State. Projects will need to be phased given funding timelines, and capacity levels within NYCHA and the industry. Phasing of design, pre-construction, and construction work within projects will be critical for effective project delivery and should consider a range of options to minimize resident disruption including resident-in-place improvement, temporary on-site and off-site accommodation, and new building construction. Project delivery formats and phasing methodologies should be chosen and programmed considering each site's and the residents' specific needs and priorities.

1.5 Weighing Needs, Opportunities & Risks

Each of the goals of comprehensive modernization explored in this White Paper should be considered concurrently although no project will implement every idea described here. In order to determine which ideas will be implemented in each project, Authority staff and consultants should complete a thorough study of available options on a per site and per building basis. Selecting viable proposals within each goal requires Authority staff and consultants to analyze the risks associated with each site and what mitigation strategies could be for each of those. For this purpose, “risk” is defined as “an uncertainty or exposure that can have an adverse impact in delivering the project”.

Thorough site studies and documentation should be undertaken to establish strategies to avoid or mitigate interventions with high risk. Due to the scope of work these projects will cover, a significant level of residual risk is anticipated even with strong risk mitigation measures; for example, high-impact interventions that allow for improved resident experience, construction efficiencies, and strong value-for-money, but for which risks cannot be fully mitigated. As part of developing this White Paper, a Risk Workshop was held in September 2021 to identify and assess key anticipated risks in comprehensive modernization projects and that may impact specific projects. These largely fell into categories of scoping, process and workflow, internal and external communications, and market conditions. A preliminary risk register based on the workshop is presented on the following page.



Comprehensive Modernization case study by industry working groups © courtesy Studio Gang

Program / Project Risks	Likelihood /Severity	Impact	Mitigation Measures
Markey Capacity/Interest: Interested vendors do not have adequate contractors to complete this work with the necessary skillset, at reasonable and competitive pricing, and/or utilizing the project delivery methods that would be optimal for NYCHA.	High	Primary: Cost Secondary: Schedule	1. Perform a Market Study to inform project approach and phasing to allow industry capacity to scale with program needs. 2. Issue a Request for Information from the industry to communicate with potential partners, stimulate interest in the program, and gather input to enhance procurement approaches to best mitigate market capacity/interest issues. 3. Explore staggering of projects / procurements.
Resident Moves/Relocation: The intensive nature of this construction work may require residents to temporarily move from apartments. Residents will be hesitant to temporarily relocate out of their homes, fear displacement or otherwise mistrust NYCHA, and require extensive support and administration resources to facilitate the moves.	High	Primary: Cost Secondary: Schedule	1. Communicate the need for temporary relocation to residents early, prior to initiating any design and construction work. 2. Collaborative establish a Residents’ Rights and Temporary Move contract that NYCHA signs with each household. 3. Dedicate a team of professionals to work with residents on suitable accommodations, social services, and moving services that NYCHA will pay for.
Scope Additions: Improvements may trigger newer building codes and larger upgrades of life safety, resiliency, resource efficiency and other building codes.	High	Primary: Cost Secondary: Scope Reduction	1. Perform a code analysis for the program and each site prior to design, to fully understand requirements. 2. Close coordination with regulatory authorities from early in the program and each project.
Utility Provider Coordination: NYCHA construction projects can result in utility companies having to self-perform work that needs to be coordinated very closely with the NYCHA vendors undertaking design and construction.	High	Primary: Schedule Secondary: Cost	1. Maintain regular coordination meetings and points of contact to communicate with the utility companies. 2. Provide forward looking information on projects to utilities for resource planning.
Maintaining Critical Services during Construction in an Occupied Building: With fully occupied buildings, full systems replacement will be challenging without extensive outages and shutdowns of critical services.	High	Primary: Schedule Secondary: Cost	1. Provide contract mechanisms for ensuring services can be provided even when electrical, heat, hot water, or other interruptions are needed or may unexpectedly occur. 2. Communicate outages to residents per Federal Monitor guidelines and add these parameters to contract documents. 3. Phase work so that interruptions are limited as much as possible for set hours per day, or perform work on off hours to minimize the impact to residents.
Commodity Price Increases: The construction market is experiencing inflation of commodities prices due to supply chain disruptions (COVID-19).	Medium	Primary: Cost (in the form of higher bids) Secondary: Scope Reduction	1. Ensure that the impact of commodity price fluctuations is as well-mitigated as possible through securing supplies in bulk and other means, and that risk-sharing is clearly delineated in contractual terms with vendors. 2. Closely monitor bid prices against estimates and regularly update cost estimates for future program and project planning. 3. Consider retaining some inflation risk if bids are coming in very high or if there is limited market interest.
Resident Impact: The proposed scope of work occurs inside the resident apartments, at resident entrances and on the grounds, which may require complex phasing and coordination and cause project delays.	Medium	Primary: Schedule Secondary: Reputation	1. Establish and follow a resident engagement plan that keeps residents informed and ensures buy-in and cooperation (e.g. monthly communication at a minimum, online portal of documents, resident liaisons) 2. Identify activities in the construction project schedules which may excessively disrupt residents, and identify and prioritize alternatives which are more resident-friendly. 3. Ensure adequate signage on the property to let residents know what work is occurring, clearly delineates unsafe work areas, and make site navigation clear.

02 CODES, FEDERAL REQUIREMENTS & CLIMATE ADAPTATION

2.1 Building Industry Standards

Substantial Work Triggers

Comprehensive modernization will address the most critical physical concerns of the buildings and grounds and provide facilities that are safe, secure, and better aligned with the NYC Building, Energy Conservation, and Fire Codes, as well as relevant federal standards. In addition, the expansive scope of comprehensive modernization projects may trigger specific requirements applicable to “substantial improvement” or “substantial reconstruction” projects. For example, according to the NYC Building Code, a “substantial improvement” is defined as any repair, reconstruction, rehabilitation, addition, or improvement of a building or structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the improvement or repair is started. If the structure has sustained substantial damage, any repairs are considered substantial improvement regardless of the actual repair work performed.

In addition, under NYC Local Law 86 of 2005, and NYC Local Laws 31 and 32 of 2016, “substantial reconstruction” means a capital project that includes (i) heating system replacement, (ii) work on at least 75 percent of dwelling units contained within such building, including but not limited to fixture replacements in kitchens and bathrooms, and (iii) substantial work on the building envelope, including but not limited to the addition of building wide air sealing measures performed in conjunction with window replacements on at least 50 percent of total glazing, addition of roof insulation on 100 percent of the roof or the addition of at least 50 percent wall insulation. “Substantial reconstruction” projects may trigger additional compliance requirements around reduce potable water consumption and the NYC Overlay of the Enterprise Green Communities criteria as further detailed below.

A thorough code analysis will be conducted for each comprehensive modernization site and project to fully understand if these or other requirements may apply prior to full project scoping and design.

Enterprise Green Communities and WELL Certification

Enterprise Green Communities (“EGC”) supports building practices that lead to healthy, efficient, and environmentally responsible homes. Through its PACT and Build to Preserve programs, NYCHA already requires, at minimum, the recently updated 2020 version of the Enterprise Green Communities criteria. EGC certification is a proven, cost-effective standard for creating healthy and energy-efficient homes. As NYCHA pursues comprehensive modernizations, the EGC criteria, designed specifically for affordable housing communities, will provide a threshold for achieving national green building best-practices and meeting carbon emissions reduction benchmarks. While compliance with NYCHA’s legal requirements is the priority in a comprehensive modernization, EGC certification with the NYC Overlay should be a goal wherever technically and financially feasible.

EGC’s 2020 Criteria was updated to reflect a partnership with the International WELL Building Institute (“IWBI”). WELL Buildings demonstrate a comprehensive and interdisciplinary approach to meaningfully address complex issues related to human health and well-being. Affordable housing that is 2020 Enterprise Green Communities-certified will also earn WELL Certification.

2.2 Federal Requirements & HUD Agreement

All comprehensive modernization projects shall be consistent with HUD's Public Housing Modernization Standards Handbook, PHAS and Annual Plan Compliance Requirements, and the HUD Agreement. HUD's Modernization Standards Handbook provides design, construction, and environmental criteria for the modernization of existing public housing stock. These standards establish a basis for evaluating the physical condition and energy efficiency of the housing stock to determine current rehabilitation needs in accordance with federal housing objectives. The handbook stipulates that any work will also need to apply with the local building codes.

As explained earlier, the HUD Agreement is a commitment to changing the Authority's trajectory and putting into place the changes necessary to ensure it is an effective landlord and a provider of safe, sanitary, and affordable housing. The HUD Agreement focuses on six "pillars": (1) lead-based paint, (2) mold, (3) pests and waste, (4) heat, (5) elevators, and (6) annual inspections and Public Housing Assessment System scores ("PHAS") (i.e. maintaining HUD's Uniform Physical Condition Standards ("UPCS")). The HUD Agreement sets forth specific performance standards and milestones that NYCHA must achieve in the interim to improve compliance and conditions under each pillar area. The HUD Agreement also established three new Departments – Compliance, Environmental Health & Safety ("EH&S"), and Quality Assurance ("QA") – to oversee NYCHA's compliance with the Agreement and other laws, rules, policies, and procedures.

NYCHA has developed and begun implementing Action Plans to mitigate non-compliance and deficient conditions in NYCHA buildings in each of these pillar areas. These Action Plans involve a combination of operational and capital investments in developments to address repairs across the pillars. NYCHA can only achieve full compliance with the HUD Agreement through significant capital investments. Through comprehensive modernization projects, NYCHA will leverage this investment in NYCHA's buildings for compliance purposes to also achieve the Authority's portfolio goals for fully meeting residents' needs, design excellence, energy efficiency, sustainability and climate adaptation.

Below is a brief summary of the current approved and draft Action Plans, as well as other related work necessary to achieve compliance with the HUD Agreement. Consultants contracted on NYCHA's comprehensive modernization projects should conduct a thorough analysis of the Agreement and relevant improvements to demonstrate that they are meeting if not exceeding agreed-upon standards across all six pillar areas, as well as reporting.

Lead Action Plan

The Lead Action Plan has eleven proposed individual actions. Key provisions in the Lead Action Plan are a new program to better manage lead paint in units with children under 6, and new measures to improve the oversight of lead activities. In addition to the Action Plan, NYCHA must certify to compliance every six months with certain federal lead rules. NYCHA is also undergoing a voluntary $100 million initiative to individually X-Ray Fluorescence (XRF) test 134,000 apartments to find and target lead in apartments at the federal standard of 1.0 mg/cm^2. NYCHA is working on plans to transition to the new, more stringent standard for lead-based paint in New York City, which goes into effect on December 1, 2021. The new standard is 0.5 mg/cm^2.

Comprehensive modernization projects will include complete lead abatement – of units, common areas, residential buildings, and building sites, including exterior areas and community centers – in compliance with the standards dictated in "Exhibit A – Requirements for Lead-Based Paint" of the HUD Agreement.

Mold Action Plan

The approved Mold Action Plan has seventeen individual actions. Key provisions in the Mold Action Plan include hiring a significant number of new staff and contractors to address mold, leak, and moisture problems; repairing or replacing roof fans; addressing long-term work orders; developing and enforcing mold and leak procedures; and staff training and developing a mold campaign to build awareness about the mold busters process and tips for preventing the mold. The Mold Action Plan is closely tied to NYCHA's pre-existing obligations under a federal consent decree in the Baez vs. NYCHA civil action.

Comprehensive modernization projects will include complete remediation of existing mold and moisture issues and implement physical and procedural improvements in order to comply with the mold subsection of "Exhibit B – Requirements for Heat, Mold, Elevators, Pests, and Annual Inspections" of the HUD Agreement.

Pest and Waste Action Plan

The Pest and Waste Action Plan has 60 individual actions. Key provisions in the Pest and Waste Action Plan include the establishment of a new standalone waste management department, the development of a NYCHA Pest Infestation Index, and the undertaking of improved procedures for pest treatment and prevention.

Comprehensive modernization projects will include physical and procedural improvements in order to comply with pest management targets described in paragraphs 39-45 of "Exhibit B – Requirements for Heat, Mold, Elevators, Pests, and Annual Inspections" of the HUD Agreement.

Comprehensive modernization projects will achieve pest population reductions to the level stated in paragraph 37 of "Exhibit B – Requirements for Heat, Mold, Elevators, Pests, and Annual Inspections" of the HUD Agreement (i.e. 50% of 50% of the existing pest population, or a 75% reduction).

Heat Action Plan

The Heat Action Plan advances protocols and projects focused on the following areas of concern: heating outage response; resident communication; evaluation and improvement; and operations infrastructure for heating outage response. Each development has an individual heat action plan. Additionally, the Heat Action Plan establishes an oversight role for NYCHA EH&S to conduct root cause/failure analyses following outages that meet certain parameters.

Comprehensive modernization projects will include physical and procedural improvements in order to comply with the heat standards described in paragraphs 2 and 10-13 of "Exhibit B – Requirements for Heat, Mold, Elevators, Pests, and Annual Inspections" of the HUR Agreement.

Elevators Action Plan

The Elevator Action Plan adopts protocols and projects addressing the following areas of concern: elevator criticality and risk mapping; elevator outage response; resident communications; interactions with internal and external stakeholders; contracts and warranties; and performance improvement plans, including capital commitments.

Comprehensive modernizations projects will include physical and procedural improvements to elevators in order to comply with paragraphs 24-27, 29, and 30-34 of "Exhibit B – Requirements for Heat, Mold, Elevators, Pests, and Annual Inspections" of the HUD Agreement.

PHAS and Annual Inspection Action Plans

The PHAS Action Plan details a series of large-scale staff training programs on HUD's Uniform Physical Conditions Standards ("UPCS") building standards, employee outreach and communication efforts, inspection and maintenance protocols, and compliance monitoring initiatives.

The Annual Inspection Action Plan proposes five actions: implementing a new standard procedure for annual inspections; improving resident engagement efforts; increasing vendor capacity; increasing inspection oversight; and developing a working group to prepare for HUD's forthcoming NSPIRE building standards.

Comprehensive modernization will achieve compliance with HUD's UPCS building standards (or NSPIRE standards if promulgated and adopted by HUD) in apartments, common areas, mechanical rooms, grounds, and exterior areas.

Tracking and Reporting

NYCHA has six cross-functional Pillar teams to manage the various initiatives set forth in the Action Plans. These teams are comprised of representatives from various NYCHA departments, including Operations, Healthy Homes, Compliance, EH&S, Strategy and Innovation, CPD, Communications, Intergovernmental, Real Estate Development, Human Resources, IT, Finance, Legal, and Community Engagement and Partnerships, and the Federal Monitor appointed through the HUD Agreement, and HUD. The Pillar Teams meet on a bi-weekly basis and maintain Quad Charts of their various projects and initiatives. The Pillar Teams also meet on a periodic basis with a senior Risk Advisory Committee to discuss progress and obstacles to the Action Plans.

In addition, NYCHA's progress in these areas is monitored through Quarterly Reports issued by the Federal Monitor and released publicly on their website. Furthermore, Compliance, EH&S, and QA have established various monitoring programs for each of the pillar areas to assess non-compliance and any necessary corrective actions for each of the pillar areas.

City Capital Action Plan and State Grant Disbursement Agreement ("GDA") Action Plan

Under Section VII, Paragraph 63(d) – (e) of the HUD Agreement, over the next ten years, the City of New York will provide a total of $2.2 billion in incremental funding for capital expenses to support NYCHA's compliance with the HUD Agreement. The Action Plan for spending of the City Capital funds proposes five improvement project types: 1) comprehensive lead and mold abatement, 2) phased lead abatement across the entire portfolio, 3) new heating plants, 4) Elevator escalation costs, and 5) waste management infrastructure. Each of these capital improvement projects are connected to the efforts described in the Action Plans above.

In addition, the State Grant Disbursement Agreement ("GDA") Action Plan governs NYCHA's obligations with respect to $450 million on capital funding from the State of New York. The funding is allocated to capital improvement projects, including replacement (and in some cases relocation) of 108 boilers at twenty-three (23) developments and replacement of 148 elevators at ten (10) identified NYCHA developments, also aligned with the pillar Action Plans described earlier.

2.3 Climate Hazards & Adaptation

Comprehensive modernization at NYCHA is taking place not only at a time of transformation for the Authority, but at a time of dramatic change in the global climate. New York City is already experiencing hotter summers, highly unpredictable winter weather, more intense storms, and heavier rainfall as a result of climate change. In the coming decades, these changes will only intensify. To continue to provide livable housing for future generations, NYCHA's comprehensive modernizations must consider the new and future climate conditions that will be faced within the useful life of our buildings.

The New York City Panel on Climate Change projects that New York City will be exposed to three major climate hazards in the coming decades: 1) extreme heat, 2) sea level rise and coastal storms, and 3) extreme rain. Additional hazards include rising groundwater levels, extreme winds, and continued cold snaps—which may exert different effects on the City in the context of overall warmer weather. These hazards will affect NYCHA directly, but climate-related disruptions to city services and infrastructure that are essential to NYCHA residents and properties form a secondary set of hazards. Secondary hazards include power outages, disruptions to the City's water supply, transportation system interruptions, and natural gas network disruptions.

The New York City Mayor's Office of Climate Resiliency ("MOCR") has developed Climate Resiliency Design Guidelines that all design teams should use as a reference guide for modernizations. The guidelines ask designers to integrate our best understanding of future climate conditions into what they are designing today. The design guidelines are regularly updated and provide step-by-step instructions to evaluate the specific climate-induced threats that each site faces. In addition, NYCHA has memorialized lessons learned from the Hurricane Sandy Disaster Recovery Program in a recent publication that should be integrated into future flood protection projects. The sections below highlight how each major climate hazard affects NYCHA specifically and provide additional information about addressing those hazards.

Extreme Heat

Heat is the deadliest climate-related hazard in New York City. Under current conditions, hot weather leads to 450 emergency room visits, 150 hospital admissions, and 115 deaths in the city in an average year. The more frequent, longer, and more intense heat events that we expect to see in the future will likely have proportionally greater effects on New Yorkers' health. In addition to the critical risks to New Yorkers' health that extreme heat poses, heat also affects quality of life in important ways by imposing limits on social contact and daily activities when it is very hot outside.

Most heat-related illness and death occurs after exposure to extreme heat indoors, when residents spend too much time in very hot conditions in their homes. NYCHA's predominantly mid-century masonry buildings are not equipped with central air conditioning and residents typically purchase and install their own window air conditioner units if they choose to use them. NYCHA residents, like low-income populations throughout New York City, have much lower access to air conditioners than the city as a whole.

