RESILIENCE AND SOLAR ASSESSMENT TOOL USER MANUAL

DC DOEE Resilience Assessments/Solar for Affordable Housing

SOLAR FOR ALL

DEPARTMENT OF ENERGY & ENVIRONMENT

Enterprise

NATIONAL HOUSING TRUST

NEW ECOLOGY
Community-Based Sustainable Development

CleanEnergyGroup
Innovation in Finance, Technology & Policy

TABLE OF CONTENTS

Photo credit: National Housing Trust

1 INTRODUCTION

Overview

The **DC DOEE Resilience and Solar Assessment Tool** is a guide for District of Columbia multifamily affordable housing owners and operators to identify potential resilience preparedness, energy and water efficiency strategies, and solar+storage opportunities to best protect vulnerable residents, reduce operating costs, and improve building durability at their development sites.

Climate change is increasing the frequency and severity of extreme storms, exacerbating droughts, shifting precipitation patterns, and causing more extreme heat waves, the impacts of which are felt disproportionately by vulnerable populations. Residents of affordable multifamily housing stand to gain the most in terms of the tangible and intangible benefits of resilience planning such as increased safety, improved health outcomes, and faster re-occupancy times after disaster strikes. Owners and operators of affordable multifamily housing can realize long-term operating and avoided impact cost savings, increased durability, and improved emergency operations through resilience planning.

The District of Columbia Department of Energy and Environment (DOEE) commissioned Enterprise Community Partners, Inc. (Enterprise) to develop this tool, and Enterprise partnered with New Ecology, Inc. (NEI) the National Housing Trust (NHT), and the Clean Energy Group (CEG) to build it out as part of the DOEE Solar for All program. The project and this assessment will advance the goals of Climate Ready DC, DC's plan to prepare for the impacts of climate change including heatwaves, flooding, and severe storms. The project will help affordable housing property owners identify potential funding and financing streams to aid in the implementation of the resiliency and efficiency strategies recommended.

The tool is intended for use by owners and operators of affordable housing, and by architecture, green rater, and engineering professionals. It is strongly recommended that one individual "resilience champion" oversees the completion of all components of the tool, although inputs are required from several different individuals for different sections. The tool consists of one questionnaire and one Excel spreadsheet with seven tabs.

The questionnaire and first tab of the spreadsheet collect basic information on the property, and can be completed by the owner or property manager or by a building professional in a phone call with the owner or property manager (and is described in Section 1 of this manual). The second tab in the spreadsheet is a set of questions to be answered by on-site property management staff (described in Section 2 of this manual). The third tab is the bulk of the resilience assessment and is to be completed on site by the owner, property manager, or building professional (described in Section 3 of this manual). The fourth tab is a data collection form for an ASHRAE Level I energy audit or equivalent and should be completed by an experience energy auditing professional (described in Section 4 of this manual)

The fifth and sixth tabs of the spreadsheet are data collection forms for the output of desktop assessments of solar photovoltaic and backup battery storage feasibility (described in Section 5 and Section 6 of this manual). Tabs 5 and 6 should be completed by a building professional experienced in renewable energy and financial and resilience metrics for backup power. The seventh tab of the spreadsheet collects all of the resilience, energy and water, and solar+storage recommendations produced by completing the

sections in the previous tabs (described in Section 7 of this manual). Each section of this manual indicates the responsible party for the information required for each related tool section and the skills and expertise needed by the responsible party.

Each tool section and responsible party is summarized in the table below:

ASSESSMENT TOOL SECTION	RESPONSIBLE PARTY
Tab 1: Project Information	Owner or Property Manager
Pre-Assessment Questionnaire	Owner or Property Manager
Tab 2: Property Staff Interview	On-site Property Manager or Staff
Tab 3: Resilience Assessment	Owner, Property Manager, or Building Professional
Tab 4: Energy and Water	Energy Auditor or Building Professional
Tab 5: Solar PV Feasibility	Energy Auditor or Building Professional
Tab 6: Solar Storage – REopt	Energy Auditor or Building Professional
Tab 7: Recommended Strategies	Owner, Property Manager, or Building Professional

To successfully complete the DC DOEE Resilience and Solar Assessment Tool and prepare to implement the resulting recommendations, the champion overseeing the tool completion will need to interface with property ownership and management and have experience in building energy auditing or coordinate with an experienced building energy audit professional, architect, or engineer. Each section of the tool should be saved or printed and together comprise the output report from the tool process.

The recommendations resulting from completing this tool, including resilience strategies, energy and water savings opportunities, and solar and battery storage feasibility, should be discussed with property ownership and management as part of ongoing operations and capital planning processes.

Resilience strategy recommendations resulting from this tool are derived from the Enterprise Community Partners, Inc. Strategies for Multifamily Building Resilience Manual and several recommended strategies support compliance for certification to the 2015 Enterprise Green Communities Criteria. However, the assessment is not intended as a comprehensive survey of all 2015 Enterprise Green Communities Criteria requirements. Prior to completing the DC DOEE Resilience and Solar Assessment Tool, the tool user should familiarize themselves with the Enterprise Multifamily Building Resilience Manual.

Assessment Tool - Tab 1

The first tab of the resilience assessment tool includes blanks to identify the property and the individual performing the assessment. Please fill in all green cells and paste in an image of the property:

Property Name	
Property Address	

Assessment Completed By	
Date Updated	

Property Photo

Pre-Assessment Questionnaire

The resilience opportunity pre-assessment questionnaire serves as the high-level property overview for the individual conducting the resilience assessment. The questionnaire should be completed by the property owner or manager, at their desk or in a phone call with the resilience champion for the project. If the property owner or manager is conducting the resilience assessment internally, the questionnaire should still be completed as it collects useful information for the assessment all in one place.

The questionnaire may be printed and returned to the assessor in physical copy, sent digitally, or completed by the assessor through a brief call with the property owner or manager. Complete as many questions as possible, leaving those blank for which the answer is unknown. Supporting documentation requested such as as-built plans will be useful during the assessment process if available, but are not required.

Responsible Party and Expertise Required

Resilience Champion
The champion overseeing the completion of the assessment should coordinate all aspects and sections of the DC DOEE Resilience and Solar Assessment process.

Owner or Property Manager
The owner or property manager assisting in the completion of the pre-assessment questionnaire and Tab 1 of the tool should have familiarity with the property operations and fundamental characteristics.

Instructions

The two-page pre-assessment questionnaire is included below. Please complete this questionnaire as the first step in the assessment process.

Pre-Assessment Questionnaire

PROPERTY NAME, ADDRESS, AND CONTACT INFORMATION

For multiple-building developments, please provide addresses for all buildings.

