



WHPC Portfolio-wide Energy Planning Process



About WHPC and Elevate

Wisconsin Housing Preservation Corp (WHPC), a 501(c)(3) nonprofit, is the largest owner of affordable housing in the State of Wisconsin. With a diverse portfolio of over 8,400 units located in more than 450 buildings across 58 of Wisconsin's 72 counties, WHPC provides safe, affordable housing for low- and moderate-income families, seniors, veterans, and persons with disabilities.

WHPC's Green Team is an internal team of asset and construction managers focused on identifying the needs and opportunities to make energy and water efficiency upgrades, utilize new technologies, and install renewable energy generation systems, such as solar photovoltaic (PV) and battery storage, throughout our portfolio to lower property operating costs, including maintenance and utility costs, and reduce greenhouse gas emissions.

Elevate is a 501(c)(3) nonprofit that seeks to create a just and equitable world in which everyone has clean and affordable heat, power, and water in their homes and communities — no matter who they are or where they live. Elevate centers equity in the climate conversation.

Acknowledgements: Funding for the development of this plan was made possible by the Public Service Commission of Wisconsin Office of Energy Innovation - 2021 Energy Innovation Grant Program.

Purpose: Overview for Affordable Housing Owners & Managers

- This presentation provides an overview for affordable housing owners and managers interested in developing a portfolio-wide energy action plan by:
 - Outlining the process, data collection and analysis, and tools for affordable housing owners and managers to analyze their own portfolio
 - Evaluate process learnings and assess findings from the portfolio analysis
 - Provide valuable case studies and next steps for making a planning process actionable
- WHPC intends for this presentation to:
 - Help build awareness of energy planning AND
 - Provide a call to action for leaders in affordable housing to incorporate clean energy, healthy building, and resiliency solutions across their portfolio and especially in rural communities that are historically underserved.

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Portfolio-wide Energy Planning Process Overview

Goals

As Wisconsin's largest provider of affordable housing, **WHPC is a leader and innovator in providing safe, affordable housing** for low- and moderate-income families, seniors, veterans, and persons with disabilities.

With grant funding from the WI Public Service Commission, WHPC launched a portfolio-wide energy planning process to inform and guide energy-related investments across the portfolio in Summer 2021.

The goals of the portfolio-wide energy planning process are to develop tools that centralize property information and inform decision-making to:

- **Preserve and provide high-quality affordable housing** by incorporating clean energy, healthy building, and resiliency solutions
- **Prioritize rural communities** that are historically underserved by energy efficiency programs
- **Minimize utility cost burden on residents**
- **Provide a roadmap** for other affordable housing portfolio owners



Process

Step 1: Aggregate Portfolio Data (Property Characteristics, Utility & Asset Management Data)

Step 2: Analyze Trends and Map Properties

Step 3: Develop an Energy Action Plan to Inform Upgrades

Step 4: Pilot Implementation of the Plan

Step 5: Share Process & Learnings

These steps build a comprehensive package of tools to support decision-making.

Tools Developed

- ✓ Comprehensive Database of WHPC's Properties
+
- ✓ Interactive Map of WHPC's Properties
+
- ✓ Building System Energy Action Plan
+
- ✓ Property Case Studies
↓
- ✓ Overview Presentation for Affordable Housing Owners & Managers

Tools: Comprehensive Database of WHPC's Properties

- The database is an Excel file with data organized by building and property
- Data was collected via surveys, existing WHPC databases, online research, utility bills, and internal analysis
- The database contains data fields such as:
 - Basic building info (e.g., address, number of units)
 - Financial data (e.g., Section 8, LIHTC)
 - Building characteristics & equipment (e.g., roof type, space heat fuel)
 - Utility data (e.g., 2020 electricity cost, 2020 water cost)
 - Solar rating (e.g., shading, orientation)
 - A full list of data collected is described in the Data Dictionary in the database Excel file
- **Primary objective:** to quantify building information across WHPC's portfolio and use this to prioritize and make data informed decisions