Analysis of indoor temperatures in NYCHA buildings shows that typical NYCHA apartments that are uncooled exceed outdoor peak temperatures by up to six degrees Fahrenheit, and they stay hot for several days after temperature peaks subside. A detailed 2019 analysis of potential façade improvements and façade shading for NYCHA buildings showed that although façade improvements and shading can achieve substantial temperature reduction, these measures must be paired with indoor mechanical cooling to achieve protection from extreme heat for residents. This is especially true for seniors living in NYCHA apartments, who spend approximately 90% of their time indoors and are more likely than other groups to have underlying health conditions that are exacerbated by extreme heat. Seniors make up approximately 22% of NYCHA's resident population and are the fastest-growing age group at NYCHA.

On a citywide basis, the Climate Resiliency Design Guidelines recommend that designers analyze the heat vulnerability of specific sites based on the overall heat vulnerability of the neighborhood it is in, using the Heat Vulnerability Index developed by the NYC Department of Health and Mental Hygiene. However, because the NYCHA resident population has characteristics associated with elevated heat mortality across the board, we recommend that design teams consider all NYCHA developments to have high heat vulnerability and include heat mitigating measures accordingly.

Therefore, in comprehensive modernization, design teams are encouraged to include heat mitigating measures, especially:

- Cooling all Residents: This should be a priority for any project where a heating system is re-designed—we know that most heat-related illness and death occurs after exposure to heat inside one's own home, and we know that uncooled NYCHA apartments can get hotter than outdoor temperatures and stay hot after the hottest outdoor weather has passed. Indoor cooling should be considered a standard part of quality New York City housing at all income levels and should be closely coordinated with the building envelope to ensure comfortable and consistent temperatures for residents.
- Cooling the development: Trees are essential to heat mitigation, and all design teams should look at opportunities to enhance tree canopy cover on campuses. NYCHA's recently published Urban Forest: A Vital Resource for New York City identifies the essential role that NYCHA's trees play in a resilient future and outlines strategies for protecting and enhancing NYCHA's piece of the New York City urban forest. NYCHA campuses are frequently one of the major sources of green space in the neighborhoods they are in, and they help to mitigate the urban heat island effect neighborhood-wide.

NYCHA's tree canopy plays an essential role in cooling and creating a micro-climate at the developments

Somewhat counterintuitively, research has found that planting more trees in already-green areas provides neighborhoods with the greatest potential to mitigate the urban heat island effect. Planting more trees on NYCHA campuses, therefore, is likely the best strategy to enhance nature-based methods of heat mitigation for NYCHA campuses and the wider community. Equally important, however, is protecting NYCHA's existing tree canopy cover, since replacing the mitigation value of older trees takes decades.

All comprehensive modernization projects should include strict provisions for protection of trees, and ideally an arborist should monitor compliance. This should be combined with other shading devices and heat-mitigating materials to maximize heat reflectivity. Reflective pavements and light-colored materials are among the easiest measures to incorporate into projects and should be the default unless there is a compelling reason to use darker materials.

Storm Surge

Storm surge is perhaps the climate hazard most familiar to NYCHA, as over 60,000 NYCHA residents lived in storm surge-affected developments when Superstorm Sandy hit New York City in 2012. More than $3 billion was allocated to repairing affected NYCHA developments and protecting them from future storm surge flooding. Rising sea levels, however, mean that additional buildings will be in the floodplain in the future, putting more NYCHA facilities at risk of flood damage.

NYCHA has gained a great deal of institutional knowledge about design, construction, and operationalization of flood proofing strategies from its Hurricane Sandy Recovery & Resilience work. In a comprehensive modernization project, design teams are encouraged to include measures that mitigate the effects of possible storm surge where NYCHA buildings are now vulnerable and where they are expected to be vulnerable in the future. Specifically, design teams should understand which buildings and portions of the grounds are or will be vulnerable to storm surge by consulting the New York City's Department of City Planning's Flood Hazard Mapper. Design teams should identify any building systems or building components that lie in current or future floodplains.

Protect to the Appropriate Time Scale

The Climate Resiliency Design Guidelines provide a framework for protecting buildings' systems and components in a cost-effective manner. A component that is expected to last 20 years does not need to be protected to the potential storm surge level expected in 2080; however, if a component is expected to last until 2080, it is imprudent to protect only to today's expected storm surge level. We recommend that design teams follow the Climate Resiliency Design Guidelines' methodology for identifying the useful life of project components and providing protections to the appropriate time-scale.

Floods, even in the most vulnerable developments, are rare; but flood protection infrastructure may be an everyday presence in residents' lives. Storm surge protections should be designed to provide maximum co-benefits on an everyday basis. For example, a flood wall installed at Baruch Houses as part of the Recovery & Resilience program integrates seating; lobbies being renovated at many Sandy-affected sites provide upgraded building security and comfort while providing the opportunity to seal out floodwaters. Nature-Based Solutions or green infrastructure should be used to provide multiple benefits to residents.

Extreme Rainfall

Heavy rain will cause increasing damages and danger in New York City in the coming decades. Today's 50-year rainstorm is expected to be the 5-year rainstorm in 2050, but drainage systems in New York City are most frequently sized for the typical 3-year or 5-year rain event in the mid-20th century. Because of the campus-style layout of many properties, these properties have unusually long stormwater drain lines relative to a private property owner, and portions of those systems under NYCHA's campuses are not maintained by the City's Department of Environmental Protection. During comprehensive modernization projects, NYCHA should ensure that stormwater systems function properly and should strive to manage additional stormwater onsite through surface detention, retention, and infiltration.

Specifically, design teams are encouraged to:

- Inspect and Repair Existing Stormwater Systems: Stormwater systems may have collapsed pipe sections or blockages that prevent heavy rains from being conveyed to the City's stormwater system as designed. NYCHA's Physical Needs Assessment does not identify subsurface repair and replacement needs for stormwater systems. With increased frequency and intensity of heavy rains, it is essential to restore these systems to a state of good repair and establish schedules for consistent clean-out of debris and sediment.
- Use Low-Maintenance Vegetated Green Infrastructure & Plan for Its Care: Vegetated green infrastructure retains stormwater while providing landscape enhancements and has been well-received by residents where installed. However, it has also proven difficult to maintain because the vegetation has different requirements and a different aesthetic than typical NYCHA landscaping. Design teams are encouraged to include vegetated green infrastructure but should choose low maintenance plant palettes when they do so and should work to establish maintenance protocols and partnerships.
- Consider Multi-Functional Infrastructure: Water squares and floodable play spaces provide temporary storage for high volumes of stormwater when heavy rains hit, but function as everyday amenities on dry days. The sunken basketball courts planned for South Jamaica houses are a perfect example of how design teams should consider managing stormwater sustainably while providing benefits to residents.

Green infrastructure installation at Edenwald Houses

Citywide Power Outages

Though rare, power outages for whole buildings or developments are devastating for NYCHA residents, particularly those with limited mobility or those dependent on life-saving medical equipment. Most of New York City is served by underground electric power lines, but design teams working on developments with overhead lines should be aware that storms are more likely to affect power in those areas. Because of the extreme nature of the power outages experienced during Superstorm Sandy, backup generation was provided for over 200 affected buildings. While backup power is important for extreme events, the high cost of providing backup power means that teams should carefully weigh the benefits and costs of including it in the comprehensive modernization scope, especially if including it would divert substantial financial resources away from improvements that would provide greater benefits to residents on a day-to-day basis.

Comprehensive modernization design teams should consider that higher density developments are more vulnerable to power outages. NYCHA tracks the number of residents with mobility impairments, the number dependent on life-saving medical equipment, and the number of seniors in each building. Buildings with higher percentages of vulnerable residents should be a higher priority for backup power provision because of the significant impact it could have.

Developments receiving comprehensive electrical upgrades may be better able to install backup power for critical systems. Previous analyses of the potential for installing backup power have looked at the cost-effectiveness of providing critical systems backup power only and have found the approach to be unfeasible at NYCHA because of the electrical work involved in separating the supply for critical systems from the whole-building load. However, design teams planning comprehensive electrical upgrades should plan to separate power lines for critical systems such as elevators and community space power. Backup generation for a smaller load may not present an insurmountable cost barrier, compared with providing backup generation for an entire building. Even if providing backup generation is not feasible at the time of comprehensive modernization, separating critical systems power provides for the possibility of installing backup power more easily in the future.

Other Considerations

Our understanding of New York City's future climate conditions continues to evolve. Additional climate considerations that design teams may wish to prepare for include:

- Extreme wind: Design teams, especially those exposed to coastal winds, should consider the effects of more intense winds on buildings. In the coming years, the New York City Panel on Climate Change is likely to release maps and projections that will provide building teams with more information on how future extreme winds may affect their sites specifically.
- Cold snaps: While the climate continues to warm, cold snaps will persist in the context of a warmer average temperature. Boilers that are slow to ramp up and down will be ill-suited to these conditions, and existing plans to move away from central steam boilers will help NYCHA adapt.
- Groundwater Rise: Some sites may begin to experience flooding that results from groundwater rising to the level of building basements, rather than from storm surge or heavy rain, and the geographic distribution of these effects may be different than it is for the other flooding hazards.

NYCHA and its design teams need to stay aware of emerging hazards as well as the state of knowledge of the hazards we already know about. Planning for future conditions is essential to continuing to provide high-quality housing for future generations.

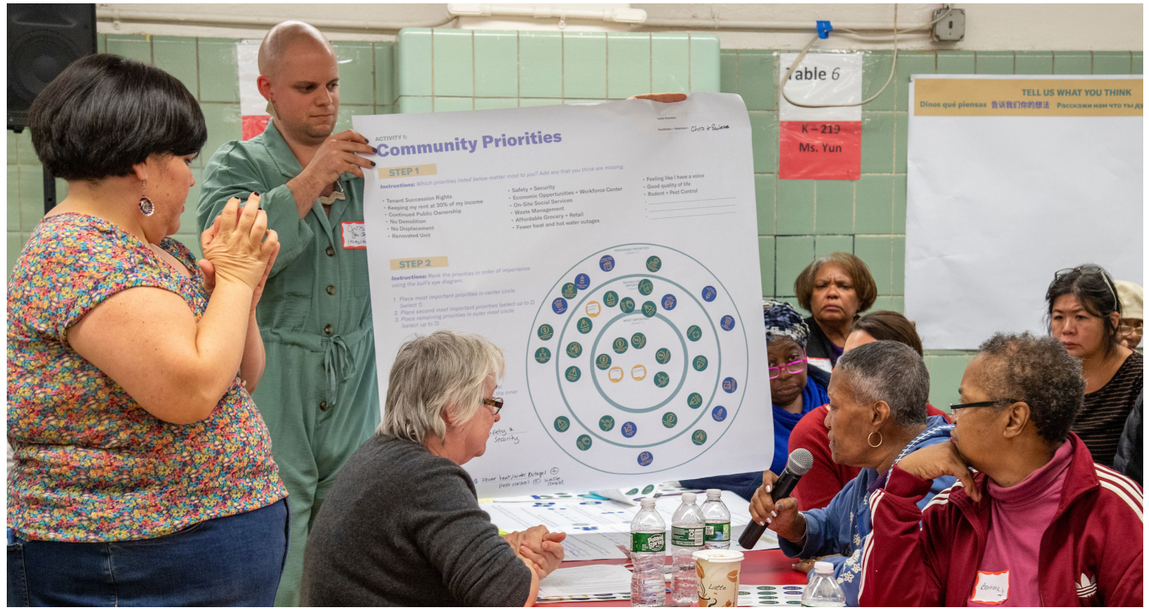
03 RESIDENT ENGAGEMENT & IMPACT

The Authority's approach to resident engagement for comprehensive modernization projects will build on policies and approaches initiated in recent years by various departments within NYCHA's Community Engagement & Partnership's Division ("CEP"), Real Estate Development Division ("REDD"), and Capital Projects Division ("CPD"), as well as by other governmental and nongovernmental partners, to ensure these projects best meet resident's housing needs and contribute to residents' economic livelihoods. A program of holistic renovations will require the Authority to develop a holistic approach to resident engagement and partnership, communication and coordination throughout planning, procurement, design, and construction processes.

3.1 Existing Policies & Practices

PACT conversions implemented by CEP and REDD are the most similar NYCHA modernization projects to comprehensive modernization projects, and require early and extensive engagement by NYCHA with residents and other community partners, as well as a detailed program of social services and economic support for residents. As comprehensive modernization projects will be similar in scale to PACT conversions, the Authority and its partners will utilize expertise and procedures developed through and for PACT and other large-scale contracting programs in developing comparable partnerships, resident services and support models. The NYCHA PACT Partner Resident Engagement Guide, and the Interim Standard Procedures for Section 3 Contractor Compliance (SP 006:20:1), soon to be replaced by a final standard procedure, are two such procedural documents.

The PACT engagement model involves early engagement with residents, well in advance of design and construction activities, and throughout project planning, community visioning and design, and construction. The PACT program also utilizes of a range of engagement models and tools from live meetings and design charettes through to online webinars and door-to-door communication efforts. PACT has also recently introduced a new, holistic property assessment and visioning framework in advance of contracting with partners, to inform and guide design activities and support residents to engage in these more actively.



Community visioning sessions led by NYCHA REDD and CEP as a part of PACT engagement model

NYCHA CPD also maintains Standard Procedures for Stakeholder Engagement for capital project overseen by the division, based on the diversity of projects the division has implemented over the years. Projects are classified as either "routine modernization projects" requiring mainly informational engagement with residents or "resident impact projects" necessitating extensive, participatory engagement with residents. Comprehensive modernization projects fall into the "resident impact projects" category, demanding "a participatory approach that requires meetings with stakeholders at each design phase, and incorporation of feedback into the final project, in addition to regular engagement." Such projects require a robust engagement strategy for all project phases beyond even the most complex component-replacement type projects implemented by CPD to date.

CPD's Standard Procedures for Stakeholder Engagement details the roles that each NYCHA department must play in the realization of a collaborative resident engagement process. They also describe the baseline requirements for NYCHA staff utilizing standard engagement tools such as project fact sheets, stakeholder meetings, resident surveys, monthly email updates, construction progress meetings, signage, phone banking, and post-construction evaluations.

Resident engagement session as a part of CPD's landscape design project at Jefferson Houses

Both the PACT Partner Resident Engagement Guide and CPD's Stakeholder Outreach Standard Procedure are resources to the multiple partners who will be involved in a comprehensive modernization, and NYCHA anticipates developing additional engagement approaches, requirements and guidance for the comprehensive modernizations based on resident input and project experience. In addition, each comprehensive modernization project's outreach and engagement strategy should be tailored to specific needs of the residents' impacted, as further discussed below.

Comprehensive modernization projects will also be subject to NYCHA's Section 3 Interim Standard Procedures (SP 006:20:1) and its forthcoming final Standard Procedures, maintained and overseen by NYCHA's Office of Resident Economic Empowerment & Sustainability (REES). NYCHA's Section 3 goals and procedures have been established to maximize resident employment and other economic opportunities, in line with requirements set by HUD that employment and other economic opportunities generated by HUD assistance or HUD-assisted projects shall, to the greatest extent feasible, be directed to low-income and very low-income persons, particularly persons who are recipients of HUD assistance for housing. The interim Standard Procedures covers the implementation of the Section 3 program through a range of contract-types, including construction and professional services, and are also further discussed.

3.2 Supporting Resident Engagement

Stakeholder Advisory Groups

Over the past few years, REDD has convened different formats of stakeholder advisory groups or committees at sites undergoing PACT conversions and renovations. These advisory groups may be involved in various areas from resident engagement planning to contractor requirements definition and selection to subsequently working directly with the selected PACT developer to represent the interests and concerns of NYCHA residents, neighbors, and community.

Although comprehensive modernization projects will not involve outside development partners, the Authority and its project partners may elect to utilize a stakeholder advisory group model – comprised of residents or broader community partners – to ensure benefits to residents and the community can be maximized and negative impacts minimized. While the model will need to be tailored to the needs and views of residents and stakeholders at each property, over time, NYCHA, resident representatives, and stakeholders should develop standardized guidelines for how stakeholder advisory groups should be constituted and operate to fairly and effectively engage in modernization projects.

For example, a stakeholder advisory group could be convened prior to community visioning sessions with residents, to participate in these sessions which inform the project scoping and planning, as well as development of procurement documents for a project. The group could also directly input to those documents as well as the contractor selection process. Having the advisory group or residents directly involved in setting evaluation criteria related to areas that most impact residents and reviewing and inputting to evaluation of proposals in these areas, will promote transparency and ensure resident priorities are fully reflected in decision-making. Provision of training on public procurement process, project delivery methods, and other relevant areas, for individuals involved in the procurement process, is an important consideration for NYCHA so that these individuals can engage effectively.

Technical Advisors

Given the complex nature of comprehensive modernization projects, residents should also be supported by independent technical advisors ("ITA"). ITAs can provide independent advice to tenant associations, residents, as well as other stakeholders, in areas such as architectural and engineering design, community planning, and legal advisory. NYCHA has supported such arrangements on various projects and recently created Resident Planning Funds to ensuring residents have access to independent, trusted partners who can provide high-quality, professional, and objective advice and outreach and planning support in a more standardized way across projects.

Residents may use these funds on a range of services including but not limited to:

- Hiring professional consultants, such as architects, community planners, attorneys, and financial advisors, to assess redevelopment potential or vet project proposals.
- Hiring local community-based organizations to support outreach efforts, facilitate communication with NYCHA staff, and/or

advocate for resident priorities.
- Hiring tenant advocates to provide tenant organizing and leadership development and/or tenant support and eviction-prevention services.
- Hosting community events or other initiatives to promote awareness about project proposals and solicit resident feedback.
- Hiring attorneys to provide legal advice.

NYCHA will continue to enhance support in this area and potentially expand Resident Planning Funds as part of comprehensive modernization projects.

3.3 Construction Planning and Coordination

Community Construction Liaisons

Community construction liaisons ("CCL") are another mode of resident engagement that is becoming more common in the construction industry. CCLs are individuals with a strong presence in a site's communities and support from the resident association, and could be a member of the resident association board or a stakeholder advisory group, or a group or residents. CCLs are typically engaged early in the project and remain on staff for a mutually agreed upon timeframe, usually through to the end of construction or full project closeout, following up with residents after work on-site has been completed.

Residents and project staff have multiple ways to communicate with the CCLs for the given project. The CCLs should therefore be provided a work phone and email address, the details of which should be published and communicated to all residents. A dedicated project webpage is also desirable. In general, CCLs are approachable, recognizable, and knowledgeable advisors, and are allocated a budget sufficient to accomplish their role and the authority to organize meetings and events for residents and project staff. During these and other events, CCLs wear branded clothing and an identification badge.