Property Name: _____

Property Address: _____

_____

Owner Representative Name:_____

Owner Representative Phone: _____

Owner Representative Email: _____

Property Contact Name:_____

Property Contact Phone: _____

Property Contact Email: _____

PROPERTY DETAILS

Number of Residential Units: _____ Number of Buildings: _____

Building Type(s): ***Low Rise – 4 floors or fewer, Mid-Rise – 5-8 floors, High Rise – 9 floors or more***

_____

Number of Floors (for each building type): _____

Year Built: _____ Total Square Footage (all buildings combined): _____

Year of Most-Recent Rehab: _____

Most-Recent Rehab Scope (moderate, substantial, gut):_____

Is the Property:

- ☐ Public Housing
- ☐ Section 202
- ☐ Section 811
- ☐ Low Income Housing Tax Credit
- ☐ None of the above

Residence Types:

- ☐ Family: _____
- ☐ Senior Citizen: _____
- ☐ Supportive: _____
- ☐ Individuals: _____
- ☐ Mixed: _____

Non-Residential Building Uses:

☐ Commercial: _____

☐ Institutional: _____

☐ Social Service/Community: _____

EXISTING DOCUMENTATION

Please attach electronic versions or photographs of the following types of information, requested if available.

Document:	***Last Updated:***
☐ HVAC-MEP Plans	_____
☐ Plot Plan/As-Built Survey/Topo. Survey	_____
☐ Elevation Certificate	_____
☐ Existing Capital/Physical Needs Assessment	_____
☐ Energy Audit	_____

BUILDING CHARACTERISTICS AND PLANNED CAPITAL WORK

Basement: Y N

Basement and first floor uses: _____

Description	***Basement***	***First Floor***	***Condition***		
Electrical/mechanical equipment	☐	☐	Good	Fair	Poor
Elevator	☐	☐	Good	Fair	Poor
Community room	☐	☐	Good	Fair	Poor
Kitchen or laundry room	☐	☐	Good	Fair	Poor
Offices	☐	☐	Good	Fair	Poor
Other (please describe below)	☐	☐	Good	Fair	Poor

_____

_____

Are you planning a repair/rehab project?

☐ Moderate Rehab

☐ Substantial Rehab

☐ Gut Rehab

Project Status:

☐ Pre-Development

☐ Design Development

☐ Construction

2 PROPERTY STAFF INTERVIEW

Overview

The resilience champion should use the property staff interview tab of the resilience assessment tool to guide a conversation with property management staff about past events that indicate hazard exposure as well as to identify resilience goals for the property. There is a good deal of local knowledge and experience that can inform a resilience assessment in ways that a physical inspection alone may not.

These responses will enable to the assessor to better respond to the questions in Tab 3 and to customize the resilience strategies recommended in Tab 7.

Responsible Party and Expertise Required

Resilience Champion
The champion overseeing the completion of the assessment should coordinate all aspects and sections of the DC DOEE Resilience and Solar Assessment process.

On-Site Property Manager or Staff
The on-site property manager or staff should have a close knowledge of and several years of experience at the property with building operations, historical events such as stormwater flooding or high wind damage, and repairs ongoing maintenance.

Instructions

Tab 2 of the resilience assessment tool, the Property Staff Interview, includes a list of items and pre-formatted drop-down responses and blanks.

For items in the Building History section of Tab 2, please complete the applicable frequency and date of last occurrence information if known. Please fill each green-colored cell by selecting a response from the drop-down menu available by clicking on that cell, or by entering a custom response for those cells without drop-down menus:

Building History		Frequency	Date of Last Occurrence
Stormwater Flooding Events	yes	1 time per year	9/15/18
Sewer Backup Events	yes	less than 1 time per year	8/22/18
Coastal Flooding Events	no	N/A	N/A
Ice and Snow Damage Events			
Gas Leak Events			
Power Loss Events > 5 Hours	yes	less than 1 time per year	4/6/14
Cause of Power Loss Event	downed power line		
Wind Damage Event			
Equipment Failure Event			

Resilience Planning	
Resilience Goals - Residents	
Resilience Goals - Organization	

Evacuate
Shelter in Place Temporarily
Shelter in Place Indefinitely

Emergency Preparedness	
Emergency Preparedness Plan	
Emergency Plan Last Updated (date)	
Emergency Repair/Reserve Fund	

Insurance	
Insurance Information Location	
Flood Insurance	
Law & Ordinance	
Mold	

Once complete, Tab 2 should be printed and included with Tabs 1, 4, 5, 6, and 7 to form the Resilience Assessment Report.

3 RESILIENCE ASSESSMENT QUESTIONS

Overview

The resilience assessment section of the DC DOEE Resilience and Solar Assessment Tool focuses specifically on climate change hazards that may impact the property assessed. By completing this portion of the overall assessment, the resilience champion, in coordination with the owner, property manager, and other building professionals, will develop the list of resilience strategies to be implemented in preparation for potential climate change impacts.

The resilience assessment in Tab 3 is a list of yes or no questions intended to guide the tool user through the building characteristics that will determine vulnerability to impact from climate-related hazards. This tab is the first part that must be completed on site.

The assessment questions are related to a variety of aspects of the property including mechanical, electrical, and plumbing equipment, structure, accessibility, utility data tracking, emergency management plans, etc. Once the questions in Tab 3 are complete, the tool generates a list of recommended resilience strategies in Tab 4, as described in the next section of this manual. The assessment questions should be answered by the owner, property manager, or a building professional such as an architect, energy auditor, or engineer during a site visit to the property.

Responsible Party and Expertise Required

Resilience Champion

The champion overseeing the completion of the assessment should coordinate all aspects and sections of the DC DOEE Resilience and Solar Assessment process.

Owner or Property Manager

The owner or property manager completing or assisting in the completion of the resilience assessment in Tab 3 should have familiarity with the design, layout, equipment, and function of the property.

Building Professional

An architect, green rater, or engineering professional completing Tab 3 of the assessment should be well-versed in building construction and mechanical system identification and function.

Instructions

Tab 3 of the DC DOEE Resilience and Solar Assessment Tool must be completed on site during a thorough walkthrough of the property. Schedule the walkthrough with property management staff and ensure that at least one maintenance staff person with in-depth knowledge of the property is present for the visit. Plan to enter at least one residential unit during the visit, with appropriate notification to residents as needed. The site visit should take approximately 2-4 hours to complete.

Tab 3 of the tool consists of six columns. The first column is question number and the second column is the question itself. The list of questions is broadly organized to allow the user to answer the questions during a site visit from the outside to the instide of the building. The user must answer every question in the third column of the tab with a response from the drop-down menu: yes, no, maybe, or N/A. Reference images and directions for answering each question are provided in the fifth and sixth columns. The fourth column is provided in case a question cannot be answered on site, to allow the user to take notes on additional information needed or individuals to follow up with. After the site visit, follow up with the appropriate people to answer the questions before moving on to the next tabs in the tool.

The user may complete this tab of the tool on site in Excel using a tablet or other electronic device, or this sheet may be printed and completed by hand on site, after which the user must transfer the answers manually into the Excel spreadsheet at a computer, before moving on to the next tabs of the assessment.