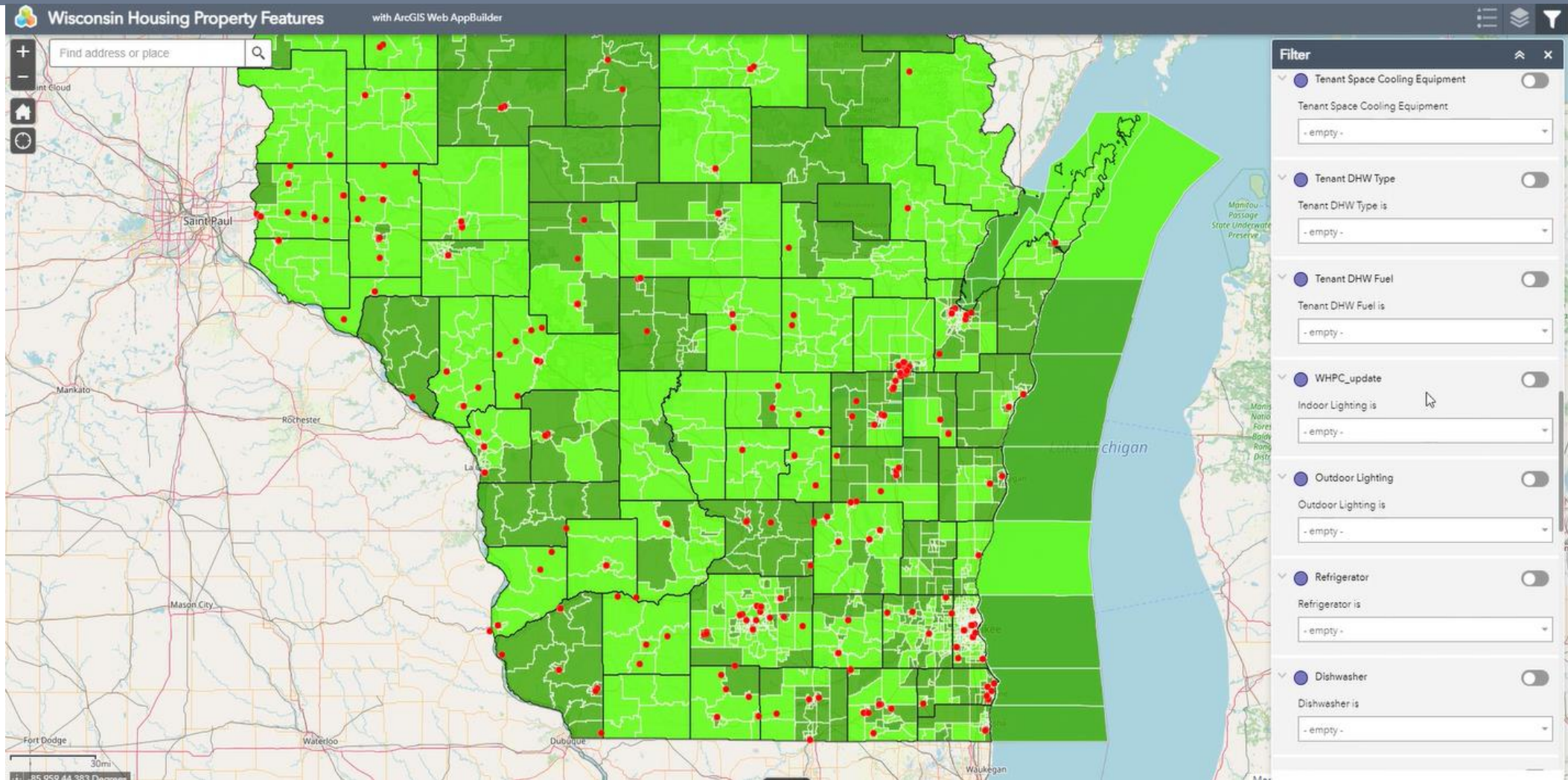
Tools: Comprehensive Database of WHPC's Properties