The expectations of the CCL position should be set out in the initial work program, for example:
- The CCL must be included in all project steering meetings and provided access to materials concerning the project. They should build a portfolio of relevant documents that can be referenced by residents interested in the project.
- As the point of contact and the conduit of information and opinions between residents, designers, contractors, and the Authority, the CCL must communicate with all parties with integrity, transparency, and independence. They must provide clear and detailed briefings on a monthly basis to residents and to the project team. Briefings should include written documentation of all relevant opinions and determinations, as well as in-person presentations and question and answer sessions.
- The CCL must offer strategic counsel on community engagement to project partners, including well-informed advice on how to ensure an inclusive process. They must promote frameworks for resident empowerment that are accountable, accessible, and transparent.
- The CCL must ensure that differences are valued, that all resident communities are informed and involved, and that potential areas of discrimination, harassment, bullying, or exclusion, are addressed with the project team and with residents.

Community-Based Construction Plans

Comprehensive modernization is a chance for NYCHA to invest with residents in a collaborative vision of their shared future. This begins with a community-based construction plan that not only incorporates resident feedback in the traditional sense, but provides residents significant input in determining the impact of capital delivery on their daily lives. A completed community-based construction plan can be a formal written document detailing not only the construction plan itself, but also related process, procedures and good practices.

The essential questions in a community-based construction plan for comprehensive modernization are: (i) when and how residents may be negatively impacted by construction activities, and (ii) how those impacts can be mitigated as much as possible within the constraints of the project. Residents should be provided enough time and technical assistance to appreciate the construction activities required. This will include early and extensive discussions with residents to better understand the impact of construction on various subsets of residents and to assess various phasing strategies. For example, a community-based construction plan should consider the needs of students, the elderly, small-business owners, and those dependent on in-person medical aid.

The most invasive component of construction will be extensive in-unit improvements that require the temporary relocation of residents. Where, for how long, and in what order residents are moved are crucial variables in the formulation of a community construction plan that all stakeholders can abide to. Residents must have a significant say in answering these and other questions pertaining to phasing. The Authority and its partners should utilize a variety of engagement strategies and collaborative programming to support resident input and buy-in to the community-based construction plan, including briefings, formal discussions, planning workshops, youth education programs, games and other informal activities, meals and block parties, and other nontraditional events. Programming should address the needs and concerns of specific development typologies and resident demographics.

3.4 Expanded Economic Development Programs

A comprehensive modernization program should aim to contribute to NYCHA's mission to provide quality housing as well as foster economic opportunities and mobility for residents. Beyond existing standards, this could include supplementary programs, policies, and collaborations specific to large-scale rehabilitation projects or that could expand to NYCHA's policies. Specific areas of focus are increasing opportunities for Section 3 Business Concerns, training NYCHA residents for jobs in the design and construction industry, and looking at ways to encourage contractors to not only to meet minimum requirements but to exceed them in terms of providing additional economic opportunities to public housing residents.

New Manufacturing Industries, Section 3 & M/WBE Programming

NYCHA's Blueprint for Change proposes to take advantage of economies of scale associated with a large number of comprehensive modernization projects to link with local manufacturing firms and create hundreds of industry jobs, especially in locations such as the Brooklyn Navy Yard and the Brooklyn Army Terminal. As comprehensive modernization will require NYCHA to purchase large numbers of products not currently manufactured at the necessary scale in the New York area and even the United States – such as heat pumps, façade panels, and new electrical systems – it is an opportune moment for the Authority to support resident employment as it holistically renovates its housing stock.

NYCHA can prioritize local manufacturing, Section 3 and minority and/or woman-owned business enterprises ("M/WBE") throughout the project lifecycle. For example, incentives for products manufactured in New York State and be incorporated in procurement activities. This would also assist in decreasing greenhouse gasses by reduced shipping and carting meeting NYCHA's goals of lowering carbon emissions. Moreover, positions created through this model should incorporate job training and employment support, should be "bridge-to-union" positions, and should prioritize Section 3 residents, Section 3 Business Concerns, and minority and/or woman-owned business enterprises.

If successful, the strategy detailed in the Blueprint will bring billions of dollars in investment to NYCHA, expanding jobs opportunities for residents and contributing towards NYC's health and economic recovery.

While NYCHA's community solar program at Queensbridge are not subject to Section 3, it is built into the solicitation process and lease agreements; that led to resident involvement in hiring and training residents for solar installation

Additional Economic Opportunities

Comprehensive modernization partners should be required to offer economic opportunities to NYCHA residents beyond the numerical goals for hiring Section 3 residents and subcontracting Section 3 business concerns. This would standardize NYCHA's informal practice of encouraging development teams on PACT-RAD projects to use Section 3 Business Concerns even for non-Section 3 contracts.

In addition, at present, if a Section 3 contractor for Professional Services is not able to project labor hours for Section 3 residents and/or subcontracting with Section 3 business concerns, they must commit to and satisfy the goals stated in a Section 3 Other Economic Opportunities ("OEO") Plan. The OEO provides space for prospective partners to detail specifications for a paid internship program, a resident training program, and a pre-apprenticeship training program, as well as a program of support to Section 3 Business Concerns. Under comprehensive modernization, prospective partners should be required to detail an additional array of economic opportunities for NYCHA residents supplementing the OEO, especially when hiring Section 3 Residents and/or subcontract to Section 3 Business Concerns is not feasible.

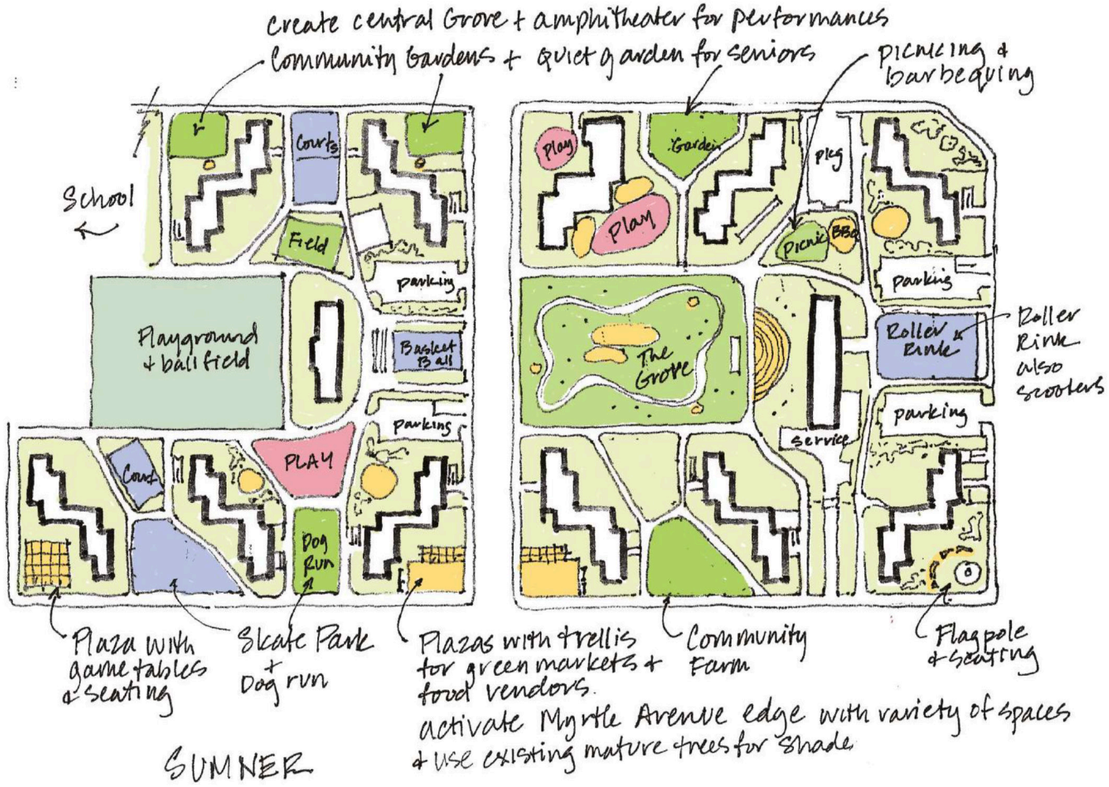
04 MODERNIZATION STRATEGIES

Grounds, Building Exteriors & Interiors

4.1 Grounds, Entryways & Accessibility

Grounds

In 2020, as a part of Connected Communities, NYCHA launched an Open Space Masterplan effort for 150 of its sites. The Masterplan physically assessed the conditions of the grounds at all of the developments—going further into depth than the Physical Needs Assessment has historically. The project also analyzed resident demographics, surrounding assets, ecological conditions, site constraints and opportunities. The project's aim was to re-envision and propose enhancements to the quality of NYCHA's many and diverse open spaces—including but are not limited to playgrounds, play spaces, gathering areas, seating areas, barbecue areas, and sport courts. High-level cost estimation was also provided for each site as a fundraising tool to garner financial support for these spaces which are often not addressed through the traditional funding streams available to NYCHA. The Masterplan projects provide a vision and framework for the many public, private, and non-profit partners that are interested in collaborating with the Authority on community-driven public realm projects.



Conceptual open space masterplanning for Sumner Houses

Exterior Lighting

Due to issues of safety and security, exterior lighting has proven to be a significant concern for NYCHA residents, elected officials, the New York Police Department, and other stakeholders. A full-site upgrade to exterior lighting should be incorporated into each comprehensive modernization project, as preliminary research shows that such improvements contribute to a decrease in crime conducted onsite. A NYCHA pilot improvement program in site lighting was primarily focused on twelve-foot pedestrian light poles along pathways and in gathering areas.

Additional lighting methods should be pursued to provide site lighting, canopy lighting, building-mounted fixtures, and sports lighting that diminish light pollution and provide residents with appropriate lighting levels for the different activities that take place at NYCHA developments in the evening and nighttime hours. In addition to providing sufficient lighting fixtures, additional consideration should also be given to the overall site layout. Landscaping features such as trees and bushes should be placed in a manner as to avoid creating blind spots or dark spots, and should be regularly maintained in order to preserve the original design intent of the site.

In 2020, NYCHA piloted the installation of solar site lighting at Howard Houses. Preliminary results from that pilot installation show that solar site lighting is a viable option for NYCHA, but more information is needed on the operational challenges and costs associated.

Upgraded exterior lighting at Polo Grounds Towers

Modern Entryway Design

Since the fall of 2020, NYCHA has been piloting a new entryway design at several developments to evaluate instituting changes to the standardized approach to entryway replacement for all developments. This new design standard includes stainless steel reinforced aluminum storefront that would come in standard sizes from multiple manufacturers in the New York City area. Currently, NYCHA's custom-made stainless-steel entryways are difficult and expensive to repair or replace—causing long lead times for addressing broken doors, locks, or storefront systems. The new entryway design is inclusive of Closed-Circuit Television cameras (CCTV) and Layered Access Control ("LAC") systems to ensure that the new entryway is safe and secure for the residents. This will include an intercom system that easily allows residents to allow access into the building from their personal devices. Once tested and evaluated, this new design standard will be revised and adopted for all future entryway replacement projects.

Accessibility at NYCHA

Comprehensive Modernization will present NYCHA with a chance to increase accessibility during our overall assessment of the full needs of a building, which has been challenging in NYCHA's traditional capital programs. Due to the lack of funding for such upgrades and the small scale of the interventions NYCHA has historically been able to make with existing constraints, the types of improvements NYCHA would like to pursue in this area has not been able to occur. Targeting unit by unit renovations is key to making as many units as possible accessible for those who need them now, but giving accessibility a key role in comprehensive modernization projects presents a unique opportunity to increase the number of these units, common areas, and other key parts of the building to ensure they are accessible to all.

NYCHA is subject to Section 504 of the Rehabilitation Act of 1973, Section 109 of the Housing and Community Development Act of 1974, the Americans with Disabilities Act of 1990, and the Fair Housing Act which requires accessibility compliance across the portfolio. Accessible is defined as the ability to be approached, entered, and used by individuals in a wheelchair, in compliance with the Uniform Federal Accessibility Standards ("UFAS"), or ADA when applicable. An accessible route connects housing and non-housing programs such as parking, community centers, or laundry rooms.

NYCHA can follow an elevator usability standard to meet elevator accessibility requirements in order to increase housing choices for those who are mobility impaired. Program accessibility offers the flexibility of allowing programs provided by NYCHA to be considered accessible, even if the full extent of the buildings is not under current condition. A comprehensive modernization should attempt to bring housing and non-housing programs to the highest extent of accessibility that is technically feasible and does not provide an undue burden on the Authority.

In most NYCHA buildings, there are many technically infeasible conditions because the buildings were originally built to minimum standards and there is not enough space to enlarge bathrooms and hallways without eliminating rooms. In high rise buildings, there is an additional constraint of elevator shafts, structural columns, plumbing stacks, and electrical chases that cannot be relocated because the run the entire height of the buildings.

Voluntary Compliance Agreement

After facing challenges to implementing the UFAS, in 1996 (and amended in 1999), through negotiations between NYCHA and HUD, a Voluntary Compliance Agreement ("VCA") was developed that identifies both how many units of housing NYCHA has to make accessible throughout its properties and how those units will be remodeled. The VCA includes terms and conditions, benchmarks, and thresholds for compliance with the standards for accessibility, as well as target dates for compliance. The principal goal is that NYCHA meets a target to provide five percent of its total housing stock as accessible (with an Accessible Route and accessibility to Non-housing Programs). Currently, five percent of NYCHA's total housing stock would equate to approximately 8,800 dwelling units.

The agreement states that the VCA expires (if satisfied) after NYCHA meets an interim milestone of making 4,944 dwelling units fully accessible. NYCHA was required to make 150 units accessible per quarter until the goal of 4,944 units is met. To date, NYCHA has converted 6,746 units of which 4,640 are fully accessible. NYCHA continues to make units fully accessible units either by capital projects or through the "trigger" requirement of the VCA (vacant units that undergo bathroom or kitchen renovation or replacement of some single elements require unit conversion).

In summary, the VCA provides for two types of accessible units. The first are called "Conversion Rate Units" and are to be fully accessible according to UFAS. A little less than 5,000 units will be initially remodeled in this category. Ultimately, the goal is to convert a total of 5% of all NYCHA units accessible, about 8,800 total units. The second type of accessible units are called "Modification Rate Units" and are provided in response to individual tenant needs. These units do not have to be completely compliant with UFAS. Starting in 1997, NYCHA is obligated to retrofit and average of 315 units in this category every quarter.

Accessibility in a Comprehensive Modernization

Additions to existing buildings must comply with the ADA or UFAS. Alterations must also comply, unless changes would result in undue burden to the authority or are technically infeasible. Thus, any change made to a public space or dwelling unit must comply with the ADA or UFAS requirements.

In 2015, NYCHA conducted a study that estimated the total cost for full conversion of all required units to meet VCA compliance would result in $260 million, or approximately $125,000 per unit. The study summarized a $2B cost estimate (including unit conversion) to address all non-accessible/compliant areas and make them barrier free. This was deemed an undue burden on the Authority to accomplish all at once, and NYCHA is instead retrofitting units and renovations to the grounds on an ongoing basis to increase the percentage of units meeting program accessibility over time.

The most common barriers to accessibility in NYCHA buildings are undersized elevator cabs, building entrances, elevators (signals, controls), and grounds (open space, parking, etc.). To accommodate the constraints of existing high-rise buildings, the VCA identifies several alternative design approaches that HUD has agreed provide equivalent accessibility. The departures from the UFAS include:

- Alternative elevator floor plans that recognize the small size of most existing NYCHA elevators. These floor plans have been tested with people who use wheelchairs, in line with federal standards and local code requirements. They allow full use of elevators although some individuals may not be able to turn around in the car.
- Alternative to floor indicators in elevator cars and lobbies to address the fact that many NYCHA buildings do not have such systems.
- Alternative bathroom plans that allow NYCHA to build accessible units without reducing the number of bedrooms in each remodeled unit. These plans have also been tested out with people who use wheelchairs.

To implement the VCA, NYCHA has developed a Modified UFAS Checklist that includes the specifications for the alternative designs. This checklist will be used by NYCHA designers and inspectors as well as HUD inspectors who are charged with checking compliance with the VCA.

NYCHA's Design Department is currently developing a standard procedure to ensure that any units that undergo trigger work will be evaluated for conversion to full accessibility. In regard to accessibility, small scale renovations can make an impact on a subset of units, but larger scale interventions such as investigating the construction of a new elevator on the outside of the existing buildings would present an opportunity to greatly improve NYCHA's compliance in this area.

4.2 Facades & Building Envelopes

Heat, Air, and Moisture

The performance of a building's façade and envelope is vital to the thermal performance of a building, and to the health of its occupants. Dew point is the temperature at which naturally occurring moisture in air condenses and becomes liquid. It depends on temperature differentials that can occur within façade assemblies. If not managed correctly, moisture buildup can cause façade failures. As façade modernization can change thermal transmittance, therefore relocating the dew point, it is essential that project teams either eliminate moisture condensation, or, if that is not possible, adequately manage the associated risk. Moisture can be reduced by limiting heat and air transfer, and by properly locating the new dew point.

The transfer of heat, air, and moisture is regulated by evolving buildings codes, which have gradually mandated that buildings have more effective continuous air barriers. Built in the post-World War II period, many NYCHA buildings were constructed without adequate air barriers or insulation. These buildings' façades often experience extensive water infiltration and weathering, causing them to underperform or fail. Over time, the mortar and, sometimes, the bricks themselves, have become damaged or worn. Façade failures have accelerated moisture penetration, metal corrosion, insulation saturation, and mold growth.

By better regulating the amount of heat, air, light, and moisture that passes through the façades and envelopes of its buildings, the Authority can therefore conserve energy, improve indoor air quality, provide residents a more comfortable interior environment, and make it easier for staff to maintain buildings to their proper performance standards. By controlling the transfer of heat, air, and moisture, NYCHA can also decrease the number of pests and irritants in its units, improving the quality of life for all residents.

Existing NYCHA Facades

Most NYCHA building envelopes are composed of three façade types: solid masonry wall construction, cavity masonry wall construction, and, in limited areas such as entranceways and elevator lobbies, curtain wall construction.

These older buildings with minimal insulation gain and lose heat faster than newer buildings. Internal heat gains from cooking and other equipment can contribute to the indoor/outdoor temperature difference that can exacerbate moisture issues in a building. Moreover, a study of NYCHA façades conducted for the Sheltering Seniors from Extreme Heat report found that with existing NYCHA façades, apartment temperatures built up during heat events and remained higher than outdoor temperatures during a blackout. Under current conditions, when outdoor temperatures peak at 96°F, the indoor temperatures reach 104°F, or 6°F higher than outside.

It is essential to consider façade upgrades within the context of the wider range of improvements that comprehensive modernization will entail. For example, new heating and cooling systems will not only integrate into a façade retrofit, but will also affect the new façade's performance, particularly during extreme weather events. Other modernization improvements that may affect façade performance include occupancy sensors, building management systems, and on-site energy generation. Comprehensive modernization will require site-specific, holistic analyses to identify the needs and requirements of new façades and envelopes.