Resilience Assessment Tool Example

Each assessment question has a unique row in Tab 3. An example of some of the questions in the tool is shown below:

	Question	Assessment	Notes - More Information Needed	Reference Image	Directions
1	Is exterior signage easy to read, with property sign and address lit adequately from the street?				Emergency vehicles and first responders need to be able to identify the property easily at all times of day and in all types of weather.
2	Are exterior pathways and entrances well lit?				Entryways should be lit by building, pole lights, or street lights. Trees and other plantings should be cut back to allow light to reach walkways. Verify that exterior light fixtures are located along exterior walkways and at building entrances and exits. Ask property management if lights are working.
3	Are exterior pathways slip-resistant?				Walk building entrance and exit walkways. Look for flagstone or smooth brick surfaces that could be slippery when wet.

4 ENERGY AND WATER SAVINGS OPPORTUNITY

Overview

Energy and water efficiency is a cornerstone of resilience. An efficient building costs less to operate and maintain during routine operations and is in better condition to respond to extreme events. Efficient buildings are also better candidates for solar photovoltaic systems and have smaller critical loads for which to provide backup power. Understanding the energy and water efficiency opportunities at a building is a key part of planning for building resilience.

Tab 4 of the assessment is the energy and water savings opportunity tab. This tab serves as a location for a qualified an architecture, green rater, or engineering professional to collect existing building utility consumption and rates summary information, existing energy and water components, and system information. The auditor will also record recommendations for upgrades to components and systems as well as estimated utility savings and a summary of all estimated savings combined for all utilities. Energy and water savings recommendations are otherwise referred to as energy conservation measures (ECMs).

Responsible Party and Expertise Required

Resilience Champion
The champion overseeing the completion of the assessment should coordinate all aspects and sections of the DC DOEE Resilience and Solar Assessment process.

Energy Auditor or Building Professional
An energy auditor or building professional such as an architect or engineer, should complete Tab 4 of the assessment. This individual should have broad energy, engineering, and building science expertise necessary to understand all types of mechanical systems, lighting, appliances, plumbing, and building envelopes, identify inefficient building conditions, recommend energy and water conservation measures, and estimate savings to be generated from those measures.

Required Information Prior to Site Visit

- Proposed renovation scope, if applicable
- Determine if utilities are paid by owner or resident
- Determine which utilities are used on-site
- 12 months of utility data (water, gas/ oil, electric) (aggregate)
- Number of apartments
- Number of bedrooms
- Utility rates for water, gas and electric

This energy and utility data grounds the assessment in the realities of the subject property. Utility data collection and analysis can point an auditor in the right direction when on site. For instance, if the utility data shows extremely high water use (greater than 100 gallons per bedroom per day) the auditor will know to pay particular attention to water systems at the property. The property information collected during the

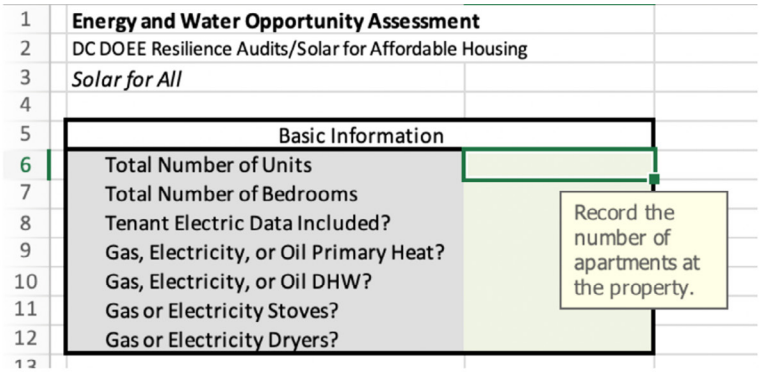
on-site assessment forms the basis of the assessment recommendations and needs to be supported by the actual property utility use.

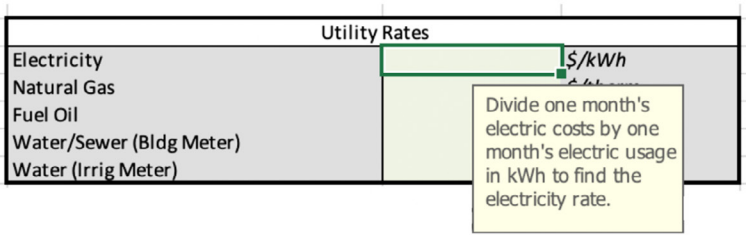
An experienced energy auditor conducting this portion of the DC DOEE Resilience assessment may want to use their own tools to determine utility savings. For consistency, any work completed outside of this tool should be copied into this tab to maintain results in one location.

Instructions

The tab is divided into five main sections: a basic information section, a utility rates section, an annual utility consumption section, a section to enter existing conditions and recommended measures, and a savings summary table.

Complete as many green cells as possible, leaving those blank for which the answer is unknown. Additional instructions for individual sections and cells are included as pop-up messages when the user hovers over green cells and titles in this Tab:





Annual Consumption by End Use		
Building Water		gallons
Irrigation Water		gallons
Baseload Electricity		kWh
Heating Electricity		kWh
Cooling Electricity		kWh
Baseload Natural Gas		therms
Heating Natural Gas		therms
Baseload Fuel Oil		gallons
Heating Fuel Oil		gallons

Building System	Energy and Water Conservation Measures	Existing Condition	Utility Savings % - Low	Utility Savings % - High	Utility Type
TOILETS	*Proposed GPF*	*Average Existing GPF*			Water (Bldg Meter)
FAUCET AERATORS	*Proposed GPM*	*Average Existing GPM (kitchen + bathroom)*			Water (Bldg Meter)
SHOWERHEADS	*Proposed GPM*	*Average Existing GPM*			Water (Bldg Meter)
IRRIGATION					Water (Irrig Meter)
EXTERIOR LIGHTING					Electricty
INTERIOR COMMON AREA LIGHTING					Electricty
APARTMENT LIGHTING					Electricty
APPLIANCES (REFRIGERATORS)	*# of Refrigerators to Replace*	*Existing Refrigerator Age*			Electricty
COMMON LAUNDRY					Electricty or Gas
VENDING MACHINES					Electricty
BUILDING CIRCULATOR PUMPS					Electricty
INSULATION IN ATTICS/ROOFS					Electricty or Gas
INSULATION IN BASEMENTS/CRAWLSPACES					Electricty or Gas
INSULATION IN APARTMENTS					Electricty or Gas
WINDOWS					Electricty or Gas
HEATING EQUIPMENT REPLACEMENT					Electricty or Gas
HEATING EQUIPMENT CONTROLS ADJUSTMENT					Electricty or Gas
COOLING / HEAT PUMPS / VRF	*Proposed System S/EER*	*Existing System S/EER*			Electricity
	Proposed System COP	*Existing System COP*			Electricity
DHW EQUIPMENT					Electricty or Gas
COMMON VENTILATION					N/A
APARTMENT VENTILATION					Electricty
COMBINED HEAT & POWER					N/A
SOLAR THERMAL					N/A