	A	B	C	W	X	Y	Z	AA	AB	AC
1										
2	Building Info						Heating & Cooling			
3	Building ID	Parent Name	Child Name	Post 15 Year	RD 515	NOAH	Tenant Space Heating Fuel	Tenant Space Heating Equipment	Tenant Space Cooling Equipment	On site observations (Mechanical Equipment)
106	W0103	Highland/Rhine Haus (Scattered)	Highland Estates II	no	no	no	Gas	Boiler	WHPC provided sleeve	
107	W0104	Highland/Rhine Haus (Scattered)	Highland Estates II	no	no	no	Gas	Boiler	WHPC provided sleeve	
108	W0105	Highland/Rhine Haus (Scattered)	Rhine Haus	no	no	no	Gas	Boiler	WHPC provided sleeve	
109	W0106	Iowa County Housing (Scattered)	Dodgeville	no	no	no	Electric	Baseboard	WHPC provided sleeve	
110	W0107	Iowa County Housing (Scattered)	Homesite Village	no	no	no	Electric	Baseboard	WHPC provided sleeve	
111	W0108	Iowa County Housing (Scattered)	Ridgeview	no	no	no	Electric	Baseboard	WHPC provided sleeve	
112	W0109	Iowa County Housing (Scattered)	Village Green	no	no	no	Electric	Baseboard	WHPC provided sleeve	
113	W0110	IW East (Scattered)	Lakeview Apartments	no	yes	no	Electric	Baseboard	WHPC provided sleeve	
114	W0111	IW East (Scattered)	Meadow View - Lola	no	yes	no	Electric	Baseboard	WHPC provided sleeve	
115	W0112	IW West (Scattered)	Cherrywood	no	yes	no	Electric	Baseboard	WHPC provided sleeve	
116	W0113	IW West (Scattered)	Forest Apartments	no	yes	no	Gas	Boiler	WHPC provided sleeve	
117	W0114	IW West (Scattered)	Pines Apartments	no	yes	no	Electric	Baseboard	WHPC provided sleeve	
118	W0115	Jackson County (Scattered)	Center Circle	no	no	no	Electric	Baseboard	Tenant provided	
119	W0116	Jackson County (Scattered)	Hillside	no	no	no	Electric	Baseboard	Tenant provided	
120	W0117	Jackson County (Scattered)	Meadow View	no	no	no	Electric	Baseboard	Tenant provided	
121	W0118	Jackson County (Scattered)	River Grove	no	no	no	Electric	Baseboard	None provided	
122	W0119	Jackson County (Scattered)	Village Center	no	no	no	Electric	Baseboard	Tenant provided	
123	W0120	Jackson County (Scattered)	West Indies	no	no	no	Electric	Baseboard	Tenant provided	
124	W0121	Janesville Commons/Neenah Court (Scattered)	Janesville Commons	no	no	no	Gas	Furnace	WHPC provided sleeve	
125	W0122	Janesville Commons/Neenah Court (Scattered)	Janesville Commons	no	no	no	Gas	Furnace	WHPC provided sleeve	
126	W0123	Janesville Commons/Neenah Court (Scattered)	Neenah Court	no	no	no	Gas	Furnace	WHPC provided sleeve	
127	W0124	Janesville Commons/Neenah Court (Scattered)	Neenah Court	no	no	no	Gas	Furnace	WHPC provided sleeve	
128	W0125	Lakeland Apartments (Scattered)	Lake Comus Manor	no	no	no	Gas	Furnace	WHPC provided sleeve	
129	W0126	Lakeland Apartments (Scattered)	Turtle Creek Family Apartments	no	no	no	Gas	Furnace	WHPC provided sleeve	
130	W0127	Lakeland Apartments (Scattered)	Turtle Creek Family Apartments	no	no	no	Gas	Furnace	WHPC provided sleeve	
131	W0128	Lakeland Apartments (Scattered)	Turtle Creek Family Apartments	no	no	no	Gas	Furnace	WHPC provided sleeve	

