

A Building Resilience Assessment for the New York City Housing Authority

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A Building Resilience Assessment for the New York City Housing Authority

Final Report

Prepared for:

New York State Energy Research and Development Authority

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Acronyms and Abbreviations

AEA	Association for Energy Affordability
B-READY	DNV GL's Building Resilience Assessment Tool
BEEEx	Building Energy Exchange
C-GEAR	Climate Geo-Enhanced Assessment of Risk (DNV GL tool)
DHS	United States Department of Homeland Security
FEMA	Federal Emergency Management Agency
GIS	Geographic Information Systems
HPD	New York City Housing Preservation and Development
HUD	United States Department of Housing and Urban Development
HVAC	Heating Ventilation and Air Conditioning
HVI	Heat Vulnerability Index
IPNA	Integrated Property Needs Assessment
LISC	Local Initiatives Support Corporation
LMI	low- to moderate-income
NGO	nongovernmental organization
NRDC	Natural Resources Defense Council
NYC	New York City
NYC DOHMH	New York City Department of Health and Mental Hygiene
NYS	New York State
NYSERDA	New York State Energy Research and Development Authority
NYCHA	New York City Housing Authority
NPCC	New York City Panel on Climate Change
DEC	New York State Department of Environmental Conservation
NYCEM	New York City Office of Emergency Management
PlaNYC	New York City Strategic Plan
PACE	Property Assessed Clean Energy
PV	solar photovoltaic
SLR	sea level rise
UB	University at Buffalo
USGBC	United States Green Building Council
ZNE	zero net energy

Summary

DNV GL Energy Services USA, Inc. developed the proprietary B-READY tool to provide building owners with information on potential climate-related hazards to their properties, system-level risks in the building stemming from these hazards, and strategies for how to mitigate the risks. The tool contains over 140 resilience improvement measures organized by the building system. The Building Resilience Assessment for the New York City Housing Authority (resilience assessment pilot) project piloted DNV GL's B-READY tool and modified it for use in assessing New York State's low- to moderate-income (LMI) multifamily building stock.

S.1 Project Overview

DNV GL performed the resilience assessment pilot in partnership with the New York City Housing Authority (NYCHA), who granted DNV GL access to and information about their developments. DNV GL worked with NYCHA and NYSERDA to select 10 demographically and geographically diverse buildings to assess for the pilot. The assessment was informed by a kickoff stakeholder workshop and NYCHA resident engagement workshops to understand how best to measure community and/or social resilience in LMI multifamily developments. DNV GL incorporated the results of these efforts into individual building reports that synthesized findings and provided NYCHA with recommendations to improve the buildings' resilience.

This pilot project served as a case study on assessing resilience in multifamily buildings for the LMI multifamily housing industry and generated insight into practical pathways for improving building resilience in New York State. DNV GL also worked with NYSERDA to identify opportunities for incorporating or expanding access to resilience assessments for multifamily buildings throughout the State.

S.2 Conclusions and Recommendations

The resilience assessment pilot yielded numerous findings that can inform programs designed to improve the resilience of LMI multifamily buildings in New York State. Conclusions and recommendations based on these findings are discussed in the following sections.

S.2.1 Conclusions

S.2.1.1 Education and Funding

- Building owners and managers need to have access to simplified tools offering concrete information about potential vulnerabilities in their building(s).
- Decision-makers need concrete information detailing the value of resilience improvements to encourage them to raise the issue to a higher priority.
- Funding sources for public housing organizations as well as internal procedures may limit the organizations' ability to make improvements due to management structures or operational requirements.
- As “resilience” is a relatively new concept that is not yet widely practiced and understood, focusing first on “emergency preparedness” may help to expedite the adoption of “resilience” as a standard concept of design.
- Emergency managers are trained in preparedness and how to manage emergency situations. The concepts behind resilience, including assessing and identifying vulnerabilities and identifying improvements, translates well for this audience. Continuing to engage emergency managers will help widen the network of resilience advocates.

S.2.1.2 Resilience Tools

- Existing programs are the most immediate avenue for expanded resilience assessments as long as the value and regulatory framework takes place to support the work. According to the utilities that were a part of this assessment, the current rules for energy efficiency programs limit opportunities to include aspects of resilience.
- Understanding typical management procedures and the ability to act on improvement recommendations is an important aspect of multifamily resilience assessments. Resilience improvement projects may be impeded by staff who have limited time available due to competing priorities or by slow approval processes stemming from the organizational structure. Future resilience assessment tools should consider these operational aspects.
- Based on the trends that DNV GL identified across NYCHA buildings, initial interviews with senior-level management with large portfolios of buildings should be conducted to understand typical operational and design practices as well as work constraints. Recognizing commonalities across buildings early on also offers the potential to scale improvement projects, including resilience.
- Feedback from tenants provides important input for a holistic resilience assessment. It helps to identify vulnerabilities in the tenant community as well as communication gaps between residents and management.

S.2.2 Communications

- Resilience proponents need information that communicates to decision-makers the value of climate change preparedness. Without concrete information, proponents do not have the necessary tools to stimulate adequate investment in resilience.

S.2.1.4 Training

- Professionals may incorporate resilience assessments through statewide initiatives like the IPNA standard, but these professionals require more training. Because building resilience is still a nascent field, engineers and architects are not yet adept at interpreting climate change risks and their impact on design decisions.
- Workshops are an effective way of engaging residents and other stakeholders in conversations about resilience, educating them on potential hazards and preparedness, and collecting feedback on their needs. However, online surveys offer the opportunity to reach a larger audience as well as to gauge the effectiveness of communications, policies, and procedures.
- LMI housing agencies should continue to leverage existing emergency preparedness and emergency response planning programs to engage residents and owners and to promote resilience.¹

S.3 Recommendations

Based on these conclusions, DNV GL offers the following recommendations:

- For multifamily housing organizations in New York State, continue to push for resilience to be incorporated into the IPNA. The IPNA process and subject matter covered in the standard uses a similar approach and covers the same aspects of a building as a resilience assessment. Merging these together will minimize duplication of efforts and provide a pathway for resilience assessments to become part of standard practices. In addition, use these efforts to gather data that can facilitate analyses on the value of resilience-related measures associated with the programs.
- As the developers of the IPNA standard and tools consider how resilience may be incorporated into that program, the statewide climate hazard resources available through NYSERDA will be useful for understanding potential exposures to different hazards across the State. Consider providing links to the New York State Climate Change Science Clearinghouse as well as the reports published by the University at Buffalo² on building resilience on websites where IPNA tool can be accessed.³ It is further recommended that future training sessions for IPNA contractors include an overview of how to assess risk and exposure to climate hazards.
- For NYSERDA, continue incorporate aspects of resilience into existing energy programs. The reviews of the RetrofitNY zero net energy pilot projects conducted as part of this project identified many ways in which resilience and energy retrofits overlap. Identifying and tracking the resilience aspects of retrofit projects will provide much needed data to measure the impacts of resilience improvements and provide an avenue for educating design professionals on evaluating and addressing climate change related risks in their projects.
- NYSERDA should also continue to work with organizations across New York State to research and develop resources that communicate the value of resilience to multifamily housing management decision-makers and engage lenders and other financiers in discussions about creating more incentives and mechanisms for resilience improvements.

- For NYSERDA and other energy efficiency program administrators in the State, work with the New York Public Service Commission to develop and adopt rules that allow and encourage resilience improvements in energy efficiency programs.
- Where NYSERDA or other New York State agencies support future resilience assessment work, start with an in-person, in-depth interview when working with an owner of a portfolio of multifamily buildings to understand operational practices, impediments that prevent or slow down building improvement projects, and the characteristics of the buildings. This foundational knowledge is needed to understand which improvements are feasible and which do not have much value to the owners.
- For NYCHA, seek alternative means to solicit and collect feedback from residents about their level of preparedness for emergency events. Resident workshops are useful for collecting this type of feedback; however, surveying residents at the contract office during leasing renewals, or incorporating resilience-related surveys into other regularly issued surveys will provide feedback from a wider audience. Further recommendations were provided in the individual reports for the buildings assessed as part of this project.