The results table, shown below, will only populate if all other sections are completed:

RESULTS		
	Low Savings	*High Savings*
Water	-	-
Electricity	-	-
Natural Gas	-	-
Fuel Oil	-	-
	Low %	*High %*
Water	**#DIV/0!**	**#DIV/0!**
Electricity	**#DIV/0!**	**#DIV/0!**
Natural Gas	**#DIV/0!**	**#DIV/0!**
Fuel Oil	**#DIV/0!**	**#DIV/0!**
	Low $	*High $*
Water	**$0**	**$0**
Electricity	**$0**	**$0**
Natural Gas	**$0**	**$0**
Fuel Oil	**$0**	**$0**

5 SOLAR PHOTOVOLTAIC FEASIBILITY

Overview

Solar photovoltaic (PV) systems, which provide renewable energy to facilities, are also recommended for resilience at many properties. Some of the considerations for deciding to install solar are whether a property has sufficient roof or site area, the owner has internal staff with experience developing or overseeing the design, construction, and financing of solar PV systems, or there is a third-party representative to oversee the procurement and operations of a system, and the property electric billing is structured in a way that can accommodate one of the many financing models for solar PV as described in the solar PV financing decision tree below. When coupled with energy efficiency, solar PV reduces dependence on grid-supplied electricity, can produce operating cost savings through reduced electrical utility costs due to net metering reimbursement, and may be compatible with battery backup systems, as described in Section 6 of this manual, which can provide redundancy in the event of grid loss. This section will walk you through an initial feasibility evaluation of solar PV for the property being assessed.

Tab 5 of the DC DOEE Resilience Opportunity Assessment tool is a decision tree which consolidates the inputs and outputs of a basic financial feasibility assessment for solar PV. The decision tree guides the user through financing options depending on available roof or site space, owner capacity for managing a solar PV procurement, electric metering constraints, and project ownership structure.

The financing model used in the preliminary feasibility assessment is direct ownership based on current average solar PV costs and incentives in the District of Columbia, but there are many other ownership models to consider using the solar PV financing decision tree described below.

Tab 5 relies on external inputs from an initial solar PV location and layout feasibility study, conducted using the PVWatts web-based solar tool. To complete the initial solar PV feasibility analysis, please first complete a PVWatts analysis. Please navigate to the NREL PVWatts tool located on the NREL website and follow the stepwise instructions to produce a report with the necessary outputs for the financial feasibility analysis in the resilience assessment tool: https://pvwatts.nrel.gov/pvwatts.php

PVWatts requires the property address and knowledge of the average electricity rate for the account to which the solar PV would be connected. For example, for a solar PV system serving the common area load on an owner-paid account, the analysis would use that account's electric rate. PVWatts produces basic system size and estimated output results. Please complete the PVWatts analysis and use the results generated to complete Tab 5 of this tool, as described below.

Responsible Party and Expertise Required

Resilience Champion

The champion overseeing the completion of the assessment should coordinate all aspects and sections of the DC DOEE Resilience and Solar Assessment process.

Energy Auditor or Building Professional

An architect, green rater, engineering professional or other consultant with an understanding of renewable energy engineering should complete the PVWatts tool and work with the resilience champion to transfer the results to the DC DOEE Resilience and Solar Assessment. This person should have an understanding of renewable energy system design and financing and an understanding of electricity usage and rates, as well as financial planning metrics for renewable energy.

Instructions

Tab 5 includes 4 sections: Rates & Factors, Solar PV System, Summary of Financial Impact, and the Solar PV Financing Decision Tree. The Rates & Factors section includes pre-filled inputs for financial assumptions for a potential solar PV project in the District. These are the recommended inputs, but you can edit these if different values apply to your property. The Solar PV system section should be completed from PVWatts, as described above, or another solar PV system design tool if preferred. The Summary of Financial Impact summarizes the financial outputs of the financial feasibility analysis for direct ownership of solar PV and includes an input for additional financial incentives if applicable. Please complete the green cells in the Solar PV System section at a minimum to see preliminary financial feasibility results:

Rates & Factors		
Life Cycle Term (Year)	25	
Inflation Rate	3%	
	Nominal	*Real*
Discount Rate	5%	2%
Escalation Rate	3%	0%

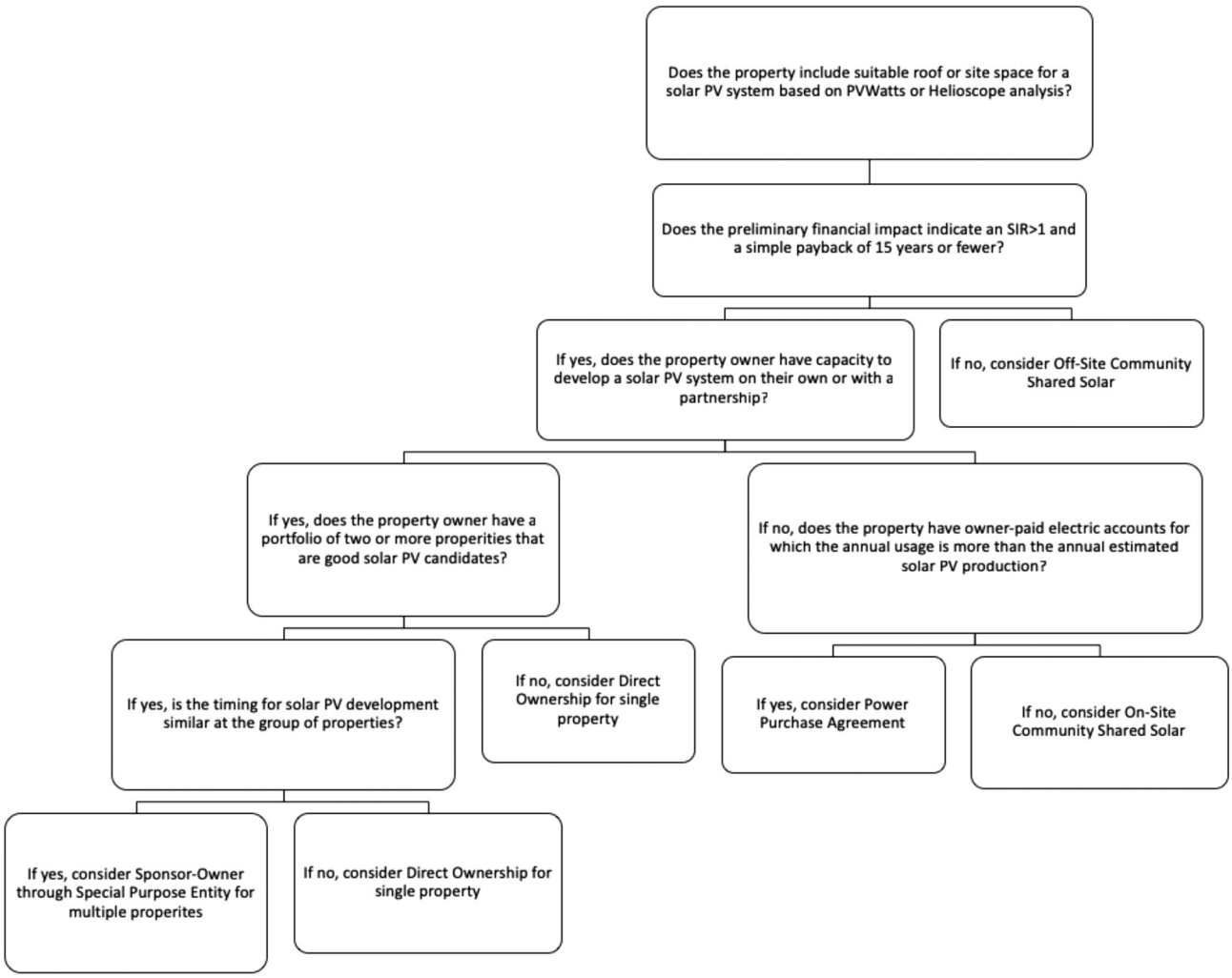
Solar PV System (from PVWatts or Helioscope)	
Solar System Capacity (kW DC)	
Annual Solar Generation (kWh)	
Federal ITC?	