Tools: Interactive Map of WHPC's Properties

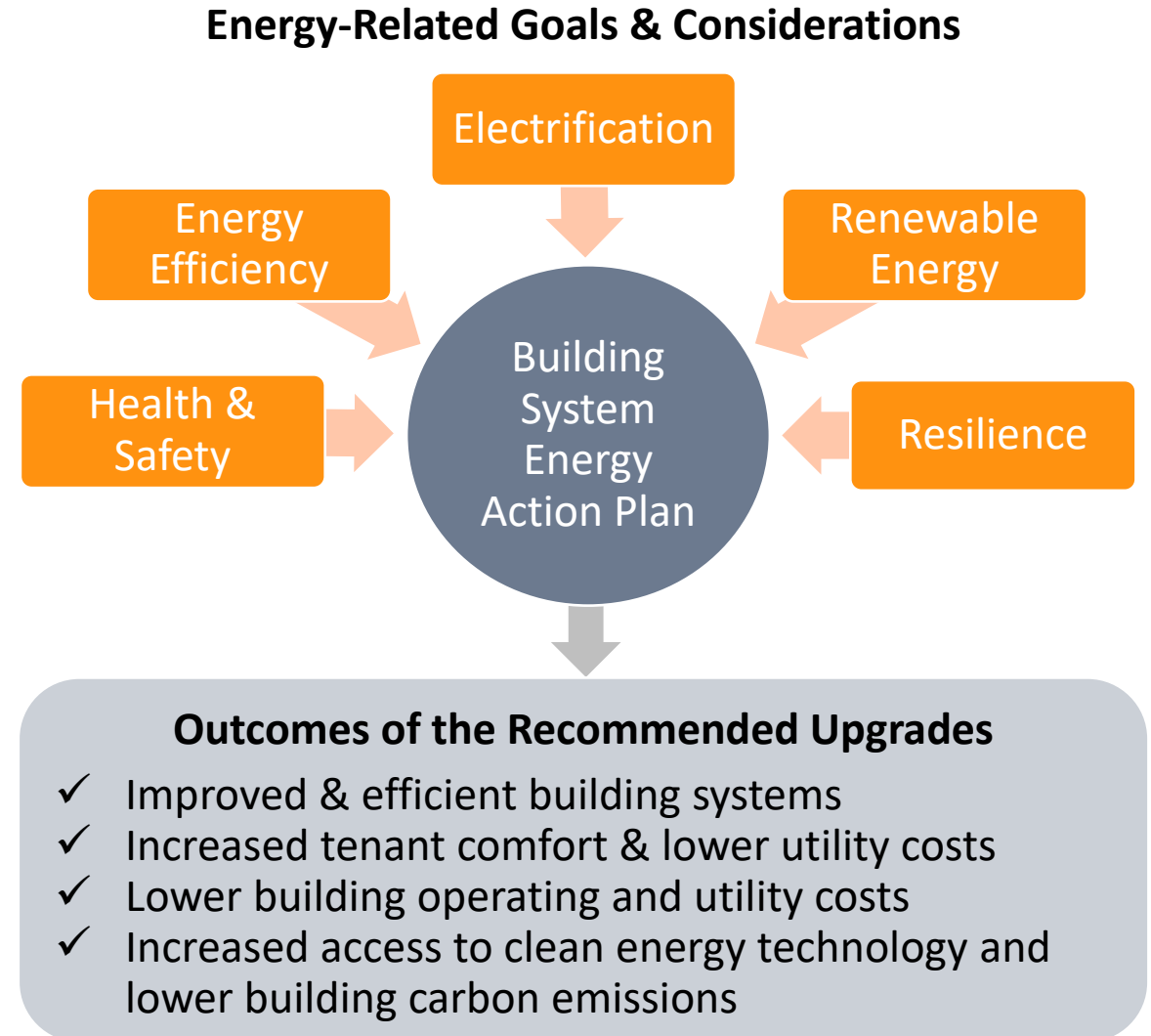
- The interactive map is built off the underlying database
- Interactive map key functions
 - Visualization – visualize building across multiple geographic criteria
 - Filtering – filter buildings by multiple data fields
 - Interactivity – user can explore multiple scenarios depending on what is sought
 - Guidance – provides step by step guidance on how to use the map
- Similar to the database, the primary objective of the map is to prioritize and make data informed decisions; however, the map allows for more user interactivity and geographic context/understanding of buildings

Tools: Interactive Map of WHPC's Properties



Tools: Building System Energy Action Plan

- The Building System Energy Action Plan is a roadmap of recommended energy upgrades for each building system to inform property-level decision making over time, such as:
 - Asset managers planning property investments
 - Property managers evaluating annual property needs, participation in efficiency programs, and contractor scopes
- Recommendations are organized by the three major points of a building life cycle:
 - Regular Operations & Maintenance
 - Equipment Replacement
 - Major Renovation (or New Construction)




Tools: Building System Energy Action Plan

Each major building system section (e.g., Heating & Cooling, Lighting, etc.) includes:

- Building System Overview
- Action Plans + Key Considerations

Domestic Hot Water Overview



System Overview: Water heating within WHPC properties is dominated by natural gas heaters that are centrally located to supply hot water to each unit. The secondary fuel used to heat water is electricity, split more evenly between central and in-unit water heaters. Approximately 20% of buildings use individual in-unit water heaters.