1 Introduction

DNV GL Energy Services USA, Inc. (DNV GL) received grant funding from New York State Energy Research and Development Authority (NYSERDA) under PON 3242, Climate Change Adaptation and Research to pilot its building resilience assessment tool, B-READY, on existing multifamily buildings in New York. DNV GL's proprietary B-READY tool contains over 140 resilience improvement measures. Using an interview process, on-site inspection, and review and synthesis of local climate conditions, the tool informs building owners of potential climate-related hazards for their properties, system-level risks in buildings, and strategies for how to mitigate those risks. The goal of the resilience assessment pilot was to test the tool and modify it for application to New York State's multifamily building stock. For the purposes of this work, a "resilient" building is a building designed to withstand and provide proper protection for its inhabitants during an extreme weather event and to quickly return to normal function after the event.

DNV GL performed the resilience assessment pilot in partnership with the New York City Housing Authority (NYCHA) who granted DNV GL access to and information about their developments. It consisted of stakeholder and resident workshops; a vulnerability assessment of the NYCHA portfolio; on-site assessments of 10 NYCHA buildings; and market research and outreach for the expanded use of the tool. The 10 buildings were chosen from NYCHA's 344 developments and based on location, potential vulnerabilities to flooding, excessive heat, or other hazards, and other demographic information.

The work was supported by the University at Buffalo (UB), which as a subcontractor to DNV GL, assisted with various aspects of the project, including help in gathering information on climatic conditions in and around New York City, the vulnerability assessment, the selection of NYCHA buildings to use in the effort, the development of content for resident engagement workshops, and research on other resilience assessment tools and techniques available to building owners. UB researchers also published a journal article about the various tools available for assessing resilience and current approaches used by professionals for incorporating climate resilience strategies into their work.

This report documents the procedures, outcomes, lessons learned, and recommendations from the pilot project.

2 Background

New York State’s buildings sector is vulnerable to the impacts of climate change, and few building-level, resiliency-planning tools exist that can assess the climate-readiness of residential buildings and identify possible improvements. DNV GL designed the B-READY tool to address the lack of information and help building owners and managers prepare for extreme weather-related events. The tool and accompanying assessment process are structured to help them understand a building’s potential climate-related vulnerabilities and the strategies that could reduce the impacts of extreme weather events.

The building resilience aspects of B-READY cover all the physical systems of a building, including the following:

- Communications and security
- Electric systems
- Fire protection
- HVAC
- Furnishings
- Operations
- Plumbing systems
- Shell and structure
- Site

The results of the assessment inform a brief technical report that is provided to the building owner or manager with information on the level of exposure to climate-related hazards, each building system’s risk level, and recommended improvements by building system.

For this resilience assessment pilot, DNV GL enhanced the B-READY tool with additional measures to address social resilience for LMI buildings. The development of this social resilience module required input from experts who have worked with multifamily housing from a design, management or policy perspective, and discussions with residents to understand needs during emergency events and verify that measures are designed to adequately assess social or community resilience. One workshop was held with LMI multifamily stakeholders including State policymakers, New York City and State-based housing organizations, consultants and other nonprofit organizations who operate in the LMI market, along with four workshops with residents of the NYCHA developments.

There were three main components of the pilot:

- Stakeholder and resident engagement
- Building resilience assessments
- Research of statewide expansion opportunities

Table 1 summarizes the activities associated with each component.

Table 1. Project Components, Related Activities, and Purpose

Project Component	Related Activities	Purpose
Stakeholder and resident engagement	<ul style="list-style-type: none"> • Initial stakeholder workshop involving LMI multifamily housing stakeholders 	<ul style="list-style-type: none"> • Introduce B-READY and the resilience assessment concept to stakeholders statewide • Determine potential measures of social/LMI community resilience
	<ul style="list-style-type: none"> • Community workshops (4) 	<ul style="list-style-type: none"> • Verify that those measures are reflective of resident experiences
Building Resilience Assessments	<ul style="list-style-type: none"> • Tool refinements <ul style="list-style-type: none"> ○ Add community resilience component ○ Ensure tool is applicable to NYS LMI housing 	<ul style="list-style-type: none"> • Address the desire to assess the resilience of social structures in LMI communities • Apply B-READY to NYS buildings
	<ul style="list-style-type: none"> • Building Selection <ul style="list-style-type: none"> ○ Gather local climate-related data ○ Gather physical and demographic information on NYCHA developments ○ Incorporate data into a web-based GIS platform 	<ul style="list-style-type: none"> • Conduct a portfolio-wide vulnerability assessment and determine which 10 buildings to focus pilot on
	<ul style="list-style-type: none"> • Data Collection <ul style="list-style-type: none"> ○ Interviews with NYCHA staff ○ Site visits to each of the 10 buildings 	<ul style="list-style-type: none"> • Gather information on the conditions and operational practices at each building
	<ul style="list-style-type: none"> • Analysis and Reporting <ul style="list-style-type: none"> ○ Enter data into B-READY tool ○ Develop a report template for the buildings assessed ○ Review templates and reporting options with NYSERDA and NYCHA 	<ul style="list-style-type: none"> • Determine a reporting structure that would most effectively communicate findings and motivate action
Research Statewide Expansion Opportunities	<ul style="list-style-type: none"> • Identify and Pursue Funding Support <ul style="list-style-type: none"> ○ Research grant funding and other funding opportunities to support additional free or low-cost assessments ○ Discuss the possibilities for funding support or integrating resilience assessments with programs with potential funders ○ Develop communications materials including a brief case study for project communications, proposal summary, and presentation slides ○ Conduct a webinar for Climate Smart Community Coordinators on multifamily building resilience assessments 	<ul style="list-style-type: none"> • Identify opportunities to make the tool accessible to multifamily building owners in NYS • Promote multifamily resilience assessments in NYS
	<ul style="list-style-type: none"> • Evaluate Overlap of Resilience and NYSERDA programs <ul style="list-style-type: none"> ○ Coordinate with IPNA standard staff, review IPNA tools and provide guidance on integrating resilience into IPNA ○ Coordinate with RetrofitNY staff on multifamily ZNE pilot, review project design documents and provide comment on overlap between resilience and the RetrofitNY program 	

This pilot project provided NYCHA with an assessment of the resilience of 10 of their buildings along with recommendations for improvements for those buildings. More widely, the pilot project served as a new case study in assessing resiliency for the LMI multifamily housing sector that yielded insight into the most practical pathways for improving the resilience of the New York State's multifamily building sector.

3 Approach

DNV GL designed the B-READY tool to provide building owners with an informative assessment of the resilience of individual buildings and to help these owners understand where they could make improvements to strengthen resilience. The B-READY assessment process begins with a discussion with the building owner, manager, or engineer about the building and its operations and is followed by a physical inspection of the building and equipment and analysis of the data. The information gathered through these activities forms the basis of the recommendations in the report. The B-READY assessment process is similar to and can complement an energy audit, which evaluates many of the same building components. The difference is that B-READY assesses building performance on the basis of climate-related risks and targets building improvements by considering the potential impacts of hazardous conditions on the building and its tenants. Figure 1 provides an overview of the B-READY process.

Figure 1. Schematic of B-READY Resilience Assessment®



To pilot B-READY and the resilience assessment process, DNV GL worked with NYCHA and NYSERDA to select 10 NYCHA buildings for assessment, with the goal of choosing a geographically, demographically, and architecturally diverse assortment of buildings. Once the 10 buildings were selected, DNV GL proceeded with data collection and analysis.

DNV GL combined the analysis with a stakeholder workshop and resident engagement workshops to determine how best to measure community or social resilience in LMI multifamily developments. DNV GL incorporated the results of these efforts into individual building reports designed to synthesize the results and provide NYCHA with an overview of the actions that can be taken to improve the buildings' resilience. Further, DNV GL worked with NYSERDA to assess opportunities for expanding access to B-READY or other means for assessing and improving resilience in multifamily buildings in New York State. The approach to each of these components of the pilot is described in the following section.