Drawing on energy retrofit best practices, comprehensive modernization projects may utilize panelized façade systems of various types. These panelized systems can vary from site to site. If implementing a panelized approach, NYCHA will have to use its purchasing power to inform product requirements and build a market. New, panelized façades should incorporate upgraded MEP systems into the products' cavities—minimizing the need to tear down walls within apartments and making it easier for NYCHA to maintain new systems to their proper performance.

Before-after imagery of renovations at converted PACT development, Baychester Houses

Local Law 11

New York City's Local Law 11 ("LL11") requires owners of buildings six stories and higher to have the exterior walls and appurtenances inspected every five years (as of 2021, NYCHA is on Cycle 9), and to electronically file a technical façade report with the New York City Department of Buildings. The Façade Inspection Safety Program ("FISP") oversees LL11. If an inspection finds that unsafe conditions exist, either a façade must either be repaired, or a sidewalk shed must immediately be erect to protect the public below. The FISP Program does not holistically address the deterioration of the building exteriors. It solves for the individual unsafe condition but does not consider building science and the building enclosure in its entirety, failing to address air and water infiltration. A comprehensive building façade renovation is more beneficial to addressing the root causes of issues like mold and sick building syndrome.

The current municipal codes require the FISP unsafe conditions to be repaired prior to any exterior restoration. As long as the substructure is sound, there are several options that more holistic investments that address unsafe façade conditions, but also address moisture infiltration, and reduce heating and cooling needs. Based on the Physical Needs Assessment, for buildings with 7 or more stories, NYCHA has over 60 million square feet of building façade to address for LL11 issues. LL11 work is generally not City Capital eligible, which generates funding challenges. It is estimated that compliance with Cycle 9 and 10 will cost the Authority over $3.7 billion.

Roughly 40% of NYCHA buildings, of all three façade types, are over six stories tall and subject to LL11. Many of these facades have had maintenance deferred to such an extent that sidewalk sheds have had to be installed. Residents consistently complain that the sheds are a threat to public safety because they decrease visibility, increase dark areas on sidewalks, and allow trash to pile up.

With little funding available, the number of sidewalk sheds will only increase. As of November 2021, over 100,000 linear feet of sheds exist on NYCHA developments. By retrofitting its facades, NYCHA will address the deferred maintenance and diminish the need for shedding. A LL11 report will still be required every five years, but the protection of a brick façade from the elements through repair and then overcladding will improve durability and improve resident quality of life by decreasing the amount of shedding needed.

RetrofitNY

As discussed earlier, RetrofitNY is an initiative of NYSERDA's Multifamily team aiming to revolutionize the way buildings are retrofitted and to facilitate a pathway to net zero energy ("NZE") performance for existing buildings. Based on the successful Energiesprong model started in the Netherlands and being rolled out across Europe, RetrofitNY recently completed its first design phase targeting six affordable housing buildings throughout New York State. As a result of this first proof-of-concept round, RetrofitNY is now focused on reducing component costs to enable widespread adoption of NZE retrofits throughout the affordable housing sector and beyond.

Through its ongoing NextGen HVAC challenge, RetrofitNY is working with public and private partners to develop panelized envelope treatments that decrease labor and material costs from construction by shifting product manufacturing off-site, and that provides increased savings to building owners by decreasing construction times and reducing utility, operating, and maintenance costs (including those associated with New York City's LL11).

RetrofitNY's research into panelized envelope systems for existing buildings has so far focused on low-rise and medium-rise buildings from one to seven stories in height. The results of NYSERDA's research and collaborative challenges are therefore applicable to some but not all NYCHA buildings.

NYSERDA and NYCHA are currently working together to facilitate the Authority's compliance with Local Law 97, and the Authority has signed on to the RetrofitNY Pledge committing to adopt an NZE or near NZE retrofit solution that meets the criteria outlined in the pledge. NYCHA's first Comprehensive Deep Energy Retrofit is currently in progress. NYSERDA's resources will continue to be useful to the Authority as it proceeds in developing a local market for panelized building envelope retrofit systems, and comprehensive modernization project teams should utilize the wealth of knowledge that RetrofitNY has developed through its research.

Gradient Design Concept for RetrofitNY Pilot by Cycle Architecture PLLC

Site-Specific Considerations & Options

Site-specific considerations will impact what kind of façade retrofit is feasible and provides the highest level of performance. Comprehensive modernization project teams should use a methodical approach that includes: 1) an existing building analysis; 2) an energy analysis, a needs assessment, and resident input; 3) schematic modeling; 4) integral design studies; 5) a regulatory analysis; and 6) a cost analysis. In analyzing the existing buildings, design teams must examine the existing façade type, the state of repair of the existing façade, the structural capacity of the overall building, and the energy requirements of the building form, among other topics. Variable structural capacity will determine how much weight can be applied to one connection point, which will impact the kind and size of new panels, as well as which MEP systems can be integrated into the cavity by the new façade.

Additionally, the scope of façade and envelope upgrades should take residents' experiences, interests, and needs into consideration. Project teams should study a building's properties and survey residents, taking care to understand variability depending on a unit's height and vantage. Teams should consider light, temperature, moisture, and other variable building properties, as well as needs determined from the resident demographics of a building. The kind and thickness of new overcladding may also depend on the direction of a building face, so project teams should be open to considering variability within a development or even a single building.

The following approaches outline different systems that can address NYCHA's current façade challenges:

a) Repointing: The minimal intervention required to address LL11 and building façade performance is the removal and replacement of the old mortar between the existing brick. Improper pointing can compromise the structural integrity of the masonry and undermine the performance of the façade. New mortar must match original mortar in compressive strength, vapor permeability, color, texture, and tooling. New bricks must also match the existing façade's structural characteristics. An additional layer of protection that can be applied is a mineral coating on top of the repointed brick. This is a cost-effective solution but does not have any energy performance benefits.

b) Brick Removal and Recladding: Another approach that would improve energy performance but also preserve the historic brick aesthetic of the buildings would be to remove the face brick and reclad them in new brick. Once the outer wythe of brick is removed and the back-up wall is restored, new cavity insulation and new face brick—of similar or different colors (for aesthetic impact) could be installed.

c) Exterior Insulation and Finish System (EIFS): Exterior Insulation and Finish Systems ("EIFS") provides a relatively low-cost solution for a non load-bearing, exterior wall cladding system. It provides an insulation board that is attached to a substrate on an existing structure in order to improve the building's energy performance. This system can also be applied with a drainage system underneath a cladding that has a wide variety of colors and textures available. The use of an EIFS system can dramatically change the aesthetic quality of an existing NYCHA building and has been installed at several PACT developments and at other housing authority retrofits.

d) Thin Overclad System: This improvement entails installing modular, prefabricated, 8" to 12" thick cladding over the existing façade. Modular units of this type are generally up to 30 feet wide and slab-to-slab tall, and they can be installed in various phasing options. Prior to installing the overclad, repairs may need to be made to the existing masonry. This is a cost-effective option and the fastest option to construct.

However, the minimum option has a number of drawbacks that entail additional consideration and mitigation. With this option, fire compartmentalization is required at every floor. A thin overclad will improve a building's U-values, increase the thermal comfort of residential units, and create modest energy savings. However, MEP systems cannot be integrated into the upgraded façade, which may add to the time and cost of upgrading those systems in their current sites, and to the difficulty of maintaining new systems in the years after the completion of a comprehensive modernization project.

e) Double Skin with Old Thermal Line: The third/fourth option involves adding a modularized, prefabricated overclad to the existing façade and a secondary screen independent of the first skin, while continuing to use the old thermal line. In this option, old skin acts as a thermal line, though it cannot be left exposed and must be overcladded. Prior to installing the overclad to the existing façade, the masonry must be repaired. The old skin overclad can be unionized, and the new skin overclad can be stick built. The prefabricated modules that will be used for the new skin vary in size, though the overclad modules are up to 30 feet wide and slab by slab tall.

The overall depth of the new addition will be somewhere between 36" and 120", depending on the thickness of the new overclad and skin, and on the size of the cavity. The buffer zone reduces heat gains and heat losses, and the new space could be used to pre-heat air for the ventilation system. Thermal bridging will be required at anchor points.

f) Double Skin with New Thermal Line: The third option entails adding a modularized, prefabricated volume to the existing façade. The existing façade can be left exposed or overcladded. If it is overcladded, either both skins can be installed together, or the interior skin can be installed at a later stage. The existing masonry will need to be repaired in either option, though only if it is left exposed will it require an additional Local Law 11 inspection every five years. The weight of this option may require strengthening the existing structure and building additional foundations.

As in the second option, the overall depth of the new addition will be somewhere between 36" and 120", depending on the thickness of the volume. In this option, however, the volume cavity is inhabitable, though its use and depth may vary. This additional living space can be as thin as an occupiable windowsill and as wide as a full balcony, and window openings may be enlarged.

Adding balconies to existing NYCHA facades will increase the usable space of existing apartments. By using high-performance glass on a new, glazed balcony, residents will be able to use these spaces year-round. The new perimeter will reduce heat gains and losses, and it can be conditioned or semi-conditioned. A glazed balcony can act as a double-skin layer, increasing thermal insulation and decreasing noise. Moreover, this option allows solar energy to preheat the ventilation air. Solar heat gains during the summer are controlled using ventilation devices and solar shading. The outer class can be opened to prevent overheating of the unit. During the winter, as higher temperatures are created in balcony spaces, residents can open the inner glass to allow a fresh supply of pre-warmed air into their units. Public housing in other parts of the world, such as in France, have utilized this approach to improve the quality of life for residents, increase the size of units, as well as reduce energy usage up to 60%, providing multiple benefits to the residents living in the units.

g) Integrating MEP Systems: Only in the second and third options can MEP systems be integrated into the upgraded facades. In the second option, upgraded MEP systems can be integrated between the new and old skin, though ease of maintenance access must be considered. Additionally, all pipes will have to be insulated because they will lie outside the thermal boundary. In the third option, MEP systems can be integrated between the new and old skins, and new piping does not have to be insulated because it will lie inside the thermal boundary.

In all three cases, maintenance access to the upgraded infrastructure will have to be considered. For example, as the second option has no occupied space, it may prove difficult for maintenance staff to reach equipment that requires attention. In such a situation, an exterior stair may be necessary to provide maintenance access.

h) High Performance Windows: Regardless of additional façade and envelope improvements, all comprehensive modernization projects should receive upgraded, high-performance windows. High-performance windows can provide energy savings and increase thermal comfort and daylighting performance. Various window shapes and sizes, window-to-wall ratios ("WWR"), and glazing types should be considered. The choice of window replacement is site-specific depending on the orientations, pressure differentials, and use factors.

New windows should meet the New York City Energy Conservation Code and the NYC Overlay of EGC. Low-emissivity coatings or films must be used to improve solar and thermal performance (U-value) without compromising the amount of visible light transmitted. Static windows (also called traditional windows) technologies to improve thermal performance include tinted glazing, low-E glazing, self-cleaning glazing, anti-reflective glass, and insulated glass. Active windows technologies include electrochromic glazing, photovoltaic glazing, thermos-chromic glazing, gas-o-chromic glazing, and liquid crystal glazing.

Window frames made from structurally improved fiberglass or uPVC, a more robust form of vinyl, typically outperform aluminum frames in terms of energy and tenant comfort. Casement and awning-type windows are far easier to operate than slider and double-hung windows, better at keeping out cold drafts, and should be installed where possible. The challenge for the future is to find a window with all these characteristics that is price-competitive, structurally acceptable for use in high-rises, resistant to solar degradation, and easily adapted for insect screens and child guards. Window selections should therefore be a result of site-specific coordination with mechanical system interventions to provide the highest performance possible.

Renovated facade and windows at converted PACT development, Baychester Houses

4.3 Roofs

The majority of NYCHA buildings have low-slope roofs, many of which were originally designed as "no-slope" coal-tar roofs. The original roofing systems had few roof drains and often allowed standing water to accumulate. In the NYCHA Design Guidelines, the Design Department recommends two roofing systems for rehabilitating existing low-slope roofs:

- Cold fluid applied reinforced roofing: no-slope with drainage enhancers (most frequently used).
- Three-ply built-up roofing with an SBS cap sheets: low slope with tapered insulation.

Designers should choose from above listed systems based on site conditions and budget. Before selecting a roofing system, analyze existing conditions, including number of roof drains, configuration of bulkhead doors, building edge condition, energy code requirements, and construction schedule. The roof coating must be Energy Star certified.

The roofing design should be selected based on existing roof condition, new requirements, and allocated budget. The roofing design incorporates analysis of the existing roof including drains, bulkheads, parapets, railings, and other applicable elements. Any new roofing design should follow the manufacturer's directions in order to receive a long-term warranty and verify compliance with latest Energy Code. Through the $1.3-billion City investment in roof replacements in 2017, NYCHA has been able to or expects to replace the roofs at eighty developments across the city (799 buildings). Through this extensive residential roof replacement work, the Design Department has also been working on new, more durable designs for lower roofs (Community and Senior Centers) attached to the main apartment buildings. A new approach was needed for protection and durability since those roofs are more exposed and subject to damage. Concrete pavers and metal panels are being carefully incorporated in the current design approach which will add to durability of the roofs in question and benefit the building quality in general.

Rooftop solar installations at converted PACT development, Ocean Bay Houses

Green Roofs
Local Law 92 and 94 of 2019 established the requirements for a Sustainable Roofing Zone, which is a requirement for either solar panel installation or green roof w/vegetation or combination of those two. Since this applies strictly for new or completely replaced roof structures NYCHA roofs were not affected with greatly with this Code, but in the future, this will be considered as an option especially for additions to the existing Community Centers or lower buildings in general.

Cool Roofs
Cool roofs reduce summer heat gains by reflecting solar light and heat, transmitting less heat into the building. The NYC Building Code, under Local Law 21, mandates a reflective 'cool roof' coating on many new and replaced roofs. Local Law 94 applies more stringent emittance, reflective, and insulation requirements.

Blue Roofs
Blue Roof concept stores water for some time and allows for slow release. It is significant way to prevent flooding and establish more reliable control on the water not allowing it to overflow the system. Stored water can be used in various ways if design provides for it, cooling and sporting activities being among them. NYCHA is exploring these possibilities to improve its communities and also protect environment around them.

Local Law 92
The NYC Department of Housing Preservation and Development ("HPD") is currently developing a compliance pathway for NYCHA buildings to comply with Local Law 92. This law will require roofs of certain buildings to be partially covered with a green roof and/or a solar photovoltaic system.

Queensbridge Houses community shared solar installation

4.4 Indoor Environments

Design Quality
The indoor environment should be a place of comfort for NYCHA residents. The recent COVID-19 pandemic highlighted the importance of having homes that provide a safe refuge from the risks that New Yorkers face outdoors. The materials used on comprehensive modernization projects must meet industry best practices, be visually appealing, and be well-suited to the needs of residents. Interior spaces and amenities are some of the areas where resident feedback resident will provide NYCHA with significant guidance on a comprehensive modernization project. People's lifestyles have changed dramatically in comparison to even a decade ago, and living spaces require more flexibility and adaptation to meet resident needs.

In renovating New York's public housing, it is essential to use healthy, durable, high-quality, and attractive materials. Materials used in all indoor environments–including dwelling units, corridors, lobbies, and other common areas–should have finishes that are robust and easy to maintain and replace. A comprehensive modernization must not only bring these indoor environments into compliance with the HUD Agreement, but should also enhance residents' perceptions of their homes, improve indoor air quality, and provide more comfortable spaces. Guidelines and specifications for a selection of products for use in indoor environments can be found in NYCHA's 2016 Design Guidelines for Rehabilitation and any subsequent updates. Comprehensive modernizations will also be required to meet, at minimum, the latest Enterprise Green Communities standards and NYC Overlay, which outline in-depth materials and components recommended for high quality, healthy, and energy-efficient indoor spaces.

Integration of Living Spaces
Due to years of replacing individual systems as different funding opportunities arose, the interiors of NYCHA buildings often have structural, electrical, or mechanical systems that were retrofitted to accommodate the existing conditions. As much as is technically feasible, comprehensive modernizations should integrate and improve the many additions and interventions a building may have undergone over the years. If a project budget allows, comprehensive modernization also presents an opportunity to reconfigure some apartment layouts to be more accessible, visibly integrated, and livable for residents. Some of the existing layouts offer smaller, compartmentalized living spaces that may not be conducive to lifestyles and general well-being of residents today.

A better integration between the overall site, building, and dwelling unit can be accomplished through better design of the thresholds, passageways, and lobbies between these spaces. Every NYCHA development has nuances, and these differences can create opportunities unique to a site. For example, a development in the Bronx offers residents two-story duplexes within an apartment building, providing a townhouse-like unit layout with the amenities of a multifamily structure.

The front doors of the apartments offer an occasion to integrate wayfinding techniques that better individualize apartment entryways. This may help residents feel a stronger connection to their particular apartments and disrupt the monotony of some of the longer hallways found in NYCHA building.

Accessibility
Improving accessibility to NYCHA's buildings and grounds, the majority of which were designed and built long before accessibility was a consideration, much less a legal requirement, is very difficult, though some apartments are easier to modify than others. While reconfiguring apartment layouts, design teams should ensure that all the units and common areas are as accessible as possible. Designers should consider:

- Accessible routes to buildings

- Accessible building entryways
- Accessible pathways to common and public-use areas
- Wheelchair accessible doors
- Accessible access and egress to and from residential units
- Accessible electrical outlets, light switches, thermostats, etc.
- Accessible bathrooms with reinforced walls that can support grab bars
- Accessible kitchens and bathrooms that are easily usable by persons with disabilities

Universal designs that allow the Authority to adapt units to meet its accessibility needs are highly encouraged.

Accessible entryways at converted PACT development, Baychester Houses

Component Parts

Lifecycle cost and durability should bear upon the evaluation of materials during the design process. Designs should incorporate proven construction cost-saving techniques, durable and cost-effective materials suitable for the intended use, energy-saving features, and cost-efficient mechanical systems. Minimizing initial construction costs and continuing operational and maintenance costs are essential to the success of affordable housing programs.

Modular products will offer NYCHA flexibility in replacing and redesigning components and units to meet future residents' needs. New kitchen equipment (such as ranges and refrigerators) and service components should be chosen in part to ease future maintenance and replacements. For example, quick-connect utility lines offer maintenance and operations flexibility in the future. All new appliances should meet the Enterprise Green Community requirements. Comprehensive modernization project planning should also consider that NYCHA residents often install appliances of their own. During renovations, residents may want their appliances to be safely removed for use elsewhere.