Goals: Reduce energy consumption used for water heating and provide opportunities for electrification and decarbonization

Benefits of Upgrades:

- ✓ Reduce energy consumption
- ✓ Electrification upgrades integrated with onsite renewable energy generation systems to reduce carbon and operational costs

Site visit: Orfordville Meadows

Note: Domestic Hot Water and Heating & Cooling sections have actions plans for each current type of equipment (e.g., Central, In-Unit). Building Envelope section has action plans for each component (e.g., attic, foundation, windows & doors).

In-unit Domestic Water Heating System: Action Plan

Regular Operations & Maintenance

Low-cost Improvements, Minor Repair, or Tenant Turnover

Goals: Increase efficiency & improve health & safety

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Opportunities

For gas systems: Engage a professional to perform Combustion Safety Testing on gas equipment to ensure proper venting
\$
N/A
H&S

Equipment Replacement

Planned Upgrade or Failure

Goals: Increase efficiency & electrify gas systems, if feasible

↓

Opportunities

Electrification Option: Upgrade to a unitary heat pump water heater (HPWH)
(See [Heat Pump Water Heaters Key Considerations](#) on next page)
\$\$
M

OR

Gas System Option: Upgrade to an ENERGY STAR® condensing gas water heater with sealed combustion
(See [In-Unit Condensing Gas Water Heater Key Considerations](#) on next page)
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2022 WHPC

Health & Safety Impact
 Upfront Cost
 Payback Period
 Maintenance

75

In-unit Domestic Water Heating System: Key Considerations

In-Unit Heat Pump Water Heater

- **General:** In-unit HPWHs are readily available on the market with storage volumes from 40-80 gallons. For how HPWHs work, refer to [U.S. DOE's Heat Pump Water Heater webpage](#).
- **Installation:** If existing equipment is gas, verify electrical service is adequate for selected HPWHs. HPWHs produce cool air as a byproduct of the water heating process and make noise while running; we recommend installing HPWHs in a location that is in a separate room not commonly occupied by occupants. Install in locations that remain between 40°F and 90°F year-round and provide at least 700 cubic feet of air volume. The Advanced Water Heating Specification [Qualified Product List](#) includes limits on sound levels by product tier. In addition, the water heater closet can be acoustically insulated to limit noise disruptions. Ducting the intake and/or exhaust of the HPWH or installing louvers on mechanical closet door is also a design option to improve airflow or direct exhaust air to unconditioned space.
- **Maintenance:** Make sure HPWH is not inadvertently set to electric-resistance mode only – "hybrid" or "heat pump" mode is necessary for energy savings. Refer to manufacturer specifications. Quarterly, clean filter located at air intake. Some models may have a "clean filter" alert on the water heater. Annually, pour a cup of bleach in the access opening of the condensate drain to kill any algae or mildew that has formed in the pipe. The expected lifespan is 15 years.
- **Utility cost:** Impacts on utility costs depend on the metering structure, payment structure, and existing fuel type. If the existing DHW fuel is electric, operational costs should decrease by switching to a HPWH. If the existing DHW fuel is gas, operational costs will likely increase by switching to a HPWH, depending gas and electric rates at the time.

In-unit Condensing Gas Water Heater

- Ensure selected model is ENERGY STAR® certified and sealed combustion or power venting
- An electric outlet near the water heater is required for installation.

Tools: Property Case Studies

- Demonstrate to asset managers and property management how the portfolio planning tools inform property-specific planning and recommended actions
- Document the implementation of the planning process to provide examples in case future opportunities arise
- Each case study provides property details and application of the Action Plan to inform decision making

NOAH Acquisition Case Study: Brookstone Townhomes – Fitchburg, WI

Property Details

- 28 Townhomes
- ~1975 Construction
- Tenant – Electric
- WHPC – Gas
- Central gas boiler + electric baseboard
- Central gas DHW



Photo Credit: Elevate

Reasons to use the action plan for this property:

- Recently acquired, naturally occurring affordable housing (NOAH)
- Upgrades planned
- Higher cost intensity for space and water heating compared to other properties