3.1 Engage Stakeholders

The stakeholder engagement aspects of this work involved two primary activities:

1. Engaged LMI multifamily housing stakeholders (both governmental and nongovernmental) in a half-day workshop
2. Conducted four resident engagement workshops
 - a. Conducted an LMI Multifamily Stakeholder Workshop

The goal of the LMI Multifamily Workshop was to inform statewide stakeholders of the resilience assessment pilot and collect their input on ways to measure the social resilience of LMI housing developments. DNV GL also sought to get their thoughts on ways to expand the pilot and make resilience assessments accessible to building owners across the State.

DNV GL worked with NYSERDA to identify a list of potential New York State stakeholders to invite, crafted an agenda, and handled the logistics for the market actor workshop. There were ultimately 10 participants in the workshop from a broad range of organizations that work in the multifamily housing sector, including the Association for Energy Affordability, City University of New York, the Community Preservation Corporation, LISC NY, Enterprise Community Partners, and the NYS Department of Environmental Conservation. The workshop was held at the Building Energy Exchange (BEEEx) in New York City on May 5, 2017.

Two sessions were conducted with the group. For the first session, two breakout groups were formed to work on two specific core problems that relate to assessing the resilience of multifamily buildings and addressing social equity in resilience. Attendees were divided up based on areas of interest, allowing them to provide their expert perspectives as they discussed related issues. The groups were given problem statements, such as the following:

- For assessing multifamily buildings, residents of low-income multifamily buildings are disproportionately affected by the impacts of climate change events.
- For social resilience, low-income multifamily buildings lack adequate systems and features to maintain safety and livability during emergency events.

With these statements in mind, the groups discussed direct causes and symptoms, underlying causes, and contributing factors. Ultimately, the exercise provided insight on ways to potentially measure how well a building or community is equipped to mitigate the issues.

The second group exercise was a transformational mapping exercise focused on refining and scaling the multifamily resilience assessment statewide. DNV GL performed this session as one group. The discussion provided a basis for understanding the stakeholders' goals and thoughts on how to expand the use of the tool throughout the State.

3.1.1 Conduct Community Engagement Workshops

The overall purpose of the community engagement workshops was to verify that the measures for social resilience added to the B-READY tool adequately assessed the ability of the community to respond and recover from an emergency event. Specifically, the workshops were designed to do the following:

- Solicit meaningful feedback from the residents on how they respond to an extreme weather event
- Create awareness and educate the residents about emergency preparedness
- Use the information gathered to measure social resilience in the community

The workshops were scheduled to coincide with regular tenant association meetings. The workshop plan included a focus group discussion designed to explore awareness of and concerns about climate-related events, and to explore potential solutions for addressing areas of need (as identified by the participants).

DNV GL held four workshops at different NYCHA facilities. The first was on December 2017 at the Carey Gardens Development, Coney Island. The development was affected by Hurricane Sandy and the workshop was planned to coincide with a Sandy Recovery Team update. The remaining three were held at the UPACA development community center in Harlem (upper Manhattan), the Jefferson Houses development in upper Manhattan, and the Morris Houses in the Bronx. During the resident engagement workshops, DNV GL introduced the work being done to help improve the resilience of NYCHA facilities, provided information on the types of hazards included in the assessments, and did two scenario-based exercises with the participants. In the scenario-based exercises, residents were given either a flooding, excessive heat, or a power outage scenario and asked a series of questions relating to their needs and probable actions during these events. To collect as much feedback as possible from a variety of residents on items that may or may not be discussed during the scenario discussions, DNV GL also distributed a separate paper survey for residents to complete (included as appendix A). The survey asked 15 questions covering participant age range, family situation, level of preparedness for emergencies, social structures, and probable course of action during certain emergency situations (e.g., power outage, flooding, excessive heat).

3.2 Refine B-READY Tool

Based on the feedback received from the LMI multifamily stakeholder workshop, DNV GL updated the B-READY tool to incorporate a social resilience assessment module. DNV GL also reviewed and adjusted the tool to be applicable to multifamily buildings in New York State.

In addition to the social resilience measures added to B-READY, DNV GL confirmed that the tool's risk assessment methodology was in line with industry standards. The risk analysis performed as part of B-READY is designed to provide an indication of the level of risk to the building and its residents from extreme weather events. The risk calculations are made based on a Coarse Risk Analysis methodology, which is a common method for conducting a risk screening. The Coarse Risk Analysis qualitatively assesses hazard frequencies and potential impacts relative to potential vulnerabilities of the asset. The team worked with internal risk assessment specialists to validate the approach.

3.3 Select Buildings

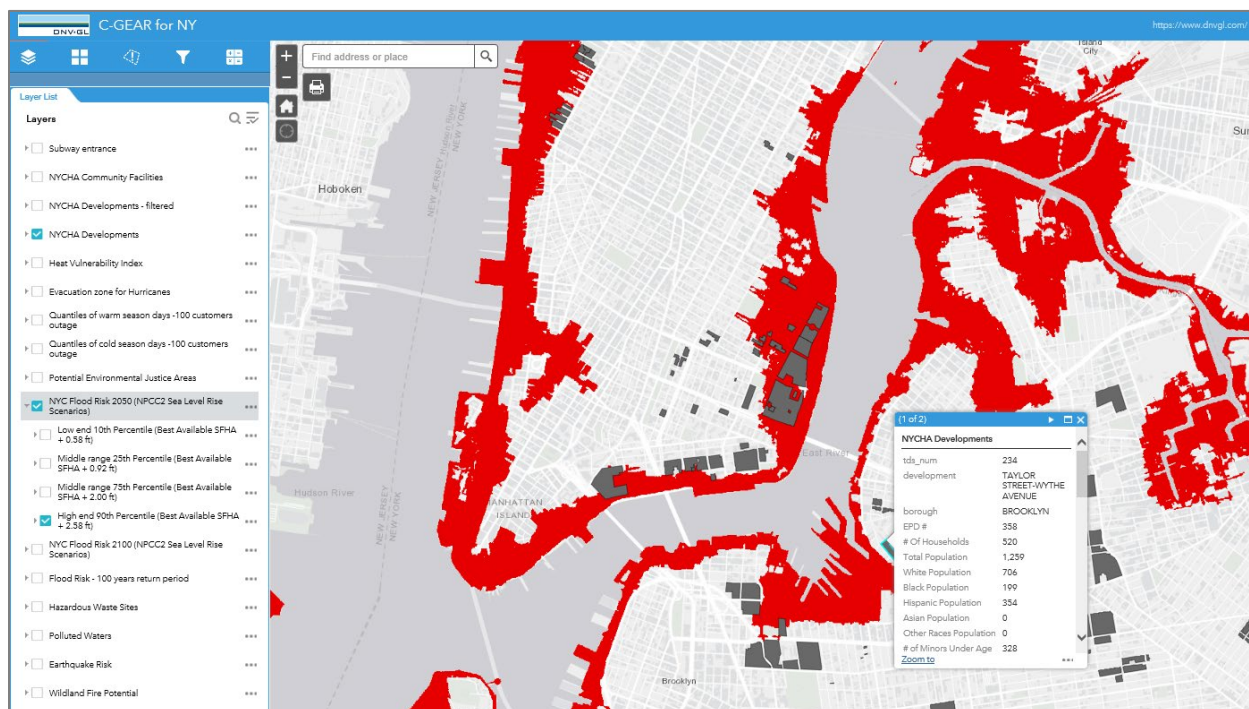
To select the ten buildings, DNV GL worked with UB and conducted a high-level, portfolio-wide vulnerability assessment. The assessment used local climate-related hazard information or proxies for vulnerability at the census or neighborhood level to determine vulnerabilities. DNV GL worked closely with UB and NYSERDA to identify appropriate indicators of vulnerability. DNV GL was able to use public sources to compile much of the GIS-based hazard information, which was then incorporated into another DNV GL-proprietary tool called C-GEAR (a web-based GIS platform that does not require users to have GIS software). DNV GL incorporated into C-GEAR all available hazard maps along with maps of indicators of potentially vulnerable populations (e.g., DEC potential environmental justice areas; the locations of community centers and subway entrances to assess access and proximity to these resources) and made these accessible to NYCHA and NYSERDA. The maps referenced the following climate change-related hazards:

- Sea level rise
- Storm surge resulting from hurricanes
- Flooding from severe storms
- Excessive heat

Simply mapping the temperatures associated with excessive heat or heat waves would not yield much value, as the impact of excessive heat on a given community depends on a combination of non-geographic factors. Accordingly, DNV GL incorporated into C-GEAR the New York City heat vulnerability index (HVI) developed by the New York City Department of Health and Mental Hygiene (NYC DOHMH), which refers to social and environmental factors to quantify a community's vulnerability to extreme heat at the census tract level.