All new cabinetry should have solid-hard wood frames and, at a minimum, five-ply side panels and seven-ply doors. All cabinetry wood products should emit no formaldehyde and be designed for easy removal so as to make apartments ADA adaptable.

Material Selection

NYCHA is strongly committed to improving indoor air quality and providing healthy and sustainable apartments free of mold, pests, and asthma-triggering materials. The use of low or no volatile organic compound ("VOC"), non-toxic, and sustainable materials is paramount when specifying products for healthy environments. Many public housing residents have chronic respiratory conditions that can be exacerbated by the off-gassing of harmful products. Non-vinyl, non-carpet flooring should be used throughout all buildings, and in rooms prone to moisture buildup, materials with moisture-resistant properties should be utilized. In order to target existing mold issues and mitigate the possibility of reoccurrence throughout NYCHA buildings, but particularly in bathrooms, kitchens, and laundry rooms, comprehensive modernization projects should prioritize materials that are (1) not prone to deterioration due to moisture intrusion, (2) resistant to the growth of mold, and (3) easily cleanable and replaceable.

Electrical Components

A typical NYCHA electrical system rehabilitation includes updates of outlets, switch configurations, lighting, fire alarms, and security systems. Comprehensive modernization project teams should design and install electrical systems so that, in case of emergency, their operation will not be grossly affected. Switchgear and main disconnects should be located above flood elevation. Also, comprehensive modernization project teams are encouraged to provide sources of emergency power.

Interior Lighting

Lighting impacts visibility, safety, and resident mood and comfort. Currently, lighting conditions in most NYCHA interior and exterior spaces are outdated and can contribute to glare, poor color rendering, and issues with depth perception. This fosters an "institutional" feeling at NYCHA developments. Moreover, dark spots or glares can contribute to an unwelcoming environment in which individuals may feel and/or be more vulnerable and susceptible to crime. Poor lighting effects such as this may also potentially inhibit CCTV cameras from capturing useful security footage in the event that a crime does occur.

LED bulbs are standard on all new NYCHA lighting and are being installed through the Authority's Energy Performance Contracts and Weatherization Assistance Program, at 101 developments. However, some older fixtures are not in the program and may still host incandescent, fluorescent, halogen, or even mercury vapor bulbs.

Natural daylighting and other resident needs should be considering when designing interior lighting systems. Lighting design should conform to the American National Standards Institute's "Guide to Designing Quality Lighting for People and Buildings." Lighting systems should incorporate redundancy in all critical areas (including egress areas, assembly occupancies, and health care facilities, etc.) so that failure of any single element of the system, such as a lamp, ballast, switch, circuit breaker, or conductor, does not leave any portion of a critical area poorly illuminated.

Renovated apartment interiors at converted PACT development, Ocean Bay Houses

Natural daylight should be provided whenever possible due to its proven psychological benefits. When daylighting is not possible, light fixtures with a higher color rendering index are preferred. These fixtures increase perceptions of safety throughout interior and exterior spaces. Seasonal shifts in lighting should also be considered, as many NYCHA buildings have specific orientations to sunlight and can be impacted by tree canopy cover.

Design teams for comprehensive modernization projects should include a Professional Lighting Designer, Lighting Certified by the National Council on Qualifications for the Lighting Professions.

Colors

Paint color significantly influence how spacious, clean, or welcoming a space feels. For ease of maintenance, NYCHA currently implements a very limited color palette in interior spaces. Comprehensive modernization projects should explore a wider range of color combinations that provide residents with variation but remain manageable for operations and maintenance staff. Particularly in high-rise buildings, color variation can support resident wayfinding. Color choices also offer an opportunity to engage and partner with residents on selecting color palettes preferred by residents.

Additionally, art can be a powerful tool for directly reflecting resident feedback in interior spaces. Art can improve the resident experience and help to inspire interest across different age groups. NYCHA has a rich history and portfolio of exterior artwork that reflects local culture and historical influences. In corridors or building lobbies, indoor art may offer a similar opportunity. Depending on residents' interest, such art may be as simple as accent colors on walls and other variations in color patterns, and as complex a full mural.

Community Centers and Building Amenities

Community centers provide NYCHA residents with programs that support their needs, such as childcare, workforce development, and youth activities. Community centers also offer residents a direct line of communication to the community-based organizations ("CBOs") that lease these spaces from the Authority, and through these CBOs, to NYCHA's Department of Family Partnerships. These centers are also destinations in times of emergency, such as extreme heat events, when they serve as cooling centers for those who may not have air conditioning in their apartments. The design of these spaces should highlight them as nodes of civic engagement and should reflect the architectural character of the neighborhood.

Other ground-floor spaces in NYCHA buildings vary in size and design. Most ground floors at NYCHA buildings lack transparency and visibility due to the compartmentalized nature of the space. These ground floors also reflect outdated needs (such as perambulator rooms) that can be renovated to host more useful infrastructure. Some needs that have been identified by staff and residents for ground floor spaces are mail and package rooms; laundry rooms; community accommodations; management, security, and resident association offices; and waste and recycling rooms. All decisions regarding which amenities are included and how they are designed should be informed by direct input from a building's residents and staff.

Waste and recycling infrastructure are also integral to the health and safety of residents and should be a key consideration when renovating ground floor spaces. NYCHA's Waste Management Plan will provide priority sites with many new assets, including interior compactors, enlarged trash hopper doors, and ground floor modifications to ensure that waste and recyclables do not attract pests.

Finally, the ground floor is where notices can be communicated and/or distributed to NYCHA residents. In 2020, NYCHA piloted a digital screen at Polo Grounds that helped to inform residents of available resources and ongoing work. In a comprehensive modernization, this kind of tool could be implemented at ground floor locations, such as in entryways, near elevators, and by stairwells, to improve the flow of communication to residents.

Renovated lobby at converted PACT development, Murphy Houses

Maintenance

Alongside the design and construction of comprehensive modernization projects, NYCHA and its contractors must develop maintenance standards for all renovated spaces, especially apartment interiors. Maintenance standards that instruct on preventative and predictive maintenance will help the Authority maximize the efficiency of its operation and to extend the useful life of equipment, systems, and structures. These standards supplement manufacturer's instructions and contribute to NYCHA's asset management system, ensuring regular maintenance.

During comprehensive modernization projects, NYCHA must also identify operations and maintenance efficiencies such as easy access to equipment and systems controls. This will prevent additional penetrations to building walls when future renovations are required.

Comprehensive modernization design requirements should also consider that residents and staff prefer spaces that can be cleaned efficiently, with fewer people spending less time. Finishes that are easy to clean–such as wall-hung fixtures that eliminates the use of legs, pedestals, and other supports, therein providing greater access to floors–are encouraged. Furthermore, in order to support NYCHA's Integrated Pest Management strategy, all penetrations should be sealed to allow Operations and Maintenance staff easy access to conduct inspections.

05 MODERNIZATION STRATEGIES

HVAC & Electrical Systems

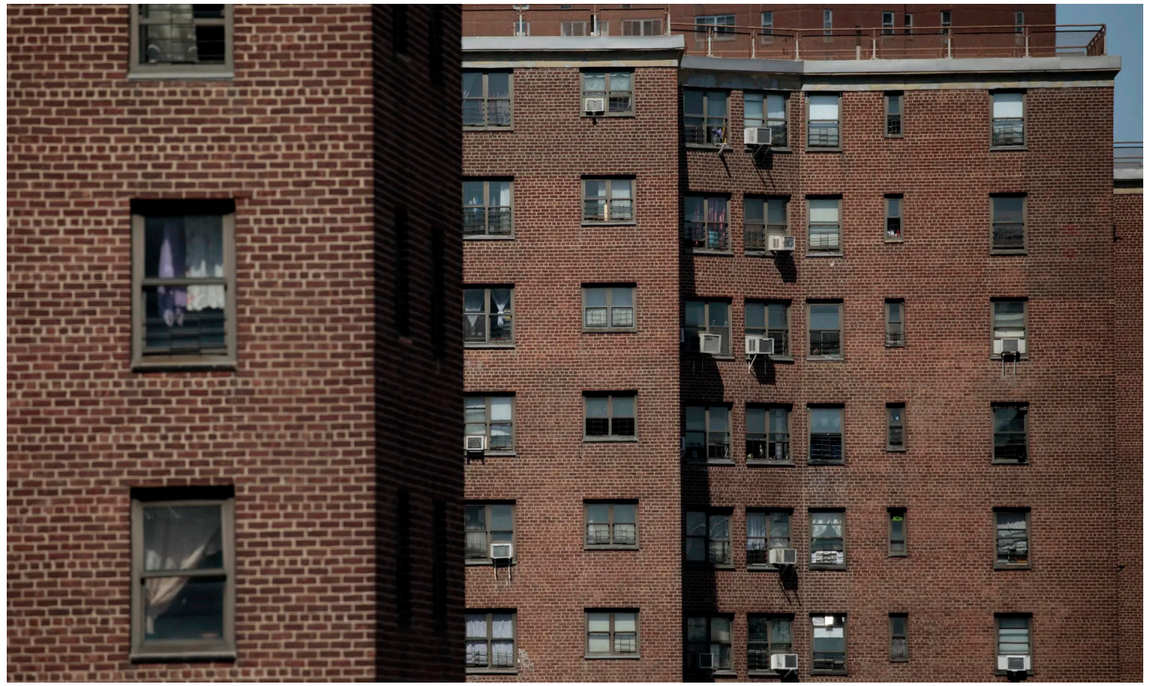
5.1 Heating, Ventilation & Cooling

Existing HVAC Conditions - Cooling

Air conditioning is the largest source of apartment electrical use in NYCHA developments and individual air conditioners are the norm for residents. Air conditioning is already the largest driver of both electricity consumption and demand within NYCHA buildings, despite not being present in every apartment. Research conducted for NYCHA in 2017 by the Environmental Defense Fund found that in NYCHA apartments, the presence of a single air conditioner increased electricity use by 30% during the summer; multiple air conditioner units had an even larger impact.

Cooling is becoming a necessity for reasons of public health and climate change. The New York City Panel on Climate Change predicts that by the 2050s, mean average temperatures will increase between 4.0 and 5.7°F; by the 2080s, the Panel expects heat waves to triple from the pre-2000 baseline of two per year to six per year. According to the Mayor's Office of Climate Resiliency, "air conditioning was found to be the most effective and important way to protect at-risk individuals on hot days and to keep them from experiencing heat-related illnesses." As mechanical cooling becomes a public-health imperative, the challenge to reduce electricity consumption and demand will become more difficult.

Climate change is expected to significantly increase air conditioning use. One of the greatest climate-related challenges that NYCHA will face in the coming years is that of extreme heat: over 100 New Yorkers are killed each year from heat stroke and other heat-related threats, and climate change is likely to increase this threat in the future. Seniors are especially vulnerable to heat-related climate threats. In addition, increased electric load during heat waves may lead to brownouts and blackouts, putting further stress on a building's residents and cooling systems.

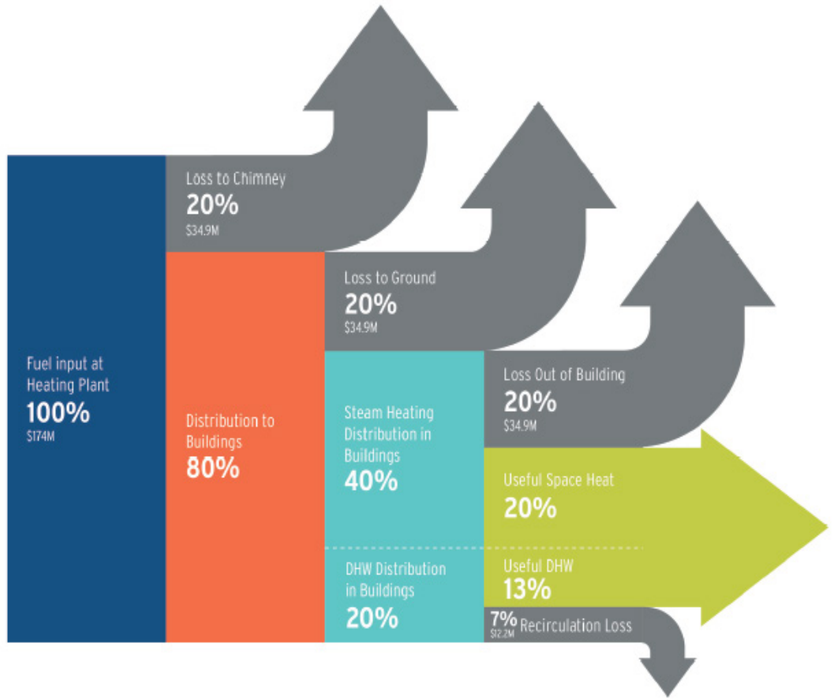


Air conditioning is the largest driver of electricity consumption and demand within NYCHA buildings

Existing HVAC Conditions – Steam Heating

Steam heat is a 19th-century technology incompatible with 21st-century needs. Steam boilers, the most common heating technology in place currently at NYCHA buildings, are among the least-efficient heating technologies. Even under ideal conditions, campus steam heat wastes energy. The best steam boilers are about 80% efficient, meaning that under ideal conditions 80% of the energy input as fuel is turned into useful heat. In comparison, the best hydronic boilers approach 95% efficiency, while heat pumps are three times more efficient than the best hydronic boilers.

The efficiency of steam boilers drops significantly during real-world operations. Because of the need for steam boiler water treatment, thousands of gallons of hot boiler water must be discharged ("blown down") every day; the energy in this water literally goes down the drain and significantly reduces efficiency. Campus systems, in which boiler plants in one building produce steam for other buildings, must contend with distribution losses—energy escaping into the air and ground instead of being used in buildings. Over the course of a year, when these and other operational losses are considered, only about a third of a campus steam system's input energy is converted to useful heat.



Campus steam heat is nearly impossible to keep running in top condition

A campus steam heating system comprises miles of pipe, thousands of pipe joints, complicated controls, numerous moving parts, high temperatures and corrosive materials. It requires almost constant monitoring and care, yet many of its elements are buried or otherwise difficult to access. Pervasive leaks in buried distribution pipes are prohibitively expensive to locate and repair. Even a small amount of neglect, deferred maintenance or incorrect operation inevitably leads to failures throughout the system. Failed steam traps, to cite just one example, lead to severe heat imbalance, resident discomfort, damaged vacuum pumps, and water hammer. A failed condensate pump motor seal can lead to wasted heat, water damage in tank rooms, excessive boiler makeup water, and boiler tube replacement.

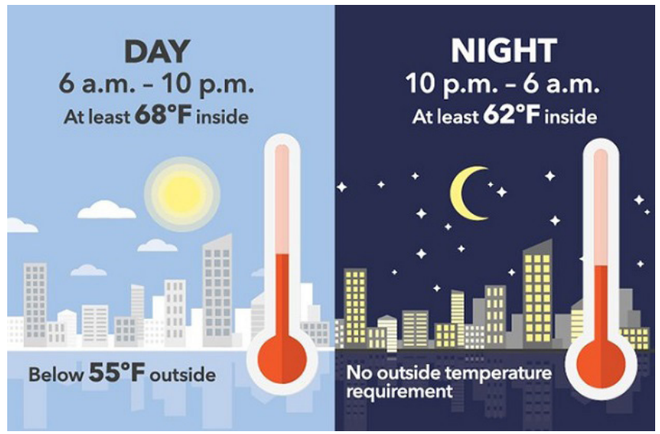
These problems extend to the underground steam distribution lines, which have not been fully replaced since their original installation and are at or near the end of their useful life. Developments that continue to use campus steam for the foreseeable future—those that have recently replaced boiler plants, for example—will require replacement (rather than repair) of underground distribution lines to keep the system in efficient working order. If NYCHA were to replace additional campus steam boiler plants in-kind and repair underground distribution between now and 2050, NYCHA would likely be expending significant resources on systems that will not contribute significantly to the 80x50 goal.

Exacerbating the situation is the fact that, industry-wide, the number of heating and mechanical professionals who know how to operate or repair these systems to their original design intent is very small and decreases every year. Proper steam system operation is challenging at the best of times. As the knowledge base dwindles, steam system operation and repair will become more and more difficult and expensive.

Existing HVAC Conditions – Overheating Apartments

Avoiding overheating is exceedingly difficult in steam heating systems because different apartments need different amounts of heat, even though the steam system has only one "speed." North-facing apartments receive less solar heat than south-facing apartments. Wind direction and intensity can also affect the heating needs of apartments at different times. Apartments located on different floors are affected differently by steam distribution problems. Some apartments experience more air leakage and drafts than others. Finally, different people may simply have different ambient temperature preferences. Heating professionals observe that in steam buildings the rule of thumb is to "turn up" the heat until the last tenant stops complaining of cold, and those who are overheated will use their "double-hung zone valves" –open their windows – to control the temperature.

Providing consistently comfortable heat in every apartment without under- or overheating would require control over the amount of steam provided to each room in each apartment. Because steam is a gas, its movement is more difficult to control than a liquid's (like hot water). It is possible to somewhat regulate the amount of steam that goes into each radiator, but in practice it is rarely achieved. Because it is difficult to control the amount of heat delivered through a steam system, the temperature in a given apartment will fluctuate significantly over the course of a day. Variable-vacuum steam systems, such as NYCHA's, theoretically can vary the temperature of steam and thus vary the output of the radiators, but even systems in a perfect state of repair are rarely, if ever, successfully operated in this way. Add to this the effects of solar heat and wind, and it becomes exceptionally difficult to "balance" a steam heating system.



NYC required interior temperatures

At NYCHA, the problem of pervasive overheating has been thoroughly documented. For example, NYCHA's Performance Tracking and Analytics Department ("PTAD") analyzed apartment temperature sensor data from October 2017 – January 2018 at 11 developments. The data showed that there was an overwhelming amount of overheating. During the day, only about 37% of daily apartment temperature averages met the study's target range of 68°F-74°F. More than half (59%) exceeded 75°F, and more than 14% exceeded 80°F. At night, 92% exceeded the upper limit of the target temperature range of 62-69°F.

Near-Term Options for Improved Efficiency

NYCHA should adopt low-carbon requirements for future boiler plant replacements, and attempt aggressive carbon reductions in heating system capital improvement projects, because not every project will be able to achieve deep reductions within NYCHA's financial constraints.

In 2019, NYCHA began to plan for heating system replacement projects at 11 developments (126 buildings, 10,050 apartments) using its newly-available design-build authority, and established low-carbon goals as a primary design requirement. Using a fixed-budget/best value methodology for design-build, NYCHA developed a technology-neutral procurement process that uses anticipated carbon intensity in 2030 and 2050 as determinants of contract award. NYCHA's design-build program provides a maximum budget for each project, along with a prioritized list of non-price factors for proposal evaluation. As of November 2021, three contracts covering seven developments' heating systems have been signed with Design-Build teams.