NOAH Acquisition Case Study: Applying the Action Plan

- **Opportunity:** Planning for upgrades at Brookstone Townhomes.
- **Additional Information:** Top quartile of energy cost intensity amongst properties where WHPC pays for tenant space heating and DHW. (*Database*)
- **Action:** Engage a professional to conduct a site assessment and identify opportunities to address high costs in planned upgrades.
- **Outcome:** Opportunities identified will inform the scope of planned upgrades with additional guidance from the system sections of the Action Plan.
 - Air seal and insulate the attic in conjunction with roof replacement
 - Air seal and insulate the cantilevered floors and overhangs and adding continuous insulation in conjunction with siding and soffit replacement
 - Insulate rim joists
 - Install low-flow showerheads, bathroom aerators, and toilets
 - Install outdoor boiler reset controls on the and replace recirculation pumps
 - Replace interior and exterior bulbs and fixtures with energy efficient LEDs and install lighting controls to ensure exterior lights are only on when needed.
 - Replace refrigerators with ENERGY STAR® refrigerators

Action Plans

- ✓ [Building Envelope: Attic/Roof](#)
- ✓ [Building Envelope: Walls & Floors](#)
- ✓ [Building Envelope – Foundation](#)
- ✓ [Plumbing Fixtures](#)
- ✓ [Heating – Central Boiler](#)
- ✓ [Lighting](#)
- ✓ [Appliances](#)

2022 WHPC

Deeper retrofit considerations include adding exterior insulation if siding is replaced, upgrading windows, and insulating the foundation. See action plans for more details.

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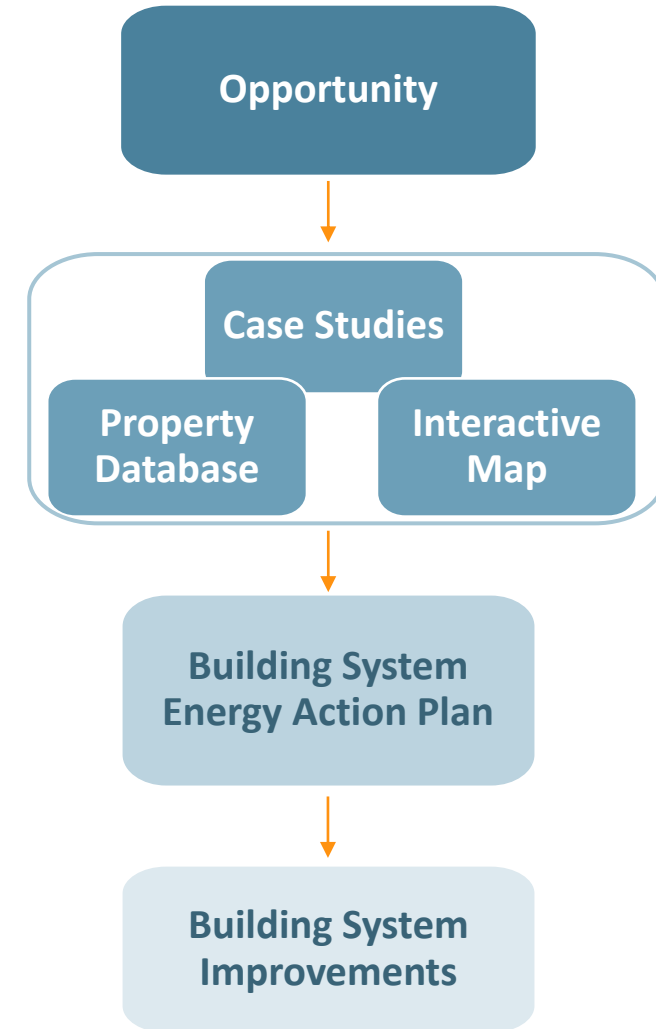
Tools: Using the Tools for Implementation

Opportunity (e.g., acquisitions, new funding source, regular equipment maintenance, tenant turnover, equipment failures, etc.) prompts utilizing the tools.

Database, map, and case studies provide data and examples to the property/asset manager to inform decision-making.