DNV GL also incorporated NYCHA housing developments, hurricane evacuation zones, warm season and cold season power outage information, potential environmental justice areas, and land-use density and intensity data. In addition, NYCHA provided physical and demographic data on each of their developments. This included information on development type, year built, square footage, number of occupants, number of units, etc. as well as the percentage of children, percentage of seniors, ethnic distribution, average income, and head of household information. NYCHA also provided other information, such as data on electricity and natural gas consumption for each of the developments. DNV GL imported the information into C-GEAR so that when an individual NYCHA facility was selected, its physical and demographic information would be visible. An example of this is shown in Figure 2.

Figure 2. C-GEAR Hazard Mapping Interface



DNV GL reviewed the compiled data to identify developments where flooding could occur from either a “100-year event” or a combination of storm surge and projected 2-foot sea level rise using the NYC Flood Risk 2050 Middle Range 75th Percentile estimate,⁴ or where residents are considered to be at high risk to heat events having an HVI of four or greater, according to the NYC DOHMH information.⁵ DNV GL then selected developments that could be affected by these events and that met other key building characteristics or indicators of vulnerability like building size, age, occupants under 18, or occupants older than 62. DNV GL selected these criteria based on the information available from NYCHA and conversations with NYCHA staff.

DNV GL identified an initial list of 22 candidate sites. In coordination with NYSERDA and NYCHA, DNV GL narrowed the list to ensure that there was a good distribution across the boroughs and all the factors of interest (e.g., a variety of hazard exposures, properties affected by Hurricane Sandy; number of senior housing buildings, different sizes, ages of buildings and construction types) were included. With these factors in mind, DNV GL then narrowed this list down to 10 buildings to visit at six developments. The sites chosen are shown in Table 2.

Table 2. Buildings Initially Identified for the Resilience Assessment

Number of Buildings Assessed	Development Name	Borough
2	Hammel	Queens
2	Carey Gardens	Brooklyn
1	UPACA (Site 5)	Manhattan
1	White	Manhattan
2	Jefferson	Manhattan
2	Claremont Parkway	Bronx

Of these developments, Hammel and Carey Gardens were affected by Hurricane Sandy in 2012. UPACA and White were both senior housing facilities. The White Housing Development is exposed to flooding dangers and UPACA is in a neighborhood with a high HVI. Claremont Parkway was chosen because of its comparatively low-energy use was of interest to NYCHA and its location in the Bronx.

3.4 Collect Data

DNV GL coordinated with NYCHA staff to schedule and conduct the on-site assessments. Upon arriving at the site, DNV GL staff met with NYCHA field inspectors from the Capital Projects Energy and Sustainability Division. After reviewing the plan for the on-site visits, it was determined that the buildings at Jefferson and Claremont were too similar to yield a useful range of results, so rather than do two buildings at each of these developments, the field team visited a building at the Morris Development and the Corsi Development. According to NYCHA staff, these were good alternate sites. Table 3 provides a listing of sites that were visited.

Table 3. Buildings Visited for the Resilience Assessment

Number of Buildings Assessed	Development Name	Borough
2	Hammel	Queens
2	Carey Gardens	Brooklyn
1	UPACA (Site 5)	Manhattan
1	White	Manhattan
1	Jefferson	Manhattan
1	Corsi	Manhattan
1	Morris	Bronx
1	Claremont Parkway	Bronx

DNV GL conducted an approximately 1-hour interview with the NYCHA staff prior to the building walk-throughs to collect information on emergency procedures and to understand the building’s history, improvements made over time, and potential areas of vulnerability to climate change events.

During the building walk-through, NYCHA staff provided DNV GL access to the areas in the building needing assessment including the basements, rooftop, mechanical and electric room, and vacant apartment units. DNV GL collected information on each building system, including communications and security, electric systems, fire protection systems, HVAC and other equipment, operations procedures, plumbing systems, building shell, and structure. DNV GL also performed a site assessment focusing on exterior building conditions, building accessibility, site design, and neighborhood connections.

3.5 Conduct Analysis and Develop Reports

3.5.1 B-READY Analysis

B-READY determines the level of resilience by analyzing the building systems and their capacity to withstand and recover from extreme weather events, using on-site data entered directly into the B-READY tool. This information then helps determine areas of deficiencies and potential improvements to reduce the impacts of climate change or extreme weather events based on the hazard exposures and systems in place.

To properly assess the deficiencies, B-READY considers the frequency and potential impacts of events. For this assessment, air quality, drought, earthquake, extreme temperatures, flooding, heatwaves, storms, and wildfires were all hazards that were included in the analysis. Frequencies and impacts were rated on a scale of one to five. The frequency ratings were determined based on information found in ClimAID,⁶ the New York State Hazard Mitigation Plan,⁷ the NPCC,⁸ and PlaNYC.⁹ Potential impact estimates were based on an estimation of potential losses due to structural damage, human health, and power disruption. Tables 4 and 5 define the scales used for the frequencies and impacts of events. In Table 4, a rating of 5 represents the most frequently occurring events. In Table 5, a rating of 5 represents the highest level of impact from an event.

Table 4. Event Frequency Scale

1	2	3	4	5
Not likely to occur	One event in 100 years	Likely to occur once every 10 years	Likely to occur 1 time per year	Likely to occur 1-10 times per year

Table 5. Impact Scale

Scale		Human	Monetary Losses	Occupancy
0	None	Discomfort (physical impediment)	<\$100	>1 day of disruption/inconvenience
1	Minor	Bruises/minor injuries	\$100 - \$1,000	Disruption/inconvenience < 1 week
2	Significant	Minor injuries (1-week absence)	\$1,000 - \$10,000	Closed for 1-5 business days
3	Serious	Serious injuries (+1 month in hospital)	\$10,000 - \$100,000	Closed for > 1 week
4	Critical	Several injuries (require hospitalization)	\$100,000 - \$1,000,000	Closed for > 1 month
5	Catastrophic	1-2 fatalities	>\$1,000,000	Permanent loss of occupancy

Note: Impact rating were based on estimated potential for loss of life, monetary losses, or occupancy-related disruptions. Monetary losses included both losses due to structural damage and losses due to power failure. The greatest potential impact in any of these categories determined the impact classification.

3.5.2 B-READY Report Development

DNV GL developed eight reports covering the ten buildings assessed as part of this pilot. The Hammel Houses report and Carey Gardens report covered two buildings at each of the developments. The reports were a product of each component of the resilience assessment including the refinements made to the B-READY tool to adequately cover multifamily buildings and include a social/community resilience assessment; the portfolio-wide vulnerability assessment and building selection process; and the gathering of information through the workshops and on-site assessments.

DNV GL designed the reports to provide NYCHA management with the most pertinent and actionable items for each of the developments. They were intended to inform potential investment decisions and operational improvements NYCHA may make to minimize damage or disruption to building operations during an extreme weather event. Findings and recommendations presented in the reports were based on a review of the building's exposure to various climate-related hazards, information gathered during an on-site survey, interviews with the Energy Team from NYCHA, and discussions during resident engagement workshops.

DNV GL prepared a draft B-READY report for the one building at the Jefferson Houses development as a template for the other reports. The draft report provided a relative resiliency score known as the B-READY Index, a summary of the key takeaways from the assessment, a summary of the building conditions, the local climate-related hazards and risk assessment, and potential improvements. After completing the report template, DNV GL developed reports for the other buildings.