Summary of Financial Impact	
Investment without ITC or Additional Incentives	$ -
Additional Incentives	
Net Investment with ITC and Additional Incentives	$ -
Total Life Cycle Savings (NPV) with ITC and Incentives	$ -
Annual First Year Utility Savings and SREC Income	$ -

	Without ITC and Incentives	*With ITC and Incentives*
Savings-to-Investment Ratio (SIR)	∞	∞
Simple Payback	0	0

Solar PV Financing Decision Tree

The Solar PV Financing Decision Tree guides the user through all of the most common solar PV development models currently used by affordable housing owners in the District of Columbia based on the pros and cons of those financing models for owners with different capacities and financing options.



The various financing options reference are reproduced and adapted from material produced and presented by Enterprise Community Partners, Inc. Financing model descriptions, benefits, and drawbacks are shown below:

Direct Ownership - Direct Purchase

Description: Property owner purchases project for cash value of system

BENEFITS:

- All economic benefits of power generated on site stay with property owner
- Off-set common area electric charges, if system offsets common area load
- Property Tax Abatement, if applicable
- Federal Investment Tax Credit, if applicable

DRAWBACKS:

- Requires up-front capital
- Need both income tax liability to take advantage of federal investment tax credit, and need property tax liability to take advantage of property tax abatement

PPA - 3rd Party Ownership

Description: 3rd party builds and owns solar on property in exchange for property owner committing to purchase energy from solar system, at a discount from public utility

BENEFITS

- No up-front or maintenance costs
- Savings of 10% to 20% for common-area electric bills
  - Can be fixed-discounted electricity price
  - Usually includes a price escalator, increasing the cost of electricity generated by the solar PV system by a fixed percent annually

DRAWBACKS:

- Only half the financial benefits of project go to property owner, additional savings beyond the 10-20% estimated above accrue to the PPC provider

Sponsor-Owned Through Special Purpose Entity

Description: Sponsor which could be owner of facility or Investor sets up special purpose entity to develop, maintain, and manage the solar PV system

BENEFITS:

- Development fee accrues to the sponsor
- Sustained income generation to sponsor
- Leverage federal investment tax credit
- PPA-style savings to accrue to property owner

DRAWBACKS:

- Cash outlay to housing entity
- Greater risk exposure to sponsor

Onsite Community Solar - 3rd Party

Description: 3rd party builds solar on rooftops. Energy sold at a discount to tenants, allowing tenants to benefit from the solar PV system, unlike a typical PPA. Lease payments paid to properties.

BENEFITS:

- No up-front or maintenance cost to housing owner
- Lease payment to property owner
- Discounts to tenants (10% to 20%)
- Project leverages tax credits
- Private property owner keeps property tax benefits – if applicable property tax abatement (i.e. NYC)

DRAWBACKS:

- Energy savings off-set residential customers' bills rather than private property owner's.
- May require property owner to facilitate contract revisions or new tenant contracts with move-ins.

6 SOLAR + STORAGE - REopt

The tab of the tool corresponding to this section is to be completed by an energy auditor or building professional with an understanding of renewable energy systems and financing, the results of this section should be communicated to the property owner and resilience champion.

Overview

Backup battery systems can improve the resilience of affordable multifamily housing by providing backup power for critical loads such as elevators, heating and cooling of community rooms, medical equipment, and communications in the event of a long-term power outage. Backup generators can also provide backup power for these critical loads, but batteries may have the added potential benefit of annual electricity cost savings and providing zero-emissions backup power.

The backup battery feasibility tab in the DC DOEE Resilience Assessment tool is intended as a location to collect the results of a preliminary battery feasibility analysis performed in the external NREL REopt Lite tool. The results are collected in one place and alongside the outputs of the other sections of the resilience assessment. REopt Lite is a free, web-based tool created by the National Renewable Energy Labs that enables building owners or managers to:

- Evaluate the economic viability of grid-connected PV, wind, and backup battery at a site
- Identify system sizes and battery dispatch strategies to minimize energy costs
- Estimate how long a system can sustain critical load during a grid outage

There are two approaches to using REopt Lite to evaluate backup battery feasibility. The resilience approach estimates battery capacity needs based on resilience needs, while the financial approach estimates battery capacity based on the most cost-effective size with the shortest payback time. The goal of this portion of the assessment is to understand battery feasibility for resilience, and that is the method employed here. The information requested in this section of the tool is the information needed to complete the resilience assessment of battery feasibility.

The primary results of the REopt Lite analysis will be recommended solar PV size when paired with a backup battery system, recommended battery power and capacity, the net present value of the combined solar PV and battery system, and an estimate of the average resilience time in terms of hours of backup power provided. A positive net present value indicates that a solar PV and backup battery system may be financially viable for a property. The average resiliency time indicates whether a solar PV and backup battery system may provide enough resilience time for residents to remain on-site during an extended power outage.

Additional in-depth financial and resilience metrics are also available for further review if the owner decides to pursue a deeper analysis of backup battery feasibility.

Responsible Party and Expertise Required

Resilience Champion

The champion overseeing the completion of the assessment should coordinate all aspects and sections of the DC DOEE Resilience and Solar Assessment process.

Energy Auditor or Building Professional

An architect, green rater, engineering professional or other consultant with an understanding of renewable energy engineering should complete the REopt Lite tool and work with the resilience champion to transfer the results to the DC DOEE Resilience and Solar Assessment. This person should have an understanding of renewable energy system design and financing and an understanding of electricity usage, demand, and rates, as well as financial planning metrics for renewable energy.