Optimize campus steam

Existing campus steam systems must be optimized. Carbon intensity across campus steam developments varies by a factor of two largely because some heating systems have been better maintained than others. With steam optimization at all developments, it is possible to reduce energy consumption and carbon intensity, and to greatly reduce the variation in performance. Although steam optimization alone will not be sufficient to achieve LL97's 2030 targets, a 15% reduction in gas consumption across the board would represent a quarter of the reduction in carbon intensity required by 2030.

Distribution maintenance and balancing: The NYCHA heating management department has already begun to adopt a more systematic approach to steam system maintenance. In 2018, for example, NYCHA replaced all steam traps on steam mains at five developments. NYCHA is also testing a conversion from radiator steam traps to orifice plates to eliminate steam in return lines and the need for radiator trap maintenance. NYCHA has also tested Thermostatic Radiator Valves in several buildings and is evaluating their efficacy.

Indoor temperature sensors and new Building Management System (BMS): In 2011, NYCHA began installing indoor temperature sensors to eliminate overheating. NYCHA greatly expanded this effort in 2016 by using the HUD Energy Performance Contracting (EPC) program, which has the advantage of not requiring commitment of capital funds, as the primary implementation mechanism. As of March 2020, NYCHA's active EPCs are funding installation of indoor temperature sensors in 64 developments (629 buildings; 51,164 apartments). An additional 44 developments have been audited for new EPCs, which will include the installation of indoor temperature sensors. The new BMS and indoor temperature feedback controls are projected to reduce energy consumption and GHG emissions by 15%.

The HUD Agreement obligates NYCHA to install indoor temperature sensors and BMS systems throughout the NYCHA portfolio. Accordingly, in February 2020, NYCHA's board approved the future award of additional new EPCs of up to $400 million to four firms (Engie, Willdan, Johnson Controls, and Ameresco) to carry out this work.

The new BMS being installed replaces an existing proprietary system with limited capabilities. Among the advantages of the new system is that if a sensor component or control device fails, NYCHA will be able to source parts and services competitively from multiple manufacturers. Additionally, the new BMS allows enhanced reporting, analytics and alarms for every point monitored in the system. The BMS will monitor apartment temperatures; boiler plants, tank rooms, and hot water generating equipment; steam pressure and other distribution factors at various points in the system; water, gas, and electricity status; and other critical indicators.

The BMS enhances operations of the department responsible for the maintenance of heating systems. Work orders can be initiated automatically when maintenance issues are detected. Apartment temperature data can be used to determine which apartments and/or lines may need preventive maintenance, such as radiator valve or trap servicing, and identify under- or overheated areas.

Distribution system maintenance and the EPC-funded work are complementary measures that must be undertaken together. Failure to maintain the distribution system jeopardizes NYCHA's ability to pay back the EPC-associated debt. EPCs are funded by bank loans, which are then paid back by a HUD subsidy sized according to the energy cost savings the EPC work delivers. In order to make sure that the cost savings materialize during the EPC term of up to 20 years, HUD requires annual monitoring and verification. Lack of distribution maintenance or poor operating parameters would result in failure to meet the savings targets, and the attendant loss of HUD subsidy. In such an event, NYCHA would need to repay the bank loan with its own resources.

Weatherize small buildings

The LL97 reduction targets for NYCHA are portfolio-wide, rather than building-specific. Mechanical systems in NYCHA's small buildings differ from those in the large developments. For example, NYCHA's small multifamily buildings often have idiosyncratic distribution configurations—sometimes the boilers serve one building, and sometimes they serve several attached buildings. Therefore, small buildings tend to be best served by building-specific packages of interventions, rather than by standardized upgrades.

In 2015 NYCHA worked with New York State Homes and Community Renewal ("HCR") to facilitate the use of the federally-funded, state-administered Weatherization Assistance Program ("WAP") for NYCHA's small buildings. NYCHA pre-qualified 8,000 apartments for the program and pledged to pursue $30 million in WAP projects over 10 years. WAP delivers a package of energy-efficiency measures including boiler and window replacements, ventilation upgrades, and hot water-conserving fixtures. NYCHA pays 20-40% of the cost, with the balance contributed by the State's WAP grant. Construction is overseen by non-profit community-based organizations designated by HCR. Since 2015, 2,983 apartments in 163 NYCHA buildings have benefitted from WAP upgrades, resulting in typical savings of 24%.

The State's Climate Leadership and Community Protection Act ("CLCPA") requires GHG emissions to be reduced 85% below 1990 levels by 2050. NYCHA will advocate for a CLCPA-compliant WAP option – an option that delivers deeper carbon reductions than the standard WAP program described above. Such a program would also help the State meet the CLCPA requirement that no less than 35% of investments made under CLCPA must benefit underserved communities.

High Performance Building Enclosures

Much of the infrastructure in NYCHA buildings dates from the original construction. This includes not only the heating distribution systems, but also the domestic and waste plumbing, electrical service to apartments, and the building envelope. Although it would likely be most cost-efficient to upgrade all systems at once, that option is also likely the most disruptive to residents when constructed conventionally.

NYCHA is currently participating in the New York State Energy Research and Development Authority's ("NYSERDA") RetrofitNY program to explore the possibility of using envelope recladding as a means to radically reduce the cost of plumbing, ventilation and electrical upgrades. RetrofitNY seeks to catalyze a market for low-cost net zero-energy retrofits using pre-fabricated envelope panels and other modularized technologies that would enable existing buildings to reach net zero carbon emissions at lower costs than traditional construction projects. Several multifamily retrofit projects are now in construction. In addition to highly-insulated and air-sealed building envelopes, these projects include energy-efficient, balanced mechanical ventilation systems to improve indoor air quality.

Renovated façade at converted PACT development, Baychester Houses

NYCHA has an active program of façade repairs (including repointing) that does not improve energy performance but is required by the City's Façade Inspection and Safety Program ("FISP"). Recent changes in the law have increased the costs of FISP compliance. A comprehensive envelope recladding program can improve energy performance, eliminate the on-going FISP costs, and radically reduce the cost of plumbing, ventilation, and electrical upgrades.

Although it would be premature to anticipate the outcomes of this demonstration project, NYCHA's newly-acquired design-build authority makes a scaled-up program of enclosure plus infrastructure retrofits a practical possibility. NYCHA comprehensive modernizations would include heating system replacement and include energy performance criteria designed to meet LL97 goals.

Multipurpose Capital Improvements

In NYCHA buildings, central boiler plants produce steam for space heating and hot water. The buried steam pipes connecting satellite buildings to the central boiler plant or steam room may leak and/or lose heat to the ground, both of which reduce system efficiency. Domestic hot water ("DHW") is typically generated by steam-to-hot-water heat exchangers located in the basement of each building. The need to produce DHW means that steam must be produced or purchased year-round, which is inefficient and costly. Finally, a centralized system has the potential for reliability issues; a failure at the central plant disrupts both heat and domestic hot water supplied to all buildings in a development, whereas a failure in a decentralized system only affects a single building. Future systems should be designed to minimize and localize the impact of any failures.

NYCHA has developed general design guidelines for converting typical campus steam NYCHA buildings – which have steam-to-hot-water heat exchangers that are fed year-round from the boiler plant – to decentralized air-source heat pump DHW systems. Air source heat pumps can generate DHW by extracting heat from the outside air–even in outdoor temperatures down to -20°F and represent one of many potential solutions.

Submetering

Addressing in-apartment energy use presents significant opportunities to improve resident quality of life through elimination of gas outages, provision of cooling, and reduction of the total cost of rent and utilities, while simultaneously reducing NYCHA's electrification costs. Electric submeters and billing for consumption in individual apartments is a proven strategy in reducing energy consumption, but the possible costs and benefits for residents must be identified and addressed before implementation.

Although NYCHA has periodically evaluated options for submetering, it has not yet prioritized in-apartment energy consumption reduction as a key part of its climate mitigation plan. Submetered billing was not previously pursued by NYCHA for a variety of reasons: NYCHA's below-market electric rates made it harder to justify the cost of submetering on the basis of cost savings, and HUD policies made it difficult to fund submetering from HUD Capital Funds. Many commercially-available submetering technologies were platform-specific, requiring NYCHA to put all its eggs in one basket with either a single vendor or proprietary technology that would have limited options for enhancement or maintenance. In the context of LL97's aggressive carbon reduction goals, it is now critical to develop an approach to in-apartment energy reduction that includes submetering.

If utility allowances were provided to NYCHA residents, they would receive a rent reduction in the amount of the utility allowance. Since New York Power Authority electricity costs roughly 25% less than electricity from the local utilities, the cost of sub-metered electricity to residents would be lower for a given amount of consumption than if they were direct-metered by the local utilities.

If residents were to use less than the amount of the utility allowance, submetering would present an opportunity to reduce their total monthly outlay for rent and utilities. The latest available submeters can provide real-time information, so energy users can identify waste and adjust consumption as needed. In the future, these meters may help residents benefit from electricity rates tailored to discourage consumption during peak periods. NYCHA's electrical infrastructure varies widely from building to building. Some buildings still have their original switchgear and wiring, while others have had theirs renovated. The cost and complexity of a submetering installation depends heavily on the topology of the electric risers and distribution to the apartments.

In Unit Thermal Controls

In unit thermal controls integrated with building management systems can provide superior comfort to tenants throughout the building without forcing the system to either overheat or underheat others. In practice, controlling individual apartment temperatures with a steam system is extremely difficult. The ability to fine tune systems and provide greater levels of control will increase significantly once NYCHA transitions from steam systems to more efficient systems, such as heat pumps.

Building Management System (BMS)

An effective BMS system allows enhanced reporting, analytics and alarms for every point monitored in the system. The BMS should monitor apartment temperatures; boiler plants, tank rooms, and hot water generating equipment; steam pressure and other distribution factors at various points in the system; water, gas, and electricity status; and other critical indicators. Should a sensor component or control device fail, NYCHA should be able to source parts and services competitively from multiple manufacturers.

Such a system enhances operations of the department responsible for the maintenance of heating systems while improving the quality of life of residents. Work orders could be initiated automatically when maintenance issues are detected and apartment temperature data could be used to determine which apartments and/or lines may need preventive maintenance, such as radiator valve or trap servicing, and identify under- or overheated areas.

Future systems should be designed to be robust and require minimal maintenance. The campus steam systems currently in place are made up of miles of underground pipe, thousands of joints and moving parts, all of which are subject to failure during routine operations and are increasingly prone to fail if proper maintenance and operations procedures are not followed.

New Efficient Technologies and Approaches

Hydronic Conversion

Hydronic distribution systems circulate hot water instead of steam to the radiators. Building-specific hydronic systems are much more energy-efficient than campus steam systems because of higher combustion efficiency, lower circulating temperature, lower “off-cycle” losses, and no losses from campus-style distribution, among other factors. Electrification through hydronic conversion would entail replacing steam distribution systems with hot water distribution and using air-to-water heat pumps (“AWHPs”) or ground-source heat pumps to heat the water. Whether or when AWHPs that can meet the needs of buildings of NYCHA’s scale will be available in the U.S. is unknown, although heat pump technology is pervasive in parts of Asia and Europe. Until AWHPs suitable for multifamily buildings become more widely available, electrification through hydronic conversion may entail two steps: first convert from steam to hydronic with gas-fired condensing boilers, then replace the boilers with heat pumps several years later.

The two-step approach, however, has three disadvantages. First, fossil-fueled boilers still require combustion, even if it is more efficient. Second, typical hydronic systems do not provide cooling (which is increasingly becoming a necessity because of climate change). Third, any gas-fueled system will require new gas service to the individual buildings, and continued availability of low-cost gas service is not guaranteed. Gas capacity is already severely constrained in some parts of the New York City metro area, and in February 2020, Mayor Bill de Blasio issued Executive Order 52 to stop any new infrastructure, such as power plant expansions, pipelines, or terminals that expand the supply of fossil fuels.

Hydronic conversion requires work in every apartment to install new distribution pipes and new convectors to replace steam radiators. NYCHA must plan carefully to minimize disruption to residents. The recent hydronic conversion at Ocean Bay-Bayside has proven that careful planning can make unit access very efficient; developer MDG reported that all in-unit heating system work was completed in only one day per apartment.

Heat Pumps

Heat pumps come in three primary forms: air-source, water-source, and ground-source, distinguished by the medium with which heat is exchanged.

The best heat pumps currently available are, on average, 6 to 10 times as efficient as a central steam system. This is possible because heat pumps move heat from outdoors to in (or indoors to out for cooling), rather than create heat through combustion. Energy, usually electricity, is used to power a compressor, and this compressor takes advantage of the laws of thermodynamics to move heat from one place to another. It takes much less energy input to move heat than to create it. The measure of a heat pump’s efficiency is the Coefficient of Performance (“COP”). A typical high-quality heat pump has an average COP of about 3.0, which means that it moves 3.0 times as much heat energy as it uses in input energy. The COP of any boiler-based system will always be less than 1.0. An inefficient steam system would have a COP of about 0.3 to 0.5.

Air-source heat pumps (“ASHP”) are an alternative to existing building heating and cooling technologies that make use of natural gas (e.g. furnaces, boilers, and absorption chillers). An ASHP uses a working fluid to transfer heat between outdoor air and indoor air. They can be run in cooling mode or heating mode and can sometimes provide both simultaneously (using heat recovery). Heat pumps are also efficient; depending on the outdoor temperature, a heat pump can achieve a COP of 3 to 4, meaning the thermal energy delivered is 3 to 4 times the electrical energy consumed. They are powered with electricity.

Outdoor units of heat pumps systems at Fort Independence

All types of ASHP systems consist of outdoor units, which house the compressor, and indoor units, which distribute conditioned air into rooms. Variable Refrigerant Flow ("VRF") systems employ centralized outdoor units to serve indoor units throughout an entire building. "Multi-split" systems require one or more outdoor units for every apartment. New York City's weather requires the use of so-called "cold climate" heat pumps that are certified by a third party.

ASHPs solve several problems. They are far more reliable than steam systems and require much less maintenance. Steam and heating hot water leaks are eliminated. ASHPs permit precise control of each room's temperature and virtually eliminate over- and underheating. Every apartment can now have air conditioning, which is critical for protecting the health and well-being of vulnerable, particularly senior, residents during hot weather (which is expected to become more frequent and severe as a result of the changing climate). In a multi-split installation, if one heat pump fails, only one apartment is affected, not an entire building, and because each apartment has its own system, the apartment submeter can provide a feedback loop to encourage energy conservation.

Water-source heat pumps require a body of water with which to exchange heat. This can be done with a water body (e.g. a lake or river) or with an adapted cooling tower (winterized or one that uses glycol). Water-source heat pumps require more infrastructure and are not as readily adaptable to retrofit applications as ASHP.

Ground-source heat pumps ("GSHPs") could also be widely used in New York City, but are best used in new construction. They require open land area for drilling or excavating, which is much easier to accomplish before a building is built. A GSHP system is currently operational at 344 East 28th street, providing the development with hot water throughout the year (see "Heat Pumps for Domestic Hot Water" section for more discussion of this GSHP system).

Building Enclosure Retrofits

Mid-century multifamily buildings, including NYCHA's, leak a lot of air and have little or no wall insulation. No matter how efficient the mechanical system, the building enclosure limits how much energy can be saved. NYCHA must therefore seek out or develop cost-effective ways to airseal and insulate its buildings to achieve the best possible energy performance.

Modeled savings show that a combination of exterior insulation and airsealing can reduce heat loss from the building on the order of 50% to 80%; however, cost-effectiveness of exterior insulation retrofit systems has not been well-documented. Pre-fabricated insulated masonry panels are already available and if it can be shown that they (or systems with similar characteristics) have the advantage of eliminating the need for costly major repointing, the savings may make such a system worthwhile. In addition to the direct energy reductions associated with high-performance envelopes, there are several additional potential benefits:

- Once a building's heating and cooling loads have been substantially reduced, it becomes possible to install smaller and less-costly heating and cooling systems. A smaller mechanical system is less likely to require an electrical upgrade and more likely to be able to operate on 120-volt circuits, and it requires less refrigerant.
- Once ASHPs are installed in a substantial proportion of buildings, the local utility's peak electrical demand will occur in the winter. Widespread adoption of envelope retrofits will allow many more buildings to install ASHPs before the peak is reached.
- Any highly-insulated building, regardless of the type of heating/cooling system, can remain habitable during an electrical service interruption longer than a building with a typical mid-century envelope. During extended cold spells, which are likely to increase in frequency, high-performance envelopes help minimize the impact of service interruptions.
- Finally, a building with a high-performance envelope could reduce GHG emissions substantially even if it retained a fossil-fueled heating system; if the heating load is reduced 80%, fossil fuel GHGs would be reduced a similar amount.

Networked Smart Window ACs

Typical older New York City apartment buildings are cooled with window AC units. Cooling with window ACs has the advantage of being easily deployed without capital improvements. The disadvantage is that because window ACs are not normally centrally managed, they contribute disproportionately to peak electrical demand. The demand impact of unmanaged ACs contributes to peaks that cause the most polluting "peaker" generating plants to run.

NYCHA is conducting a pilot with Smart ACs at Meltzer Tower, which tests the costs and benefits of providing state-of-the-art, networked ACs to residents at no cost to them. The air conditioners connect wirelessly to a proprietary remote management system, which is monitored by NYCHA's BMS. Although residents retain manual control of their ACs, the BMS can remotely "modulate" the ACs during hot weather to ensure residents' rooms remain at a comfortable temperature while minimizing peak demand and energy costs. Central management also enables NYCHA to turn on ACs that have been turned off during a declared heat emergency. The networked ACs were installed in 2019 and NYCHA has tested the management system and the emergency "on" features in 2020. During the pandemic, the City of New York installed 11,866 additional ACs throughout NYCHA. The specifications of the new ACs matched the Smart AC program and are wireless, allowing the Authority to manage remotely.

Before-after images of Smart AC installation at Meltzer Towers

5.2 Electrical

For NYCHA to successfully meet the goals of LL97, it must either drastically reduce the space heating and domestic hot water loads in its buildings or convert as much of those loads as possible to non-fossil-fuel-generated electricity. The conversion of fossil fuel loads to electricity, or electrification, is the process we will focus on in this section. In 2020 NYCHA released its Climate Mitigation Roadmap which goes into further detail on the Authority's approach to electrification.

Current Electrical Capacity
Most NYCHA buildings use their original electrical systems, many of which have never been upgraded and, as a result, have limited capacity. It is common for a NYCHA apartment to have two "legs" of as little as 40 amps (for a total of 80 amps at 120 volts AC). Others can have up to two legs of 100 amps (i.e., a total of 200 amps at 120 volts).