3.6 Research Statewide Expansion Opportunities

The goal of this work was to identify means for expanding access to B-READY across New York State. DNV GL researched and identified federal, local, and State government entities, utilities, and nonprofit organizations to reach out to that may provide grant funding or other programmatic funding for this type of work. After exploring opportunities with these types of organizations, DNV GL then turned to current programmatic work that NYSERDA was leading to determine ways resilience may be incorporated. This involved reviewing and coordinating on the Integrated Physical Needs Assessment (IPNA) standard development and the RetrofitNY Multifamily Zero Net Energy (ZNE) pilot. To help identify ways to make building resilience assessments more accessible to multifamily property owners, DNV GL researched funding opportunities, contacted potential funders and program administrators, and assessed ways to incorporate resilience work into existing statewide programs. The primary activities to support these efforts included the following:

1. Conducted research and outreach to federal and State agencies, and potential partner organizations who may provide funding for comprehensive resilience assessments, or have access to funding through low-income, multifamily housing networks
2. Coordinated with NYSERDA to determine the overlap with and assess opportunities for resilience in programs like the RetrofitNY Multifamily ZNE Pilot and the development of the IPNA

3.6.1 Conduct Outreach and Explore Funding

DNV GL researched various State and federal funding opportunities available and conducted outreach to relevant organizations to discuss potential partnerships in New York State. Initially, DNV GL identified 31 organizations as possible candidates to reach out to for discussion about the resilience assessment work as well as what funding opportunities might be available.

To support outreach efforts, DNV GL developed communications materials to help promote building resilience and describe the process. Contacts at agencies or organizations often requested a case study, sample report, or other documentation to review so they could better understand the work and its value. To accommodate these requests, DNV GL prepared a case study informed by the initial outcomes from the on-site assessments and a slide deck describing B-READY and the assessment process (see appendix B).

DNV GL also prepared a proposal template for a research project on multifamily affordable housing resilience. The intent was to provide a framework to facilitate discussion when talking with research-oriented organizations that seek to address gaps in resilience planning, emergency event management organizations such as the United States Department of Homeland Security, or nonprofit organizations such as Kresge Foundation.

Lastly, DNV GL has prepared a three-minute video¹⁰ abstract relating to the NYCHA project to help disseminate information about multifamily building resilience assessments and the results of the NYCHA pilot to other low-income multifamily providers. The video highlighted the approach for assessing building resilience, the climate hazards assessed, and a discussion of key findings from the NYCHA assessment.

In conducting the outreach, DNV GL was able to have conversations with 15 of the 31 organizations identified. This included conversations with 3Cubed, Enterprise Community Partners, and Local Initiative Support Corporation (LISC)—organizations focused primarily on the multifamily affordable housing sector. DNV GL initiated conversations with the Natural Resources Defense Council (NRDC) about integrating the B-READY assessments into the IPNA standard in the State,¹¹ and with the United States Green Building Council (USGBC) about aligning B-READY with ReLi—a building resilience certification program in development. DNV GL also discussed the pilot with ConEdison and National Grid to determine if energy efficiency programs could possibly support resilience assessment work.

Throughout this work New York State Department of Environmental Conservation (DEC) has offered their support for resilience work. As part of this support DEC hosted a webinar on the topic as part of their Climate Smart Communities program. These webinars are open to anyone in New York State but are primarily attended by municipalities that participate in the Climate Smart Communities program. The webinar was held in January of 2019. DNV GL along with the UB and Enterprise Community Partners covered multifamily building resilience and used the NYCHA B-READY project as a case study.¹²

3.6.2 Research into the Current Practices of Design Professionals and Existing Tools

As part of this project, researchers at the UB published an article on the climate resilience approaches adopted by building professionals. The researchers completed a literature review and an examination of 18 climate change resilience documents developed to guide building sector professionals in the United States. One goal of the literature review was to better understand how professionals are framing and possibly incorporating resilience strategies in their projects. A second goal was to provide information to the market on resilience assessment tools and further promote the practices of resilience improvement planning.

The article, published in the MDPI journal *Sustainability*,¹³ categorized climate change resilience activities in four academic domains: ecology, engineering, disaster risk reduction, and the social sciences. The findings indicate the challenges of translating the concept of resilience into comprehensive, specific design and building strategies for design professionals to adopt. Additionally, the article discusses how competing conceptions of resilience may impact the implementation and effectiveness of climate change resilience strategies in the built environment.¹⁴

3.6.3 Assess Overlap Between Resilience and NYSERDA Programs

DNV GL reviewed the possibilities for integrating resilience work into NYSERDA multifamily programs: The IPNA standard and the RetrofitNY Multifamily ZNE pilot program. For both of these, DNV GL worked directly with the program managers to review program documents and identify resilience-related aspects.

Development of the IPNA standard and tool is a collaborative effort between city and State housing agencies, NYSERDA, utilities, and financing organizations. It combines a traditional property needs assessment, which is often required to finance projects for multifamily buildings with an energy and water efficiency audit and health assessment. DNV GL collaborated with NYSERDA and reviewed both the standard and the tool to determine its fit for resilience work. For the IPNA standard, DNV GL collaborated with NYSERDA and reviewed both the standard and the tool to determine how resilience may be incorporated. This involved providing comments on the overlap with building resilience, providing guidance to NYSERDA on the types of questions for financiers about the development of the standard, and attending a stakeholder call to provide input on training needs for IPNA contractors. The results of this effort are summarized in section 3.

For the RetrofitNY Multifamily ZNE pilot, DNV GL was asked to review the design documents for the six multifamily retrofit projects participating in the program. The project teams for these projects were aiming to achieve ZNE status for the buildings through a deep energy retrofit process that included improvements to the building envelopes, highly efficient HVAC systems, and on-site solar photovoltaic (PV) arrays. DNV GL reviewed the concept design documents for each of the projects, provided comments on the resilience aspects to help educate the design teams, and offered items for the teams to consider that would further enhance building resilience. DNV GL also helped NYSERDA create a template for the teams to use to more clearly capture and describe the resilience aspects for future design submittals. After submitting the schematic design document packages, DNV GL conducted another review to determine what adjustments had made and issued another set of comments for each of the design teams.

4 Results

The findings from this pilot are organized into three main components that are described in section 2: stakeholder engagement; building resilience assessments; and statewide expansion opportunities research. Overall, the results of this effort provided guidance to NYCHA on improving the resilience of the buildings assessed; however, more broadly, they may help in determining the future direction of resilience work in the LMI multifamily housing sector in New York State.

4.1 Stakeholder Engagement

4.1.1 LMI Multifamily Stakeholder Workshop

The LMI Multifamily Stakeholder Workshop taught the important lesson that categorizing the causes and symptoms of resilience problems is generally a complex effort, and success depends on the strengths of community systems in place. Understanding the factors that lead to these problems can help facilitate collaborative approaches and foster community resilience.

As a result of the discussion, insight was gained on the direct causes and symptoms, underlying causes, and factors that contribute to vulnerabilities in multifamily housing development. From these insights a series of potential questions to help to determine the level of resilience in multifamily housing were identified including the following:

- Are safe areas in buildings identified (lobby, roof)?
- Is there backup power for emergency systems?
- Is the development capable of islanding from the grid?
- Are windows fixed or operable?
- Is resident training to understand emergency response conducted?
- Are there visible signs of deterioration?
- Is there access to transportation?
- Is there evidence of community engagement (e.g., recycling, knowing the building supervisor's name)?
- What is the Family Stability Ratings based on, number of police calls?
- How fast does something get fixed (maintenance call records)?
- Are access or egress pathways free of clutter?
- What is the financial stability of the building ownership?
- Does overcrowding exist?
- Are there high proportions of undocumented immigrants in the building?

Further, the transformational mapping exercise which focused on methods for scaling multifamily resilience assessments statewide identified the following near-term and long-term needs:

Near-term needs:

- Government agencies, NGOs, and the private market need more concrete data on the benefits of resilience to effectively communicate its value
- The resilience assessment process must be streamlined and made more easily accessible to property managers and building owners
- Government agencies and NGOs should work together to identify beneficiaries (an initial target market)
- Government agencies, NGOs, and the private market must conduct outreach and engage residents and building owners on the subject (including training)
- Private market and NGOs must quantify the dollar value of resilience and risk
- NGOs must continue to engage the insurance industry on the topic of resilience
- All must work to identify incentives and other funding mechanisms for resilience programs

Long-term needs:

- Improvements in code and permitting process
- Inclusion of risk assessment in PACE programs
- Committed ongoing funding streams
- Demonstrated concrete value

4.1.2 Community Engagement

The community engagement workshops revealed that the scenario discussions were effective in getting participants to think more deeply about how to proceed in an emergency event, and what resources they would need. Guiding residents through a specific event contributed to a productive discussion about emergency preparedness. DNV GL learned about how well the residents were prepared; what they considered to be lacking; and how well NYCHA was reaching residents with communications about emergency preparedness.