Instructions

Tab 6 of the resilience assessment tool, Solar Storage – REopt, collects the high-level results of the REopt Lite analysis for the project. Complete a REopt Lite assessment for the project here: **https://reopt.nrel.gov/tool.** The REopt Lite tool also includes help pop-ups throughout for all inputs to help guide you, and a help manual located here: **https://reopt.nrel.gov/tool/REopt%20Lite%20Web%20Tool%20User%20Manual.pdf**

Please fill each required green-colored cell with the REopt analysis results:

NREL REopt Lite Analysis Results

Recommended Solar PV Installation Size (kW)	
Recommended Battery Power (kW)	
Recommended Battery Capacity (kWh)	
Net Present Value ($)	
Average Resiliency (hours)	

Below is a list of all of the possible inputs for the REopt tool, so that the user can prepare to complete the tool before loading the site and beginning. These inputs are also described in the REopt lite user manual, at the link shown above. Not all inputs are required to generate an output, the inputs that aren't required add more detail and accuracy to the final output.

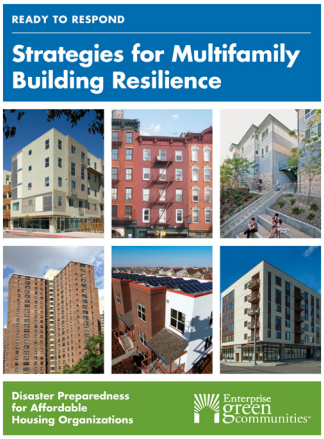
INPUT	REQUIRED?	DESCRIPTION
Site Location	Y	The building address.
Electricity Rate	Y	The utility and electric rate for the common area electric meter, found on a representative electric bill.
Custom Electricity Rate	N	If the rate is a custom rate (uncommon), check this box and enter the custom rate details in the cells that pop up.
Net Metering Size Limit (kW)	N	Enter a net metering size limit if one exists, enter 0 if net metering is not available.
Wholesale rate ($/kWh)	N	If the site does not allow net metering or exported electricity exceeds net metering limit, enter the wholes rate at which electricity exported to the grid is compensated.
Site Name	N	Assign a name to the building.

INPUT	REQUIRED?	DESCRIPTION
Land Available (acres)	N	Enter the land available for a solar PV installation, if any. Default is "unlimited", enter a limit if known.
Roofspace Available (sq ft)	N	Enter the roof space available for a solar PV installation, if any. Default is "unlimited", enter a limit if known.
Annual Energy Consumption (kWh)	Y	Enter the annual electricity consumption in kWh. Disregard the "Upload" tab in this section.
Critical Load Factor (%)	Y	Enter the percentage of electric load a battery would need to cover during a grid power outage. This percentage may be estimated by an electrical engineer or knowledgeable facilities staff person or other technical expert. Disregard the "Upload" and "Build" tabs in this section.
Outage Duration (hours)	Y	Enter the anticipated outage length you would like to use for planning purposes. This time frame should be based on the longest outage you would expect the building to sustain.
Outage Start Date	Y	Enter the anticipated date of the outage. This date should be selected based on the times of the year that are most likely to result in an outage, such as hurricane season, or those times when an outage may be most damaging, such as mid-Winter.
Outage Start Time	Y	Enter an outage start time. This time should reflect the most likely time of day that an outage will occur or the most damaging time of day that an outage will occur, using your best judgement.
Type of Outage (typical/major)	N	Enter whether the planned outage is typical or major.
Existing Generator?	N	Select this option if there is an existing generator at the site, and enter the generator information requested.
Microgrid Upgrade Cost (% of system capital cost)	N	Enter the estimated costs of additional equipment needed to connect the building to a microgrid, as a percentage, if known. The default value is 30%.
Avoided Outage Costs ($/kWh)	N	Enter the value of the losses the building would sustain in the event of an outage, if known. Default value is $100/kWh.
PV System Capital Cost ($/kW)	N	Enter the cost per kW to install solar PV at the building, if known.
Existing PV System?	N	Select this box if there is an existing solar PV system at the site, and input the requested information if so.
Federal Capital Incentives	N	Enter the federal solar PV incentives for the system on a percentage or a rebate basis, if known.
State Incentives	N	Enter the District solar PV incentives for the system on a percentage or a rebate basis, and enter the maximum incentive and rebate amounts, if known.
Utility Incentives	N	Enter the utility solar PV incentives for the system on a percentage or a rebate basis, and enter the maximum incentive and rebate amounts, if known.
Federal Production Incentives	N	Enter the federal production incentive, duration, maximum, and system size limit, if known.
PV O&M Costs ($/kW/year)	N	Enter the solar PV system operations and maintenance cost per kW per year, if known. The default value is $16.
Minimum Desired PV Size (kW)	N	Enter the minimum desired solar PV system size, if known. The default value is 0.
Maximum Desired PV Size (kW)	N	Enter the maximum desired solar PV system size, if known. The default value is unlimited.

INPUT	REQUIRED?	DESCRIPTION
Module Type	N	Enter the module type as standard, premium, or thin film. Note that most solar PV installations will be standard, and premium installations come with an added cost. Thin film systems will be uncommon.
Array Type	N	Enter the anticipated solar PV system type, as either rooftop, ground mount fixed, or ground mount tracking. Note that most systems will be rooftop.
Array Azimuth (deg)	N	Enter the cardinal direction of the lower edge of a potential solar PV system, if known. The default value is 180.
Array Tilt (deg)	N	Enter the tilt of the potential solar PV panels, if known.
DC to AC Size Ratio	N	Enter the DC to AC ratio for the solar system, if known. The default value is 1.1.
System Losses (%)	N	Enter the solar PV system performance losses, if known. The default value is 14%.
MACRS Schedule (years)	N	Enter the Modified Accelerated Cost Recovery System schedule for the solar PV system as 0, 5, or 7 years, if known.
Battery Capital Cost ($/kWh)	N	Enter the expected cost of batteries in dollars per kWh, if known. The default value is $800.
Power Capacity Cost ($/kW)	N	Enter the expected cost of battery power capacity in dollars per kW, if known. The default value is $1,000.
Capacity Replacement ($/kWh)	N	Enter the battery capacity replacement at end of life cost in dollars per kWh, if known. The default value is $230.
Capacity Replacement Year	N	Enter the projected capacity replacement year, if known. The default value is 10.
Power Capacity Replacement ($/kW)	N	Enter the battery power capacity replacement at end of life cost in dollars per kWh, if known. The default value is $460.
Power Capacity Replacement Year	N	Enter the projected power capacity replacement year, if known. The default value is 10.
Minimum Energy Capacity (kWh)	N	Enter the minimum energy capacity desired for the battery system, if known. The default is 0.
Maximum Energy Capacity (kWh)	N	Enter the maximum energy capacity desired for the battery system, if known. The default is unlimited.
Minimum Power Capacity (kW)	N	Enter the minimum power capacity desired for the battery system, if known. The default is 0.
Maximum Power Capacity (kW)	N	Enter the maximum power capacity desired for the battery system, if known. The default is unlimited.
Allow Grid to Charge Battery?	N	Enter yes if the grid will be allowed to charge the battery when the solar PV can't or is not included. If the grid is allowed to charge the battery in place of the solar PV system at any time, the battery may not qualify for federal tax credits.
MACRS Schedule (years)	N	Enter the Modified Accelerated Cost Recovery System schedule for the battery system as 0, 5, or 7 years, if known.