As NYCHA moves to electrify its buildings, if the electrical capacity of the apartments, and the building as a whole, is inadequate to handle the new loads safely, the cost of increasing the capacity will be substantial, and will siphon away valuable capital funds that could be used for electrification. It is therefore in NYCHA's interest to find ways to avoid the need for capacity upgrades. At this time, there are five options NYCHA could pursue, either individually or in combination:

01. **Reduce Existing Loads in Apartments:** A substantial portion of the energy used within apartments is associated with four base uses: the refrigerator, lighting, air conditioning, and gas stove. With the exception of the refrigerator, which runs continually, these uses not only depend on the efficiency of the equipment but also on user behavior (for example, how much the lights are left on). With the exception of TVs, most other in-apartment uses, including hair dryers, computers, etc., are relatively small. At NYCHA, the refrigerators are already as efficient as prevailing technology allows. NYCHA replaced incandescent lighting with CFLs starting in 2007 and began replacing all lighting with LEDs in 2017.

    When many NYCHA buildings were designed, the apartment lighting load was assumed to be 3 watts per square foot (see table at right). Now that LEDs prevail, today's lighting load is closer to 1 watt per square foot. In a typical 850-square foot apartment, that is a difference of 1,700 watts (1.7 kilowatts) or about 14 amps. When the buildings were first designed, there were no personal computers, flat-screen TVs, internet, microwave ovens and other devices that are common today. These all increase the apartment load and could possibly more than make up for the necessary lighting reduction.

    Through comprehensive modernization projects, NYCHA recommends, and may perhaps require, residents to use more energy efficient appliances. Window air conditioners are more efficient today than just a few years ago, and as the changing climate makes them a necessity in New York City, they offer a possible opportunity for increased efficiency.

02. **Submeter All Apartments:** Most NYCHA residents are unaware of how much energy they use. Only about six percent of NYCHA's apartments are direct-metered and billed for electricity. The median kilowatt-hour ("kWh") of electricity per square foot in master-metered NYCHA developments is four times that of direct-metered NYCHA developments.

    Unmetered tenants use more energy than their counterparts in individually-metered apartments, because they lack both the means to measure how much energy they use and have no cost incentive to conserve. In 1996, the Federal government required the use of individual meters for all public housing residents wherever the meters could be installed practically and affordably, but at the time it was a logistical and financial impracticality for NYCHA to accomplish Individual direct meters for each apartment can only be provided in buildings where there is a dedicated electrical riser for each apartment.

    Most NYCHA buildings were not built with such dedicated risers, so direct metering would be prohibitively expensive. In addition, direct-metered residents would pay the higher Con Edison rate for their electricity; therefore, a conversion to direct metering would be less beneficial for residents.

    Electric submetering provides the price feedback residents need to guide their consumption behavior and is more financially feasible to install. Any transition to submetering at NYCHA must be carefully managed, but the savings to both NYCHA and the residents will be substantial, and the residents' increased agency will give them a greater sense of control and improve their quality of life. According to NYSERDA's Residential Electrical Submetering Manual, buildings reduce their kWh consumption by about 18 percent on average, and their kW demand by about 24 percent on average when submeters are installed in master-metered buildings and residents are billed for the electricity they consume. Since NYCHA's average master-metered use is so much higher than its average direct-metered use, savings can be expected to be significantly greater in NYCHA buildings. If utility allowances were provided to NYCHA sub-metered residents in the same way they are provided to their Section 8 counterparts, they would receive a rent reduction in the amount of the utility allowance and they would no longer have to pay the appliance surcharge for air conditioners.

03. **Take advantage of Additional Capacity**: In some NYCHA buildings, the conductors feeding the apartment electrical panels are capable of safely handling more amps than the panel is sized for. Where there are main breakers in the panel or at the apartment feed in the basement, it is possible to increase main breaker or fuse size to the apartment. For panels not served by main breakers, capacity can be increased by adding one or two breakers to the panel (if the panel is full, half-width breakers can be used. If the panel is the plug fuse type, a new panel or subpanel would be needed). This option would be subject to electrical code compliance to ensure resident safety.

04. **Reduce common-area loads:** In buildings where the fossil-fueled heating and/or DHW systems are to be removed or deactivated, several large loads can be shut down except for use during demand management (see below). Vacuum pumps, condensate pumps, oil and gas burners, air compressors and other equipment will not be needed for much of the time. This frees up much-needed capacity for the rest of the building. In addition, lighting controls and more efficient common area lights, and smaller and more efficient rooftop ventilation fans, can also yield significant capacity.

05. **Limit Demand**: Just as utility companies have developed programs to control their peak power (kW) load, NYCHA has begun to as well. NYCHA's Meltzer Tower Smart AC pilot is testing the costs and benefits of providing state-of-the-art, networked ACs to residents at no cost to them. The ACs connect wirelessly to a management system, which is monitored by NYCHA's BMS. While residents retain manual control of their ACs, the BMS can remotely "modulate" the ACs during hot weather to ensure residents' rooms remain at a comfortable temperature while minimizing peak demand and energy costs. Central management would also enable NYCHA to turn on ACs that have been turned off during a declared heat emergency.

    As more and more buildings city-wide adopt heat pumps, the local utility's peak demand will shift to the wintertime. Similarly, to summer demand-limiting programs, the existing heating system can remain in place and operate only during the coldest hours of the heating season (typically well under 100 hours per year). This not only helps the utility but also makes it possible to reduce the size of the heat pump in each apartment, limiting demand even further.

New Electrical Loads
The three large new loads of an electrified building will likely be some combination of air-source heat pumps for space heating, air-to-water heat pumps for DHW and electric induction stoves for cooking.

Air-Source Heat Pumps (ASHPs) for Space Heating
All types of ASHP systems consist of outdoor units, which house the compressor, and indoor units, which distribute conditioned air into rooms. Variable Refrigerant Flow systems employ centralized outdoor units to serve indoor units throughout an entire building. “Multi-split” systems require one or more outdoor units for every apartment. New York City’s weather requires the use of so-called “cold climate” heat pumps that are certified by a third party.

ASHPs solve several problems. They are far more reliable than steam systems and require much less maintenance. Steam and heating hot water leaks are eliminated. ASHPs permit precise control of each room’s temperature and virtually eliminate over- and underheating. Every apartment can now have air conditioning, which is critical for protecting the health and well-being of vulnerable, particularly senior, residents during hot weather (which is expected to become more frequent and severe as a result of the changing climate). In a multi-split installation, if one heat pump fails, only one apartment is affected, not an entire building, and because each apartment has its own system, apartment submeters can provide a feedback loop to encourage energy conservation.

ASHP retrofits in NYCHA apartments will be a significant capital investment. To bring as many ASHPs to as many residents as possible, these costs must be reduced. A window sized ASHP would eliminate most of the labor cost by avoiding the need for new electrical and condensate lines and any associated finish carpentry, and the need for core drilling. It would also reduce the duration and complexity of in-apartment work, reducing disruption for residents. Currently, no product exists that meets this specific need, although no new technologies are needed to create it. As in the past with apartment-sized efficient refrigerators, NYCHA is now collaborating with NYSERDA to work with manufacturers to bring such a product to market.

Heat Pumps for Space Heating
Some experts support replacing the fossil-fired boilers of hydronic (forced hot water) space heating systems with air-to-water heat pumps (AWHPs) or water-to-water ground-source heat pumps (GSHPs). Others go further in calling for conversion of steam heat to hydronic heat as an interim measure and then swapping out the boilers for AWHPs or GSHPs several years from now.

Whether or when AWHPs that can meet the needs of buildings of NYCHA’s scale will be available in the U.S. is unknown, although medium-scale versions of the technology are widely found in parts of Asia and Europe. Until AWHPs suitable for multifamily buildings become more widely available, electrification through hydronic conversion may appear attractive.

Unfortunately, few NYCHA buildings are hydronically heated. More crucially, typical hydronic systems do not provide cooling, and any gas-fueled interim system would require new gas service to the individual buildings, and continued availability of low-cost gas service is not guaranteed. Gas capacity is already severely constrained in some parts of the New York City metro area, and in February 2020, Mayor Bill de Blasio issued Executive Order 52 to stop any new infrastructure, such as power plant expansions, pipelines, or terminals that expand the supply of fossil fuels.

In general, then, the hydronic option is not likely to be cost effective for NYCHA, even in buildings that already have hydronic distribution, but comprehensive modernizations teams should conduct due diligence for sites to verify. This is also the case for GSHP because of the need for extensive and deep excavation for the heat exchanger loop.

Heat Pumps for Domestic Hot Water
The existing centralized DHW delivery system at most NYCHA developments operates at an annual efficiency below 50% due largely to water and steam leaks, poorly performing recirculation systems (an issue very common in large multifamily buildings in NYC), and distribution losses. A recent study conducted for NYCHA projected that an AWHP DHW system, dedicated to each building in a development to eliminate central system distribution losses, would save 45%-62% of DHW greenhouse gas emissions, given today’s electricity grid generation fuel mix.

NYCHA has experimented with a GSHP system for DHW at 344 E 28th Street site in Manhattan. Two 20-ton closed-loop (glycol) ground source units and two 2,000-gallon cement-lined DHW storage tanks were installed in the building’s underground garage. Two brazed plate heat exchanges were installed to pre-heat the glycol before it entered the heat exchanges. An additional heat recovery exchanger was installed in each storage tank, which are utilized to recover useful heat from the hot condensate leaving the steam system, thereby eliminating the use of potable water for quenching.

According to a point-in-time M&P analysis commissioned by NYCHA, the GSHP system initially created savings sufficient to pay back to cost of the project in roughly six years. Unfortunately, further in-house analysis showed that a ConEdison rate change in the summer of 2014 increased the Authority’s costs and offset the initial savings, particularly in the summer months, when the savings were highest (as the GHSP only supplemented domestic hot water). Nevertheless, by 2018, the rate had reversed, and the GSHP system at 28th Street is again creating savings. From this pilot project, the Authority concluded that although GSHP systems can be advantageous, the technology will only be applicable at specific developments (where the location, geography, and typology of the site support the change), and will not be the optimal replacement for many centralized steam systems.

As noted previously, the selection of AWHPs currently available in the US is limited; NYCHA may again have to encourage manufacturers to expand their product lines. In any case, load reduction measures such as low flow water fixtures should be pursued at any site before sizing a new heat pump plant.

Point-Of-Use Electric Resistance DHW
Point-of-use (“POU”) DHW systems have many advantages: zero recirculation losses; almost zero standby losses; high reliability; and relatively low installation cost. Unfortunately, POU systems are not currently advisable for NYCHA, as they are currently much less efficient than heat pump water heaters and require large amounts of electrical capacity for relatively small output. NYCHA should assess how this technology evolves in this area, due to the benefits that this type of installation could provide in terms of maintenance, repairs, and reliability, for products that are more energy efficient.

Electric Induction Stoves
Most NYCHA buildings have gas stoves. Gas stoves consume a relatively small amount of fossil fuel, but they present many problems for NYCHA. Gas stove combustion is very inefficient – perhaps 40% at best. The gas flame presents a significant fire hazard and carbon monoxide presents an asphyxiation hazard. Some residents use the stove as a supplemental heat source, which is dangerous. Much of the gas piping is original in any given building, and as such is subject to leaks and subsequent shutdowns of the entire gas system in the building until comprehensive repairs are completed.

Fire Department-mandated gas shutoffs affect every apartment in an entire building or even an entire development, even if a leak is very localized. The loss of gas service—sometimes for months at a time—means residents cannot prepare meals without relying on hot plates or microwave ovens, which is annoying at best and a significant hardship at worst. Largely because of the age of the gas lines, the immediate replacement need is large. Gas riser replacement projects planned through funding year 2023 currently total $145 million.

Electric induction stoves have been available in the US since the 1970s, but only recently begun to increase market share to a noticeable level. Unlike standard resistance electric stoves, induction units transfer heat via a magnetic field. This method of heat transfer conveys several advantages, including faster heating of food, more efficient heat transfer (and thus higher energy efficiency) and sharply reduced risk of burns or kitchen fires. If the oven is used as supplemental heat in an apartment, there is less risk of fire and no danger of asphyxiation.

Installing both ASHPs and induction stoves in the same building would be expected to require a complete electric service upgrade because in most apartments it would not be possible to run both at the same time without tripping circuit breakers. A control system that managed peak load in each apartment by modulating demand could avoid an upgrade. Similar controls have been available in Europe for almost 30 years.

Queensbridge Houses community shared solar installation

New Local Sources of Electricity

NYCHA should take advantage of any sources of renewable energy it can exploit cost-effectively. Wind power is almost certainly out of the question, but solar photovoltaic ("PV") panels are already being installed at several NYCHA developments. Recently, 1.8-megawatt of solar arrays across 27 rooftops was constructed at Queensbridge North and South. A second lease has been signed and construction is underway for 1.2 MW across 40 rooftops at Kingsborough, Glenwood, and Carver Houses.

Since solar projects are difficult to implement on high-rise buildings due to costs and Fire Department regulations, NYCHA's solar projects are occurring mostly on mid-rise buildings. Moreover, since NYCHA has undertaken the roof replacement of many of its buildings, it allows for installation of solar arrays across larger footprints than are typically found in New York City's residential stock. Additionally, NYCHA, as a public agency, cannot take advantage of the substantial tax incentives for PV that a private entity could. Further, the total electric power available from any single rooftop installation is fairly small.

However, in the aggregate, NYCHA expects its roofs to produce an estimated 25 MW by 2025. To accomplish this NYCHA has arranged with third-party solar developers to lease its roofs for "community solar" projects. The solar developer owns and operates the system (and is able to take advantage of solar tax credits). NYCHA receives lease payments for the use of its roofs, as well as commitments to a) hire and train NYCHA residents to install the system, and b) to sell a portion of the power to local low- and moderate-income New Yorkers at a discount of 10 percent or more off the normal ConEdison rate.

06 PROJECT PLANNING, DELIVERY METHODS & PHASING

6.1 Holistic Life-Cycle Planning

Physical Needs Assessments

Historically, HUD recommends that Public Housing Authorities (“PHAs”) conduct a statistical sampling of the portfolio to estimate the capital accrual and backlog needs. NYCHA has performed Physical Needs Assessments (“PNA”) for this purpose and to guide long-term capital planning as well as annual project budgeting and scoping. These PNA includes on-site visual assessments, consultation with property management and maintenance staff, and market cost analysis. NYCHA’s last such assessment was completed in 2017, and a new PNA exercise has been recently initiated.

The traditional PNA approach may, however, not fully reflect the realities of capital planning in the housing industry generally. The methodology envisions addressing individual deficiencies and replacement of systems that have reached their expected useful life. The assessments utilize relatively detailed, large scale inspections of buildings and grounds, and provide a snapshot in time of potential repairs and replacements of individual components and/or systems. While this is consistent with NYCHA’s experience and focus on component-based replacements and upgrades historically, the results of this approach are not as meaningful for estimating capital needs in the context of integrated renovations or comprehensive modernization, nor application of new technologies with energy and operating efficiencies rather than replacement-in-kind.

In order to address the drawbacks of the traditional method of performing the PNA, a new methodology is envisioned for the NYCHA’s next PNA exercise. This methodology will leverage Building Information Models (“BIM”) and Geographic Information Systems (“GIS”), and model various scenarios for application of new technologies. These tools along with historical PNA data (used as a baseline) and regularly updated building operations data will provide an ongoing, almost real time, assessment of the physical needs in the future Additionally, NYCHA will be able to better use the results for a whole-building approach with inclusion of modern technologies.

Life-Cycle Planning

By re-envisioning the PNA and NYCHA’s capital needs information more broadly, the Authority will be able to move to a more holistic, life-cycle planning model for comprehensive modernizations. Evaluating the need of properties in an integrated way will result in a more effective and efficiency strategy that allows any renovation effort to incorporate the efficiencies and cost benefits of multipurpose concurrent construction projects.

Life-cycle planning also allows for more integration for operational pressures and considerations to be included in the capital interventions for each building or development. This ensures aspects that may fall “between the gaps” of the specified elements of the standard PNA approach are well-considered. For example, distribution systems that will need upgrades at different times than their attached boiler/heating equipment.

6.2 Project Delivery Methods

NYCHA will assess the best options for project delivery for each specific site's needs and requirements, and the market's capacity for implementation. Major project delivery methods are overviewed below.

Design-Bid-Build
Design-Bid-Build, the construction project delivery method historically used by NYCHA and other government entities, entails NYCHA contracting a design firm and a general contractor separately. The general contractor is selected based on the lowest-cost bid meeting the minimum requirements. Ultimately, design-bid-build follows a sequential process which may present several drawbacks in a comprehensive modernization scenario, including but not limited to a longer timeline, higher project costs, and inability to select a vendor on a "best value" basis that takes into account other factors like quality, value for money, and M/WBE and resident employment opportunities.

Design-Build
New York's Legislature passed legislation first granting NYCHA design-build authority in 2018. Since then, the Authority has executed three multi-project design-build contracts comprising projects at various developments and in various scope. For projects in which design-build is appropriate, project delivery can be 12 to 18 months faster due to the collapsed procurement schedule, overlap of design and construction activities, and streamlining of other processes compared to design-bid-build project delivery. Design-build also provides a valuable opportunity for engaging the designer and the contractor in early value engineering and constructability analysis, thereby enhancing efficiencies in means and methods, as well as identifying potential cost savings. Because design-build utilizes "best value" selection, quality, and M/WBE and resident employment opportunities, can also be prioritized.

While design-build is relatively new to NYCHA and local vendors, it is used broadly across the United States and internationally. Many best practices exist to model NYCHA use of this project delivery method on. NYCHA's recent design-build contracts have allowed for joint ventures of multiple entities that could team up and respond to an RFP. In addition, as lump sum type contracts have been used, this requires NYCHA to have a strong scope definition or design specifications at the beginning of the procurement process, and schematic designs are developed by vendors during the process. Use of design-build project delivery can have higher bid costs than traditional design-bid-build projects and can be significant financial endeavors for local firms which may not be sufficiently addressed through stipends. This may have the adverse effect of limiting firms that can apply to the project.

Enhanced / Progressive Design-Build
The authorizing legislation for NYCHA to utilize design-build also indicates use of an Enhanced or Progressive Design-Build approach based on use of a Guaranteed Maximum Price (GMP) type contract. As schematic designs are not developed during the procurement process for this approach, several cost components such as design, pre-construction services, and construction overhead and profit, are negotiated and agreed up-front on a fixed-price basis, while the main construction costs are paid based on actual costs incurred during the project. The GMP is agreed as the maximum amount for these construction costs, once the design is significantly developed but before construction starts, allowing this estimate to be more accurate.

This approach can provide additional time and cost savings beyond basic design-build project delivery. It requires less administrative overhead for NYCHA during the procurement process, but administration and management of the contract is then more intensive on an ongoing basis, given payment is on a cost reimbursement basis rather than lump sum basis. NYCHA has not yet utilized this approach for capital projects, but will explore its use in the future for comprehensive modernization projects.