4.1.3 Key Takeaways from Workshops

- There are persistent heating and cooling issues in the NYCHA buildings
- What is considered a “cooling center” is not well understood by residents
- The procedural practices of NYCHA to register medical equipment and check fire alarms and carbon monoxide detectors are not well understood by residents
- There are concerns about public safety and forms of egress from high-rise buildings
- Residents under 40 years of age are not well engaged in conversations around emergency preparedness
- Residents would like to have more training on emergency preparedness

4.1.4 Key Takeaways from the 38 Workshop Surveys Completed

- Sixty-six percent of the workshop participants were over the age of 65
- Sixty-six percent of participants acknowledge having received communications from NYCHA about preparing for extreme weather events
- Most participants (61%) indicated they have some kind of family emergency plan in place
- Twenty-one percent of participants indicated they interact with fewer than five other residents on a regular basis
- Sixty-one percent attend community events regularly
- Cell phone and radio are the primary means of getting information during a power outage
- Thirty percent of participant use the community centers for cooling purposes
- Sixty-three percent indicated an awareness of symptoms of heat-related illnesses
- Thirty-two percent felt they were not adequately prepared for a heatwave

Note: The results for 4.1.4 are based on responses from the workshop participants only and are not representative of the development community overall.

Through these conversations and conversations with NYCHA staff, DNV GL identified practices NYCHA could adopt to improve community resilience. Continuing to engage residents in emergency preparedness discussions through direct outreach and scenario planning exercises and using these engagement opportunities to make sure residents know about all forms of egress during a fire or other emergency events will help residents be more prepared. Surveying residents on a regular basis using available online platforms would serve as a good touchpoint with the residents and provide NYCHA the opportunity to gauge the efficacy of their emergency preparedness messaging.

Additionally, the residents who attend tenant association meetings are self-selecting, more active tenants. Hosting events separate from tenant association meetings may attract a more diverse crowd. Providing resilience or emergency preparedness workshops in partnership with organizations that provide similar workshops such as the U.S. National Guard, American Red Cross, or Union Settlement Senior Services may help boost attendance and relieve some of NYCHA's burden in organizing such events. NYCHA emergency management staff expressed that engaging these organizations for future emergency preparedness workshops was being considered.

4.1.5 Key Takeaways Relevant to the B-READY Tool

These workshops demonstrated that the measures incorporated into B-READY following the LMI multifamily stakeholder group provided a good indication of the of community resilience; however, several measures could be incorporated into future versions of B-READY as part of the community resilience components that would provide additional insights. These included the following:

- Are police officers or other public safety officials actively engaged in the community?
- Do residents check in with their neighbors during emergency events?
- Do residents have first aid kits?
- Have residents signed up to receive emergency alerts?
- Is emergency preparedness training offered to residents?
- Do residents have access to radios and extra batteries during power outages?
- Do emergency plans include a reliable method for transportation away from dangers?

4.2 Building Resilience Reporting

Reviewing the risk analysis for each building reveals similarities in findings across the buildings in terms of both potential operational improvements and capital improvements. The risk analysis portion of the reports covers the relative level of risk according to a climatic event, the level of risk mitigation according to hazardous conditions, and the mitigated risk by the building system. Depending on the location of the development in the city, the relative level of risk to climatic events varies. If the development is in, or close to, an area identified as a flood plain for a “100-year storm” event, flooding and extreme precipitation are likely the highest concern. Away from the flood-prone areas, windstorms, air quality, heat waves, and extreme precipitation are often found to be the highest concerns. For mitigated risk by hazardous conditions, the B-READY analysis determined that most developments had little protection against air pollution, flooding, hail, lightning, and water pollution. This suggests that the measures associated with mitigating these hazards in B-READY are not standard practice for NYCHA facilities and have not been prioritized as part of past improvement efforts.

Patterns also emerged around the level of risk mitigated by the building system. The B-READY analysis often found that the building systems with substantial deficiencies were electrical and lighting systems, on-site energy generation, and storage (backup power systems), building operations, site design, and interior furnishings. Overall, the top-recommended strategies identified for the NYCHA buildings included the following:

- Ensure that the local heating and cooling center has a reliable backup power system and provide a backup power supply for critical systems throughout the residential portion of the developments.
- For sites where flooding is or may become an issue due to sea level rise or precipitation patterns, provide physical barriers and features to help manage coastal surge flooding and impacts to residents.
- Protect electrical equipment against water damage in basements and below grade.
- Modernize electrical systems and install energy efficient lighting systems throughout the buildings.
- Provide a means for extended water supply by installing water-efficient fixtures and increasing water storage.
- Continue to engage residents on emergency preparedness through direct outreach and scenario planning exercises and use resident engagement opportunities to ensure that residents are fully aware of all forms of egress during a fire or other emergency events.
- Use online survey platforms to gauge preparedness as well as the effectiveness of messaging and terminology.
- Ensure all staff understand their responsibilities and tasks before, during, and after hazard events. This can be accomplished through regularly held internal emergency preparedness meetings.
- Establish a list of equipment vendors for renting equipment, such as pumps and generators, to improve response to a hazardous weather event or an extended utility outage.

One of the main takeaways from this process was that when engaging with a customer who owns and manages a large portfolio of buildings, a great amount will be learned in terms of the buildings' resilience simply by asking operational and design questions typical to the work as well as work constraint questions. For instance, NYCHA, as a public housing authority, relies on federal funding to maintain and operate their properties. Because of the structures required, their ability to prioritize and make improvements is often limited by funding requirements and standard administrative procedures.

4.3 Statewide Expansion Opportunities Research

This section details DNV GL's findings about opportunities for statewide expansion of resilience assessments.

4.3.1 Outreach and Funding Exploration

Throughout the latter stages of the project, DNV GL continued to investigate funding and programmatic opportunities in New York State, specifically targeting the following:

- Partner organizations working with multifamily buildings (e.g., AEA, Enterprise Community Partners)
- Federal programs and funding (e.g., U.S. Department of Housing and Urban Development (HUD), Federal Emergency Management Agency (FEMA), U.S. Department of Homeland Security)
- Philanthropic funding (e.g., Rockefeller Foundation, Kresge Foundation)

Table 6 summarizes the results of the contacts DNV GL made.

Table 6. Results from Outreach to Nonprofit Organizations

Organization	Outreach Summary
Association for Energy Affordability (AEA)	Multiple conversations were held about integrating resilience in AEA's program work. The organization implements multifamily energy efficiency programs both in New York State and California and is an approved Multifamily Performance Partner for NYSERDA. AEA agreed to test the value of this tool through its weatherization program initially in Alameda County, CA with hopes of expanding and replicating the model in New York State.
Enterprise Community Partners	Multiple conversations were held about the resilience work and collaborated on DEC webinar; offered a proposal for use of C-GEAR for portfolio-wide vulnerability assessments; collaborated (along with NRDC) on development of Climate Resilience Financing brief (currently in development); agreed to continue to collaborate and share information on NY-based work.
Natural Resources Defense Council (NRDC)	Discussed opportunities for incorporating resilience into the IPNA. Agreed to continue, discuss, and share information. DNV GL later engaged directly with NYSERDA on this as described later in this report.
Local Initiative Support Corporation (LISC)	Interest was expressed in testing the resilience assessment tool and incorporating these types of improvements into regular capital projects, but needed a better understanding of the value of the assessments before moving forward.
Community Preservation Corp.	Interested in the resilience assessment work and asked to be kept informed of our progress. No commitment to a partnership was made, however.
Kresge Foundation	Identified an opportunity to apply for funding but needed a nonprofit or community-based organization to partner with to pursue. DNV GL was unable to secure a partner before expression-of-interest deadline.
Rockefeller Foundation	Set up call to discuss and review case study but were told that they would be unlikely to contribute unless a nonprofit partner was involved.
3Cubed	Discussed conducting a nationwide program on the health and resilience benefits of improving the energy efficiency of affordable multifamily housing, which includes work in New York State.
U.S. Green Building Council	Discussed the development of GRESB and USGBC's new ReLi certification to understand if partnership opportunities might exist that would allow for expanding B-READY across New York State. No commitment was made, however.