7 RESILIENCE STRATEGIES

Overview



The resilience strategies contained in the DC DOEE Resilience Assessment tool are practical interventions that when implemented will enable owners to make their properties more resilient to extreme events and climate change hazards. The list of strategies originated with the work by Enterprise Community Partners, Inc. in creating the *Ready to Respond: Strategies for Multifamily Building Resilience* manual.[1] The strategies vary significantly in scale and cost, and not all strategies are appropriate or recommended at all sites. The purpose of the resilience strategies section of the tool is to help owners understand which strategies are advisable at a given property, at what estimated order of magnitude cost, and what potential funding or financing assistance is available.

Tab 7 of the resilience assessment compiles recommended resilience strategies for the property assessed. The tool users' answers to the questions in Tab 3 automatically generate the list of recommended strategies.

Responsible Party and Expertise Required

Resilience Champion

The champion overseeing the completion of the assessment should coordinate all aspects and sections of the DC DOEE Resilience and Solar Assessment process. The resilience champion should review the Ready to Respond: Strategies for Multifamily Building Resilience manual in preparation for completing this tab.

Owner or Property Manager

The owner or property manager assisting in the completion of Tab 4 of the tool should have familiarity with the property operations and capital planning process and should have reviewed the Ready to Respond: Strategies for Multifamily Building Resilience manual.

Building Professional, Architect, or Engineer

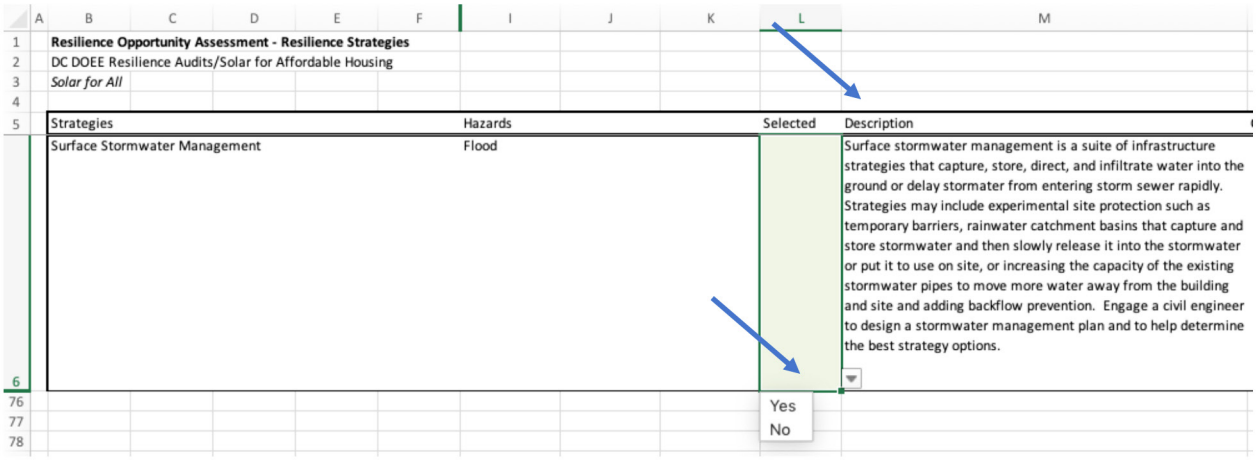
Building professionals, architects, and engineers engaged in capital planning or other current work for the property should be engaged in the completion of Tab 4 as applicable. These individuals should have knowledge of the property and site as well as the strategies included in the Ready to Respond: Strategies for Multifamily Building Resilience manual.

[1] https://www.enterprisecommunity.org/resources/ready-respond-strategies-multifamily-building-resilience-13356

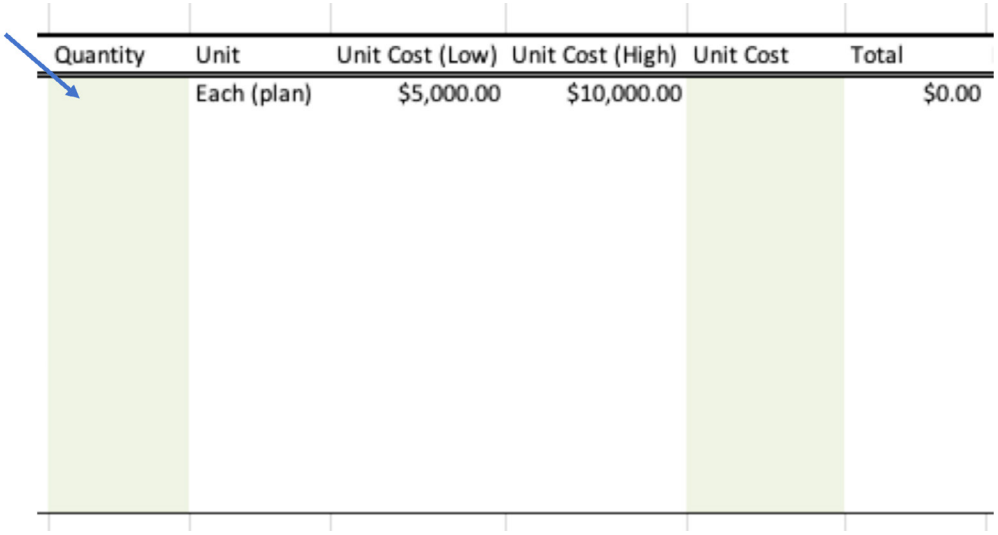
Instructions

After you have completed Tab 3, the table in Tab 7 will populate with the strategies indicated by the users' answers in that tab. The list of strategies is the first column in Tab 7, titled "Strategies." The hazards driving each recommended strategy are listed in the second column in Tab 7, "Hazards."