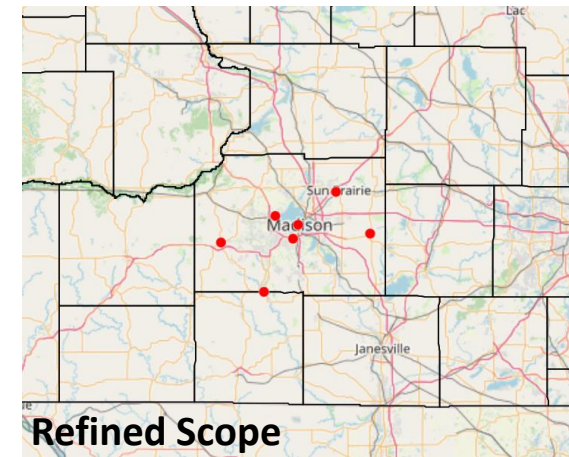
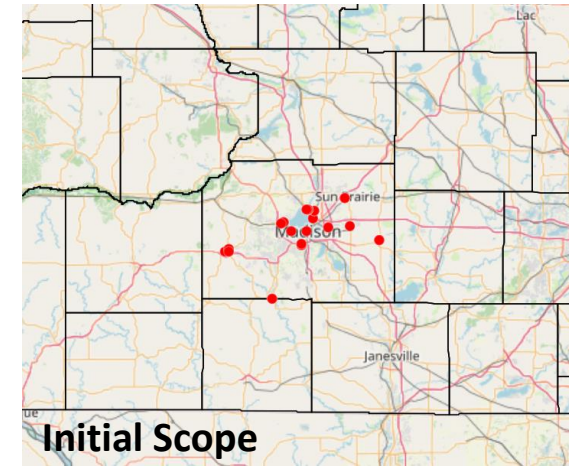
Building System Energy Action Plan provides recommendations for energy-related improvements.

Building System Improvements are the implementation of the planning process.



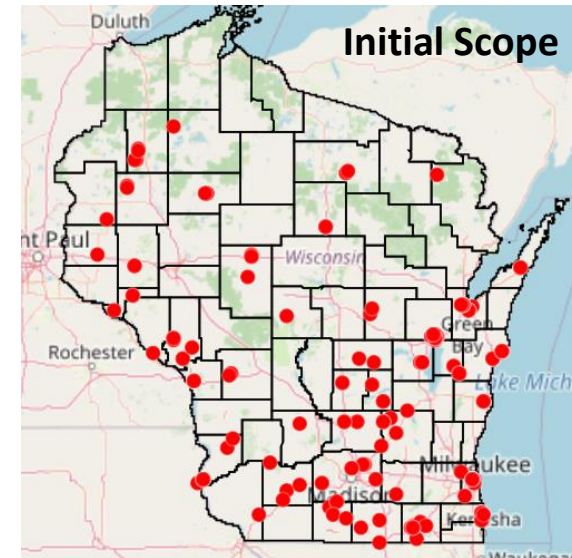
Example Use Case: Grant Funding Opportunity

- **Opportunity:** Grant funding for health and safety related building improvements in Dane County
- **Initial Scope:** All buildings within Dane County (*Map or Database*)
- **Refined Scope:** All buildings within Dane County with in-unit gas equipment (*Map or Database*)
- **Action:** Electrify in-unit gas equipment (*Action Plan*)



Example Use Case: Major Rehab / Refinance

- **Opportunity:** Planning for refinance and rehab of LIHTC properties approaching year 15
- **Initial Scope:** All LIHTC properties (*Map or Database*)
- **Refined Scope:** LIHTC properties that are near year 13 (*Database*)
- **Action:** Incorporate recommended upgrades into rehab scope of work (*Action Plan*)



Key Takeaways for Developing a Portfolio-wide Energy Plan

- Use data available and build out the database over time
 - Surveying property management staff is an efficient method to gather property details; following up the survey with phone calls / emails helps to fill any data gaps
 - Some data, such as whole-building utility consumption, may be harder to obtain due to limitations from utilities and/or can take a significant amount of time to obtain
- Make time in the process for data cleaning and organization
- Develop a baseline understanding of the current characteristics of the portfolio and inform applicable recommendations using the database
- Gather input from (anticipated) users of the map (e.g., leadership, asset managers, property managers) to understand how the map will be used to inform the needed layers and visualization of the data, including visible data points, filters, geographic layers, etc.
- Utilize an iterative, multi-stakeholder engagement process with property and asset management representatives to determine the desired balance of actionable recommendations and detailed information to present in easy-to-follow visualizations



Making the Plan Actionable

Making the Plan Actionable for 9% or 4% LIHTC Properties

Depending if the property is planned for development or existing and either pursuing credits or has received credits, the starting point of planning will vary by property.