Of the federal entities reached, the Federal Emergency Management Agency (FEMA) and U.S. Housing and Urban Development (HUD) expressed interest in the work and requested more information; however, they did not identify any immediate funding opportunities. DNV GL made initial contact with the Department of Homeland Security (DHS), but there was no further progress with respect to grant funding opportunities. At the State and local government level, DNV GL was able to contact the New York City Housing Preservation and Development (HPD), DEC, and NYC Office of Emergency Management (NYCEM). All of these entities also expressed an interest in the work, but none identified concrete

mechanisms or programs that could support further resilience assessments. HPD said they were looking at ways to incorporate resilience in their sustainability program and would require all projects seeking financing to complete a risk exposure assessment. The DEC offered their support for resilience work but did not currently have an appropriate program to which it could be added. The DEC did, however, help to promote the work by hosting the Climate Smart Communities webinar on the subject.

From these efforts, DNV GL learned that while this work is seen as important, there are competing priorities for supporting infrastructure and available funding sources, and navigating the application process can be difficult. Federal agencies such as FEMA, HUD, and DHS offer programs through which building resilience improvements could be made; however, applications for funding must be filed during certain times and when solicitations are open, there may be a lengthy vetting process for new projects. In addition, other organizations are mission driven and provide funding support to other energy, housing, education, and workforce initiatives. There are many organizations promoting resilience, but as this is still an emerging field, resilience is not widely understood to be a sound investment. Further evidence is needed to demonstrate the value and impacts of resilience improvements on the costs of owning and operating multifamily properties, and on the ability of residents to endure emergency events.

Through discussions with ConEdison we learned that the cost/benefit rules set around energy efficiency programs by the NYS Department of Public Service make it difficult to incorporate resilience aspects into energy efficiency programs. Although there is overlap between the processes for identifying improvements and certain projects, resilience improvements do not have a return on investment that is as measurable as energy efficiency measures.

Ultimately, the most promising pathways for scaling multifamily resilience improvement work in the near term were found in NYSERDA programs. This is because the issue of climate change risk management and improving the resilience of buildings has been prioritized by NYSERDA and the State of New York. NYSERDA currently also has extensive resources in place for scaling resilience improvements and educating the market.

4.3.2 Overlap of Resilience Assessments and Existing NYSERDA Programs

This review showed a clear overlap between the information collected for IPNA by the Needs Assessor and Energy Assessor and the information needed to assess resilience. For example, IPNA and a resilience assessment would both inspect the condition of sidewalks, drains, fire passages, landscaping, and energy

and water systems. The solar assessment done in the IPNA is also very useful for assessing resilience, as are the measures included in Healthy Rehab Interventions and Environmental Exposures. However, the IPNA standard doesn't consider climate hazards in the needs assessment.

For the most part, the RetrofitNY Multifamily ZNE pilot design teams understood and were able to document how the deep energy/ZNE retrofits contribute to increased resilience in these buildings. However, items like having adequate backup power for the building did not appear to be a priority for the design teams. Certain resilience measures apply only to select regions of the State. For example, there is not as great of a need for backflow prevention devices in projects in Upstate New York as there is in New York City. Overall, the design teams were reluctant to incorporate additional resilience improvement items in their projects. Based on the comments provided by the teams in the schematic design submittal, they felt the additional items relating to communications, community, and site design were out of scope. For future program work, incentives for resilience measures may encourage design teams to consider resilience as a motivation for their design approach. Based on feedback from the RetrofitNY ZNE pilot program managers, tracking the resilience strategies used by the teams in these projects will likely continue.

5 Conclusions and Recommendations

This project yielded numerous findings that can help inform the direction of future programs to improve the resilience of LMI multifamily buildings in New York State. This section presents the conclusions and recommendations from the NYCHA resilience assessment pilot.

5.1 Conclusions

5.1.1 Education and Funding

- Building owners and managers need to have access to simplified tools offering them concrete information about potential vulnerabilities their buildings.
- Decision-makers need to be presented with concrete information detailing the value of resilience improvements to encourage them to raise the issue to a higher priority.
- Funding sources for public housing organizations as well as internal procedures may limit the organizations' ability to make improvements due to management structures/operational requirements.
- As “resilience” is a relatively new concept not yet widely practiced, focusing first on “emergency preparedness” may help to expedite the adoption of “resilience” as a standard concept of design.
- Emergency managers are trained in preparedness and how to handle emergency situations. The concepts behind resilience, including assessing and identifying vulnerabilities and identifying improvements, translates well for this audience. Continuing to engage emergency managers will help widen the network of resilience advocates.

5.1.2 Resilience Tools

- Existing programs are the most immediate avenue for expanded resilience assessments as long as the value is promoted, and regulatory framework supports the work. According to the utilities that were part of this assessment, the current rules for energy efficiency programs limit opportunities to include aspects of resilience.
- Understanding typical management procedures and the ability to act on improvement recommendations is an important aspect of multifamily resilience assessments. Resilience improvement projects may be impeded by staff who have limited time available due to competing priorities or by slow approval processes stemming from the organizational structure. Future resilience assessment tools should consider these operational aspects.
- Based on the trends that DNV GL identified across NYCHA buildings, initial interviews with an owner, manager, or other senior-level management of a large portfolio of buildings should be conducted to understand the typical operational and design practices as well as the work constraints. Recognizing commonalities across buildings early on also offers the potential to scale improvement projects, including resilience.

- Feedback from tenants provides important input for a holistic resilience assessment. It helps to identify vulnerabilities in the tenant community as well as disconnects between the parties.

5.1.3 Communications

- Resilience proponents need information that communicates to decision-makers the concrete values associated with resilience. Without this concrete information, proponents do not have the necessary tools to stimulate adequate investment.

5.1.4 Training

- Professionals may incorporate resilience assessments through Statewide initiatives like the IPNA standard, but these professionals require more training. Because building resilience is still a nascent field, engineers and architects are not well enough adept at interpreting climate change risks and resilience-informed design decisions.
- Workshops are an effective way of engaging residents and other stakeholders in conversations about resilience, educating them on potential hazards and preparedness, and collecting feedback on their needs; however, online surveys offer the opportunity to reach a larger audience and also to gauge the effectiveness of communications, policies, and procedures.
- LMI housing agencies should continue to leverage existing emergency preparedness and emergency response planning programs to engage residents and owners and to promote resilience.¹⁵

5.2 Recommendations

Based on these conclusions, DNV GL offers the following recommendations:

- Multifamily housing organizations in New York State should continue to push for the incorporation of resilience into the IPNA. The IPNA process and subject matter covered in the standard uses a similar approach and covers the same aspects of a building as a resilience assessment. Merging these aspects will minimize duplication of efforts and provide a pathway for resilience assessments to become part of standard practices. In addition, use these efforts to gather data that can facilitate analyses on the value of resilience-related measures associated with the programs.
- As the developers of the IPNA standard and tools consider how resilience may be incorporated into that program, the statewide climate hazard resources available through NYSERDA will be useful for understanding potential exposures to different hazards across the State. Consider providing links to the New York State Climate Change Science Clearinghouse as well as the reports published by the UB¹⁶ on building resilience on websites where IPNA tool can be accessed.¹⁷ It is further recommended that future training sessions for IPNA contractors include an overview of how to assess risk and exposure to climate hazards.