Construction Manager at Risk
Construction Manager at Risk is a project delivery method whereby NYCHA would select a Construction Manager ("CM") early during the design phase who is also responsible for building the project. The CM would commit to delivering the project within a defined schedule and price, typically a Guaranteed Maximum Price (GMP). The CM provides early input into the design, including value engineering and constructability analyses, and is responsible for construction in the same way that a general contractor is under a design-bid-build arrangement.

This project delivery method can provide many of the same benefits as enhanced design-build, and may be more suitable for certain circumstances where maintaining separate design and construction contractors aligns with project needs, but may not yield the same level of cost savings as design-build project delivery. NYCHA does not currently have authority to utilize this method under New York State law, but would anticipate utilizing this method if provided authorization in the future.

Construction groundbreaking at Coney Island Houses

6.3 Phasing & Resident Temporary Moves

Phasing of design, pre-construction, and construction work within each project concerns what work is done when and how long it takes. This impacts the effectiveness of the project delivery, including the overall project duration and what it costs to complete this work, residents' day-to-day lives during construction, and when residents may not be able to access certain areas of a property or building or remain in their units, as well as property staff's access to parts of the property and buildings during construction. Simply put, phasing is the most sensitive of all of the logistical matters that must be dealt with when planning a comprehensive modernization project and will be significantly more complex than phasing a typical NYCHA construction project today. Beyond logistical coordination, resident engagement in construction and any temporary move planning, are paramount to the successful implementation of a project. Getting project phasing right is essential to the success of the program and therefore to the Authority's future.

In particular, temporary moves of residents during construction may be legally mandated to ensure resident safety during environmental hazards abatement or modernization work, or may be necessary for resident convenience, or to ensure abatement, repair or modernization work required for adhering to decent, safe and sanitary housing standards is not cost prohibitive. NYCHA is responsible for providing housing to current residents throughout project delivery; however, NYCHA properties typically have vacancy rates of less than two percent and often less than one percent. Moving residents on-site within the property to allow in-unit construction or in lines or segments of a building that should be renovated together, may therefore prove challenging even if vacancies are held by NYCHA from early on in a project.

NYCHA's goal is to minimize temporary resident moves in number and duration as much as possible, and maximize work being done with residents-in-place. Where such moves are required, NYCHA will consider various available solutions: moves within the resident's development or to other NYCHA developments, short-term moves to hotels or use of private accommodation within the neighborhood, use of temporary modular housing, and new building construction. In all circumstances, NYCHA is responsible for covering any reasonable costs associated with resident moves, including moving support and coverage of expenses for move and/or storage of resident possessions. Each comprehensive modernization project will have unique characteristics that impact the mix of solutions available, and each family's circumstances and composition will need to be considered in selecting appropriate solutions.

Overall, phasing is a crucial topic for resident engagement, and resident preferences should be given strong consideration in the development of phasing plans. Opportunities for resident engagement on project phasing should begin early in the planning process and should be scheduled regularly and often. Comprehensive modernization phasing plans should minimize the impact of construction upon residents and maximize the quality of improvements provided both inside and outside of units.

Resident-In-Place

Of the various options, NYCHA has the most experience with resident-in-place construction including when renovation inside apartments are undertaken. This approach has been used by PACT partners, and by the Authority during its Recovery & Resilience projects. Resident-in-place construction keeps residents in their homes during construction. It also avoids a number of temporary move concerns that must be cleared with HUD and mitigates resident concerns of being outside of their homes and neighborhoods.

Despite these benefits, NYCHA and its partners have learned firsthand that there are numerous risks associated with the resident-in-place option. First, resident-in-places raises liability and disruption issues about which residents have expressed concern in the past. Second, it requires contractors to closely coordinated with residents while they are working on in-unit improvements. Resident-in-place therefore necessitates a larger and more consistent resident engagement operation than any other option, and if numerous additional staff are required, costs may become an issue. Third, renovations with resident in place also may extend construction timelines, which lead to increased costs and extended durations of resident inconvenience and impact. Extending a project's timeline beyond a certain duration may not also be possible given the inability for construction companies to secure bonding for longer durations from financial firms.

In addition, the most important factor on determining if resident-in-place renovations are possible is the ability to perform abatement of environmental hazards for lead, asbestos, and mold. If this work requires resident moves at any point to ensure their safety, this would also likely lend itself to performing the full or most of the renovation scope of work in the unit during the relocation period to limit resident inconvenience, outages of services, and the difficulty of living in a construction zone. These risks and consideration should therefore be adequately mitigated for resident-in-place to be utilized.

Moves Within Resident's Development or to Another NYCHA Property

Where resident-in-place renovations are not feasible or cause an undue burden to residents or becomes cost prohibitive for NUCHA, on-site moves to vacant units are preferred by residents and by NYCHA. While moving residents one-time into fully renovated units may minimize disruption and costs, residents often prefer to move back to their original units. In either case, given the low vacancy rates at NYCHA properties, this will almost always require vacant units to be held at the property from early on to build up a stock of units that can be renovated early on.

Temporary moves within the residents' development should be considered first, followed by developments in the surrounding neighborhood. Vacancies at neighboring developments may also therefore need to be held from early on in the project. Offsite relocation outside of the neighborhood may need to be considered if options within the neighborhood are not available, or if this option is preferred by the resident. NYCHA will strive to keep as many residents temporarily relocated within their original development to the greatest extent possible, but off-site relocation may be necessary to ensure family composition and other factors can be well accommodated.

Moves to Private Accommodation or Hotels

Other off-site temporary move options include use of private accommodation or hotels in or close to the neighborhood. Further analysis of the feasibility of utilizing apartments in private buildings will need to be undertaken on a case-by-case basis for each project. Hotel accommodation is typically only suitable for short-term resident moves of several days up to several weeks, but may be an appropriate solution for certain households for a longer time period. Both of these options will require significant planning and preparation for NYCHA to put in place contracts or leases with private partners, ensure private apartment or hotel accommodation meets the relevant minimum standards, and effectively facilitate resident temporary moves.

Temporary Modular Housing

Temporary modular housing entails placing prefabricated units on-site at a development undergoing comprehensive modernization. Where required, residents are temporarily moved from their apartments to the modular units while their individual apartments are renovated. Residents are then returned to their apartments, at which point a different set of residents is temporarily moved to the modular units. Residents may prefer the temporary modular housing option because it does not subject them to the daily disruptions of construction, but it does allow them to remain in on-site.

NYCHA has not identified instances where temporary modular units have been utilized in the New York City area; however, there are examples of usage of such units on a temporary or longer-term basis in other parts of the country and internationally which NYCHA has explored. This option is only applicable if NYCHA can identify suppliers who have the capacity to provide such units at scale, and if there is sufficient open space and available infrastructure onsite for the required number of units for a particular development. If there is sufficient space and if residents are amenable to the idea, NYCHA must still consider whether to buy or rent the modular units, and, in the former case, what to do with the units once the project is completed. Units may be able to be reused on multiple projects if they are well maintained. In addition, temporary modular units are designed to be ADA accessible, however if modular units are stacked vertically, an elevator may need to also be provided.

Use of temporary modular units also carry a number of operational consideration and risks that must be mitigated during the planning process for this strategy to be successful. These include:

- Management and maintenance of modular units during construction
- The cleaning of modular units between resident moves
- Safe storage of residents' possessions during their stay in the modular units
- The provision of water, electrical, and waste services to the modular units

- Compliance with all Federal, State and City requirements around resident temporary relocation and building codes.

Management and Maintenance of Modular Units
Modular units will experience wear and tear, and project teams must be prepared to fix problems as they occur in order to keep the units operable for the duration of construction. Either a contractor must be hired to manage the modular units, or the Authority's property management staff will have to split their time between existing and temporary units.

Cleaning Modular Units
Modular units are not constructed to be occupied by many different households over many months. Between residents stays, modular units will have to be thoroughly cleaned and sanitized and all systems returned to working condition. As in the management of modular units, a contractor may have to be hired to clean the units.

Safe Storage of Residents' Possessions
Residents will only be able to bring a limited number of their possessions from their apartments to the modular units. Residents must be provided boxes and other storage products for their remaining possessions. These possessions should be stored safely and securely on the grounds of the project site. Project teams must provide staff to move residents' possessions to and from the storage facility. Project teams should also discuss what access residents will have to their possessions while they are stored.

Water, Electrical, and Waste Services
Temporary modular units should be wired and piped to the development's water and electrical systems, or an alternative mode of providing these services must be accounted for during the project planning process. Utility collection will be difficult with temporary, modular units, so whether and how residents pay for their utilities should be accounted for in planning. Additionally, residents should receive the same waste management services in the modular units as they would receive in their usual apartments.

A broad range of technical, logistical, and staffing requirements should therefore be considered in determining whether temporary modular units are an appropriate approach for a site. NYCHA will continue to explore temporary modular units as a possible solution to be utilized in comprehensive modernization projects through:

- Connecting with the NYC Office of Emergency Management to discuss their current model and opportunities for procurement, scalability, and potential implementation.
- Further engaging with entities who have designed and executed modular housing projects, such as King County, Washington, the Vancouver Affordable Housing Agency and British Columbia Housing, to understand progress and their first iteration of disassembly for their modular units, and the London YMCA and other entities that have successfully executed denser temporary or longer-term modular housing solutions.
- Researching the market of manufacturers available for this product and preliminary construction costs and logistics to establish cost estimates and manufacturing limitations.
- Analyzing the cost, timeline, and impact to resident quality of life on residents of the selected site to properly determine feasibility of implementation at specific sites.

New Building Construction
In the new building option, residents remain in their current residences while contractors construct a new building with the same number (or more) units of one building at the existing development. Once the building is completed, residents from the first building to undergo renovation can move to the new building, along with their possessions. The old building is then renovated for residents of the remaining buildings to progressively move into as their buildings undergo renovation. This would allow residents to only move once into a fully renovated space, avoid construction with residents-in-place, and potentially expand the number of affordable housing units provided onsite. An alternative version of this approach is to add additional floors to an existing, lower-story building, where feasible, and utilize the new units on these floors in a similar way.

Many in the construction industry who participated in the comprehensive modernization design charrette expressed enthusiasm for the new building option. From the contractor's perspective, it is the most expedient and easiest option to pursue. It may be possible to accelerate the construction schedule and certainly minimize the impact to residents for about the same cost as the escalation associated with extending the construction schedule and managing resident-in place construction. However, for numerous reasons, including resident preference among them, NYCHA does not believe the new building option alone is likely to meet the needs of comprehensive modernization projects. It opens financial and regulatory hurdles that currently appear extremely challenging to surmount. The additional upfront time to gain approval for and build a new structure may also hinder use of this option in early projects. In the future, it may become more feasible.

6.4 Commissioning for New Technologies

Service Contracts
Comprehensive modernization will necessarily involve the application of building technologies never before utilized by the Authority. This may lead to an incongruence between the systems that the Authority's Operations and Maintenance, Repair & Skilled Trades ("MRST") staff are trained to service and the technologies that are in use at renovated developments. While it is NYCHA's goal to develop in-house expertise on new technologies, comprehensive modernization must realistically and holistically address the short and medium-term demands of these upgraded systems.

For this reason, NYCHA anticipate some use of external service contracts for at least the first five years of operation for all upgraded systems that are not within the capacity of the Authority's current workforce. Technologies the maintenance of which may have to be outsourced include heat pumps and VRF devices; façade panels and EIFS; generators; interior and exterior sensors; and temporary, on-site modular housing. The service components of contracts should address preventative maintenance, emergency maintenance, and repair maintenance strategies, as well as supplies and equipment, waste disposal, subconsultant hiring, and other relevant issues.

Integrated Contracts
It has been NYCHA's experience that service contracts falter if a different contractor is responsible for manufacturing and delivering a product than for maintaining that product once it has been commissioned. Therefore, whenever possible, comprehensive modernization contracts pertaining to new technologies should cover the product and its maintenance for a period of at least five years of operation ("delivery and service") or for the duration of its need. This approach has the added benefit of incentivizing manufacturers to maintain their products to their optimal performance standards.

Language issued in the RFPs for existing NYCHA service contracts were provided by the device manufacturers pursuant to the requirements of their products. As this is not feasible when issuing RFP for contracts that combine capital and operational spending, it is essential that teams managing comprehensive modernization have sufficient expertise to provide requisite language for procurement and maintenance.

Internal Coordination of Contracts
All divisions at NYCHA must work together to ensure that contracts for new building systems adequately address capital delivery and operations and maintenance topics. Moreover, they must ensure that the Authority is prepared to supervise the contract for the duration of its term. Achieving these goals will require NYCHA to improve cooperation across divisions and establish a detailed governance structure to establish workflow and responsibilities across the Authority. CPD, Operations, and MRST must work together, with the design-build teams, to review RFPs and bids, choose contractors, and oversee the installation and upkeep of new systems.

In case where one contract covers product delivery and operations and maintenance, the Authority should be prepared to transition oversight of the contract from one department's staff to another department's staff. CPD will oversee the installation and commissioning of new systems. A trigger will then transition all parties to a second phase of the contract, to be overseen by MRST and Operations. For these reasons, MRST and Operations should be brought into discussions about service contracts prior to the issuance of integrated RFPs for delivering and servicing technologically advanced building systems.

Turnover of completed equipment from one department to another should be detailed in a written standard procedure to ensure adherence to recommended maintenance per warranty and guarantees, as well as for general upkeep of all systems.

Associated Systems
Delivery and service contracts should include stipulations regarding systems associated with the pertinent technology, although the details of those stipulations may vary depending on NYCHA's experience with the associated systems and its capacity to take on an additional operational obligation.

For example, new air source heat pumps will connect to a building's electrical system, which NYCHA's electricians already maintain. A delivery and service contract may stipulate that for the purposes of servicing the new heat pumps, the contractor is obligated to conduct necessary maintenance on the building's electrical systems (insofar as they are not general electrical issues, but issues that pertain specifically to the needs of the heat pumps). Alternatively, the delivery and service contract may stipulate a narrow division of labor and account for coordination between the contractor, servicing the heat pumps, and NYCHA staff, servicing the electrical system. Regardless of how delivery and service contracts are structured, they should account associated systems.

All departments within NYCHA that have a role in overseeing a delivery and service contract should participate in discussions about how that contract is structured. It is imperative that new systems are adequately serviced at every scale, and that NYCHA develop lines of communication and coordination to pursue and oversee contracts without major lapses.

Demand Response Contracts
At NYCHA sites where electricity generating technologies are to be installed, the Authority and its comprehensive modernization partners should consider enrolling the new devices in one or more Demand Response Programs. These programs generate revenue for NYCHA, offsetting in part or in whole the cost of servicing the new energy systems. Responsibility for operating the new energy generating systems in compliance with the rules, procedures, and guideline set forth by the chosen Demand Response Program(s) should be written into the delivery and service contract. NYCHA may choose a Demand Response Program(s) itself, or NYCHA may require the delivery and service contractor to determine a program and enroll its systems.

NYCHA Staff and Section 3 Training
It is the ultimate goal of NYCHA to have the capacity to maintain new building systems, and to be able to gain new expertise on an ongoing basis as new products are brought to market. This is particularly important given that comprehensive modernization of the portfolio will take many years to execute in full. Comprehensive modernization projects completed in later years may not have the same technologies as projects in earlier phases.

Consequently, delivery and service contracts should include stipulations for the training and certification of NYCHA staff and NYCHA residents on the new systems. The former is essential for adequate contract oversight, and for the possibility that the service portion of the contract is not renewed at the end of its term. The latter is critical for NYCHA's Section 3 resident impact goals and requirements, as described earlier in this document.

ACKNOWLEDGEMENTS

NYCHA Board

Joseph Adams, Resident Board Member
Matt Gewolb, Board Member
Paula Gavin, Board Member
Victor A. González, Resident Board Member
Jacqueline Young, Resident Board Member
Magalie D. Austin, Board Member

Citywide Council of Presidents (CCOP) Executive Board

Daniel Barber
Reginald (Reggie) Bowman
Verona Bradham
Lillie Marshall
Lilithe Lozano
Ethel Velez
Ann Cotton Morris
Brenda Harris

New York City Housing Authority

Greg Russ, Chair and Chief Executive Officer
Daniel Sherrod, Chief Operating Officer

Executive Committee

Andrew Kaplan, Deputy Chief of Staff
Barbara Brancaccio, Chief Communications Officer
Patti Bayross, Executive Vice President & Chief Information Officer
Lisa Bova-Hiatt, Executive Vice President of Legal Affairs and General Counsel
Jonathan Gouveia, Executive Vice President for Real Estate Development
Kerri Jew, Executive Vice President & Chief Administrative Officer
Annika Lescott, Executive Vice-President & Chief Financial Officer
J. Steven Lovci, Executive Vice President of Capital Projects
Lakesha Miller, Executive Vice President for Leased Housing
Sideya Sherman, Executive Vice President for Community Engagement & Partnerships
Eva Trimble, Executive Vice-President for Strategy & Innovation
Shaan Mavani, Chief Asset & Capital Managing Officer
Brad Greenburg, Chief Compliance Officer

Capital Projects Division

Aden Munassar, Senior Advisor
Vlada Kenniff, Vice President, Energy and Sustainability
Joy Sinderbrand, Vice President, Recovery and Resilience Department
Oliver Osterwind, Vice President, Project Management
Ellen Zielinski, Director of Energy and Sustainability
Ajay Muraleedharan, Operations Manager, Project Management
Delma Palma, Deputy Director of Architecture and Urban Design, Design Department
Edwin Mendez, Deputy Director of Energy
Siobhan Watson, Program Manager, Recovery and Resilience Department
Vaidehi Mody, Urban Designer, Design Department
Jordan Bonomo, Program Manager
Christopher White, Program Associate
Tom Sahagian, Consultant
Rory Christian, Consultant
Aron Chilewich, Urban Planning Intern

Contributing NYCHA Staff

Michele Moore, Director, Comprehensive Modernization
Michael Jones, Director of Design, Real Estate Development
Michael Parkinson, Director of Community Planning, Real Estate Development
Tischelle George, Deputy Director, Resident Engagement
Shanna Castillo, Director, Resident Economic Empowerment & Sustainability
Jason Goldberg, Chief of Corporate Affairs
Michael Corwin, Editorial Director, Communications

Contributing NYCHA Residents

Tamika Williams, Pomonok Houses Resident
Alberto Mercado, Baruch Houses Resident
Rosa Pinero, Moore Houses Resident

Industry Partners

American Council of Engineering Companies (ACEC)
American Institute of Architects (AIA)
Construction Management Association of America (CMAA)
NYCHA Monitor