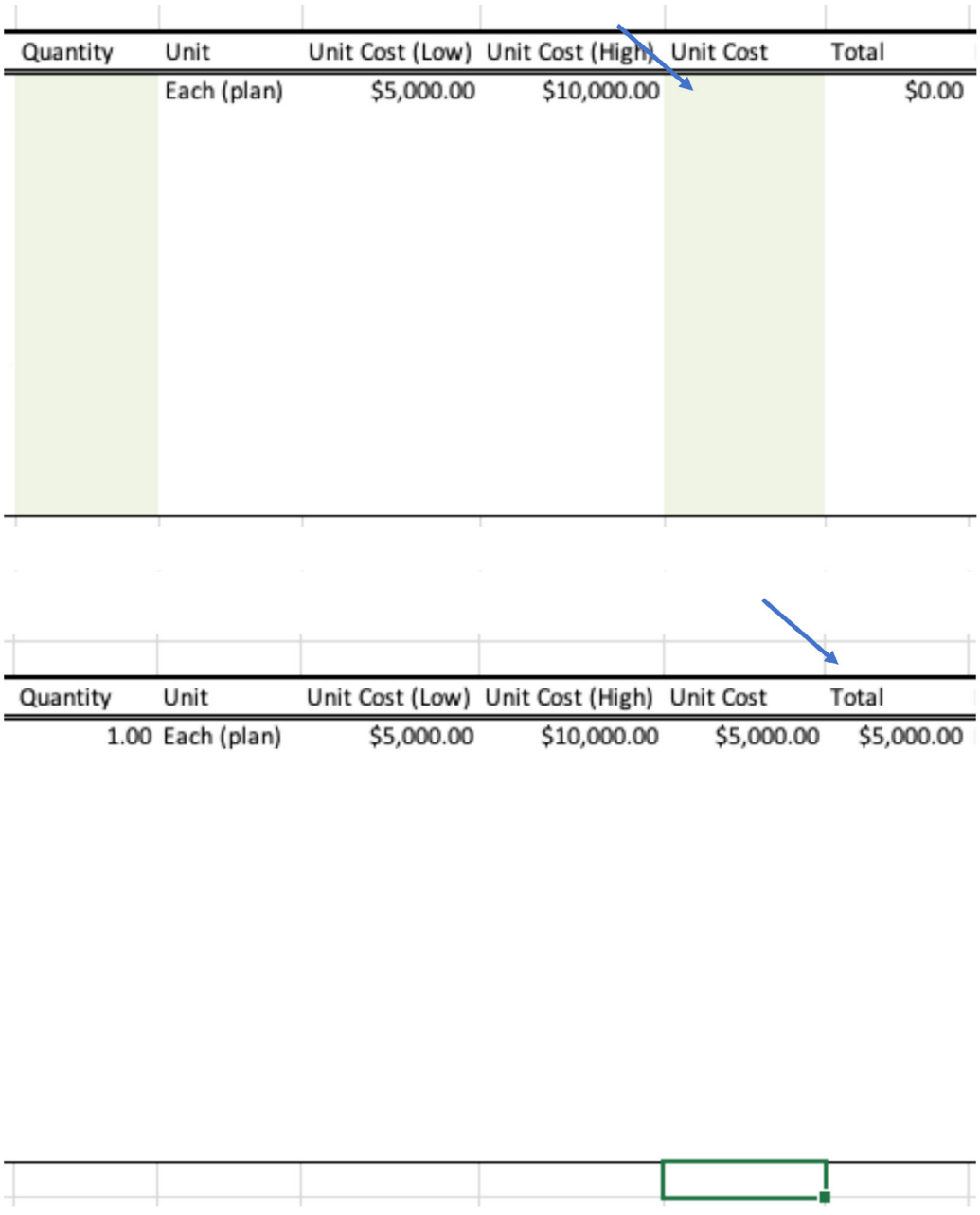
Tool users then must select yes or no in the third column, "Selected," for each strategy to indicate whether it should be applied to the property. This step is the "gut check" that allows the tool user to reject or accept strategies appropriate to the property in terms of rehab and investment schedule and long-term capital plan. To aid the user in making this decision, the fourth column, "Description," provides a detailed description of the strategy recommended. The tool user and resilience champion should also reference the *Enterprise Ready to Respond: Strategies for Building Resilience* manual to better understand the strategies and their implementation: **https://www.enterprisecommunity.org/resources/ready-respond-strategies-multifamily-building-resilience-13356**



For each strategy for which the user selects "yes," three cells will turn green, requiring further user inputs. For these strategies, in the fifth column, titled "Quantity," the tool user should estimate the quantity of each recommended strategy needed for the property. The units the quantity should be described in are shown in the sixth column, "Unit."



Estimated strategy unit costs specific to the D.C. affordable housing market are shown in the seventh and eighth columns, "Unit Cost (Low)" and "Unit Cost (High)". The user should then estimate whether the high or low cost is most likely for the property in question, and fill that estimated per unit cost into the ninth column, "Unit Cost." The tool will then calculate a total cost for the strategy and display that cost in the "Total" column.



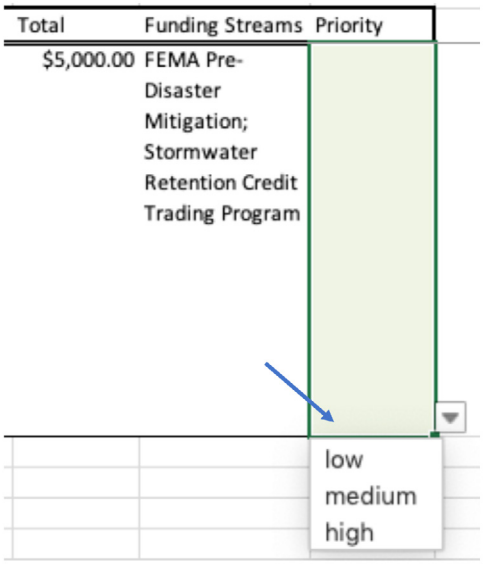
Quantity	Unit	Unit Cost (Low)	Unit Cost (High)	Unit Cost	Total
	Each (plan)	$5,000.00	$10,000.00		$0.00

Quantity	Unit	Unit Cost (Low)	Unit Cost (High)	Unit Cost	Total
1.00	Each (plan)	$5,000.00	$10,000.00	$5,000.00	$5,000.00

Any strategies for which potential funding streams have been identified will include identification of those funding streams in the tenth column, "Funding Streams." Links to external funding streams are included at the end of this section of the tool user manual.

The final column in the table is titled "Priority". The tool user or resilience champion, in coordination with the property owner, should rank each strategy selected as low, medium, or high. Strategies should be ranked based on resilience benefit as estimated using the strategy description and the Ready to Respond: Strategies for Multifamily Building Resilience manual, cost, and timing of implementation relative to the timing of any planned capital work at the property.

Please complete each green cell to the extent possible and use this table as the resilience strategy recommendation output report for the assessment.



Once complete, Tab 7 should be printed as part of the final output report from the tool.

External Funding Streams

Stormwater Retention Credits
https://doee.dc.gov/src

Energy Performance Contracting – For Public Housing Only (HUD)
https://www.hud.gov/program_offices/public_indian_housing/programs/ph/phecc/eperformance

FEMA Pre-Disaster Mitigation Grant Program
https://www.fema.gov/pre-disaster-mitigation-grant-program

DCSEU Equipment Rebates (Lighting, Electric and Gas, Variable Frequency Drives)
https://www.dcseu.com/for-my-business/apply-rebates

DCSEU Income Qualified Efficiency Fund
https://www.dcseu.com/for-my-business/income-qualified-efficiency-fund

DC DOEE Weatherization Assistance Program
https://doee.dc.gov/service/weatherization-assistance-program

Property Assessed Clean Energy Financing (PACE)
http://programs.dsireusa.org/system/program/detail/4206