- For NYSERDA, continue to incorporate aspects of resilience into existing energy programs. The reviews of the RetrofitNY zero net energy pilot projects conducted as part of this project identified many ways in which resilience and energy retrofits overlap. Identifying and tracking the resilience aspects of retrofit projects will provide much needed data to measure the impacts of resilience improvements and provide an avenue for educating design professionals on evaluating and addressing climate change related risks in their projects.
- NYSERDA should also continue to work with organizations across the State to research and develop resources that communicate the value of resilience to multifamily housing management decision-makers and engage lenders and other financiers in discussions about creating more incentives and mechanisms for resilience improvements.
- For NYSERDA and other energy efficiency program administrators in New York State, work with the New York Public Service Commission to develop and adopt rules that allow and encourage resilience improvements in energy efficiency programs.
- Where NYSERDA or other State agencies support future resilience assessment work, start with an in-person, in-depth interview when working with an owner with a portfolio of multifamily buildings to understand operational practices, impediments that prevent or slow down building improvement projects, and the characteristics of the buildings. This foundational knowledge is needed to understand which improvements are feasible and which do not have much value to the owners.
- For NYCHA, seek alternative means to solicit and collect feedback from residents about their level of preparedness for emergency events. Resident workshops are useful for collecting this type of feedback; however, surveying residents at the contract office during leasing renewals, or incorporating resilience-related surveys into other regularly issued surveys will provide feedback from a wider audience. Further recommendations were provided in the individual reports for the buildings assessed as part of this project.

Appendix A. Resident Engagement Survey

NYCHA BUILDING RESILIENCE ASSESSEMENT: SOCIAL RESILIENCE SURVEY

Updated: Dec. 13, 2018

General Questions

1. Please provide your age range

- Under 25
- 25 - 40
- 41 - 55
- 55 - 65
- 65+

2. Do you live with children under the age of 10?

- Yes
- No
- Other _____

3. How much have you thought about preparing for extreme weather events prior to today?

- Not at all
- Only a little
- A moderate amount
- A great deal

4. What is your native language?

- English
- Spanish
- Russian
- Cantonese
- Mandarin
- Japanese
- Korean
- Other (please describe): _____
- Decline to Answer

5. Do you or have you received communications from the building management, tenant association, or community groups with information about preparing for extreme weather events?

- Yes
- No
- Please elaborate _____

6. Are communications provided in your native language?

- Yes
- No
- Have not experienced an emergency

7. Do you have a personal emergency plan?

- Yes
- No

8. Do you have a first aid kit or "go-bag"?

- Yes
- No

9. How many of your neighbors do you know and regularly interact with?

- None
- <5
- 5 – 10
- 10 – 20
- >20

10. Are there regular community events and do you attend these events?

- Yes, and I attend when I can
- Yes, but I have not attended
- No, there are no regular community events

11. Who do you rely on for information about community events or activities?

Write in response _____

12. During a power outage, what is your primary means of receiving information?

- Telephone (land-line)
- Cell phone
- Word of mouth
- Radio
- Other _____

Heat-Specific Questions

13. Where do you go to keep cool?

- Community center
- Public Park
- Library
- Grocery store
- A relative's or friend's house
- Other _____

14. Are you aware of the conditions (or risk factors) related to heat-related illnesses?


This includes: Age (65 years or older), chronic medical conditions, impaired judgment due to dementia or mental illness, abuse drugs or alcohol, overweight.

- Yes
- No

15. On a scale of 1 to 5 (with 5 being the highest level of preparedness), how prepared are you for a heat wave?

- 1 (not prepared)
- 2
- 3
- 4
- 5 (fully prepared)

Appendix B. Communications and Outreach Case Study



B-READY is a tool designed to help building owners strengthen the resilience of their buildings and prepare for the future.

ENERGY

B-READY FOR THE NEW YORK CITY HOUSING AUTHORITY

A resilience assessment pilot program funded by NYSERDA

DNV GL used its B-READY tool to assess ten NYCHA buildings in support of NYCHA's effort to understand and address risks from climate-related events, as part of its NextGeneration NYCHA Sustainability Agenda strategies.

Program Overview

To support NYCHA's goal of addressing climate change-related risks, DNV GL assessed 10 NYCHA buildings using its B-READY tool. As part of the pilot, DNV GL conducted a vulnerability assessment of 10 high-risk sites, with characteristics that are representative of the NYCHA portfolio so that lessons learned can be applied more broadly. The B-READY building resilience assessments provide a resilience index (based on a 1-100 scale)

and a set of recommended actions for improving each building's ability to withstand climate-related events. In collaboration with local industry stakeholders, DNV GL customized the B-READY tool to address the unique concerns of low-income multifamily housing. The pilot has guided the refinement of the tool, including the development of a social equity component, unique to B-READY. This programmatic approach could be utilized statewide to improve the resilience of NY's multifamily housing stock.



Urban Green Spaces. Source: Pixabay

Key Project Outcomes

While the project is ongoing, the assessments have yielded insights into the types of resilience measures that should be explored for public, multifamily buildings in New York City.

- Reliable backup power is critical for multifamily housing. In particular, low-income housing often has high populations of elderly and disabled residents who rely on power for critical systems, like elevators for mobility and medical equipment. While initial implementation costs can be high, the avoided cost of resident displacement, building system failures, and subsequent recovery make it a worthwhile investment.
- The inclusion of a community space is essential. This space can serve as both a central disaster collection point and a place for community events, which helps neighbors strengthen social ties and improve social resilience, a critical element of disaster response.
- Understanding building-specific vulnerabilities is fundamental to prioritizing resilience improvements. Buildings in flood zones should prioritize measures like moving mechanical equipment above the design flood elevation, while buildings in high heat vulnerability zones need to improve ventilation and increase shade cover on site.



B-READY

PROJECT GOALS

- Identify potential vulnerabilities and areas for improvement in 10 buildings using B-READY
- Employ workshops to engage directly with the community and understand their level of preparedness and resilience
- Leverage workshops to evaluate social equity, a unique component of B-READY, enabling a more holistic assessment of LMI community resilience



Endnotes

- 1 Visit National Guard Citizen Preparedness Training Corp: <https://dmna.ny.gov/cpc/> for more information.
- 2 <https://ap.buffalo.edu/research/research-initiatives/adapting-buildings.html>
- 3 Visit NYC Housing Development Corporation: <http://nychdc.com/Current%20RFP> or NYC Housing Preservation and Development: <https://www1.nyc.gov/site/hpd/developers/development-programs/integrated-physical-needs-assessment.page> for more information.
- 4 Source: <https://data.cityofnewyork.us/City-Government/1-foot-Digital-Elevation-Model-DEM-/dpc8-z3jc>
- 5 See <http://a816-dohbsp.nyc.gov/IndicatorPublic/VisualizationData.aspx?id=2191,4466a0,100,Summarize>
- 6 <https://www.nyserda.ny.gov/About/Publications/Research%20and%20Development%20Technical%20Reports/Environmental%20Research%20and%20Development%20Technical%20Reports/Response%20to%20Climate%20Change%20in%20New%20York>
- 7 <http://www.dhSES.ny.gov/recovery/mitigation/plan.cfm>
- 8 <https://www1.nyc.gov/site/orr/challenges/nyc-panel-on-climate-change.page>
- 9 http://www.nyc.gov/html/planyc/downloads/pdf/140422_PlanNYCP-Report_FINAL_Web.pdf
- 10 <https://www.dnvgl.com/videos/b-ready-163585>
- 11 NRDC and Energy Efficiency for All initially lead the collaborative to develop the IPNA standard. The lead responsibility was later handed over to NYSERDA.
- 12 <https://www.dec.ny.gov/energy/84359.html>
- 13 Rajkovich, Nicholas B. and Okour, Yasmien. Climate Change Resilience Strategies for the Building Sector: Examining Existing Domains of Resilience Utilized by Design Professionals. Sustainability 2019, 11(10), 2888. <https://www.mdpi.com/2071-1050/11/10/2888>
- 14 *ibid*
- 15 Visit National Guard Citizen Preparedness Training Corp: <https://dmna.ny.gov/cpc/> for more information.
- 16 <https://ap.buffalo.edu/research/research-initiatives/adapting-buildings.html>
- 17 Visit NYC Housing Development Corporation: <http://nychdc.com/Current%20RFP> or NYC Housing Preservation and Development: <https://www1.nyc.gov/site/hpd/developers/development-programs/integrated-physical-needs-assessment.page> for more information.

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