Major Rehab/Refinance Planning & Construction

(e.g., when applying for credits for an existing property or planning for Limited Partner (LP) exit in years 8-10, 13-15, or 28-30)

- Use the **Database** and **Map** to identify property and building characteristics and other attributes that could help identify funding sources
- Refer to the *Major Renovation* opportunities for each system in the **Building System Action Plan** to inform the rehab scope
- Implement upgrades
- Update building characteristics in the **Database**

New Development Planning & Construction

- Refer to the *Major Renovation* opportunities for each system in the **Building System Action Plan** to inform the design
- Add new property and characteristics to the **Database** and **Map**

Regular On-going Property Operations & Maintenance

(e.g., tenant turnover, low-cost improvements, minor repairs)

- Refer to the *Regular Operations & Maintenance* opportunities in the **Building System Action Plan** to identify opportunities to incorporate into the property's annual budget and operations and maintenance plans
- Implement upgrades
- Update building characteristics in the **Database**, as applicable

At Time of Equipment Replacement

(e.g., planned upgrade or unplanned failures)

- Refer to the *Equipment Replacement* opportunities for the specific systems in the **Building System Action Plan** to inform the equipment selection and additional opportunities for upgrades
- Update building characteristics in the **Database**, as applicable

Making the Plan Actionable for USDA RD, HUD, NOAH Properties

Given that investments in USDA RD HUD, and NOAH properties are not on a set timeline, the starting point of planning will vary by property.

Acquisition Planning

- Add new property and characteristics to the **Database and Map**
- Refer to the appropriate category of opportunities for each system in the **Building System Action Plan** based on the plan for the property (e.g., operate as is, replace equipment at end of useful life or moderate rehab, or major rehab)

Major Rehab Planning & Construction

(e.g., when refinancing or as funding becomes available, such as Capital Magnet Funds)

- Use the **Database and Map** to identify property and building characteristics and other attributes that could help identify funding sources
- Refer to the *Major Renovation* opportunities for each system in the **Building System Action Plan** to inform the rehab scope
- Implement upgrades
- Update building characteristics in the **Database**

Regular On-going Property Operations & Maintenance

(e.g., tenant turnover, low-cost improvements, minor repairs)

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Photo Credit: Elevate

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 - Install low-flow showerheads, bathroom aerators, and toilets
 - Install outdoor boiler reset controls on the and replace recirculation pumps
 - Replace bulbs and fixtures with energy efficient LEDs and lighting controls
 - Replace refrigerators with ENERGY STAR® refrigerators

Action Plans

- ✓ Building Envelope: Attic/Roof
- ✓ Building Envelope: Walls & Floors
- ✓ Building Envelope – Foundation
- ✓ Plumbing Fixtures
- ✓ Heating – Central Boiler
- ✓ Lighting
- ✓ Appliances

HUD Section 8 Case Study: River Grove – Black River Falls, WI

Property Details

- 40 units, 3-story masonry
- Built in 1978
- All-electric, all electricity WHPC-paid
- Electric baseboard heat, no A/C provided, central electric DHW
- Flat roof, no shading

Reasons to use the action plan for this property:

- HUD Section 8 property
- No rehab planned in next 10 years
- High owner-paid costs, older systems
- Good candidate for electrification – needs cooling, utilities WHPC paid, electric baseboard heat, good solar rating



HUD Section 8 Case Study: River Grove – Black River Falls, WI

- **Opportunity:** Public Service Commission of Wisconsin Office of Energy Innovation - 2022 Energy Innovation Grant Program
- **Initial Scope:** All-electric properties WHPC-paid properties with flat roofs for high solar rating for potential onsite renewable energy generation (Map)
- **Refined Scope:** Properties high electric costs (*Database*)
- **Action:** Application submitted and awarded to upgrade to heat pump technology with future consideration for installing solar PV (*Action Plan*)

Action Plans

- ✓ Heating – Electric Baseboards: Action Plan
- ✓ Cooling – Window A/C or None Provided: Action Plan
- ✓ Renewable Energy: Solar / Solar + Storage Action Plan



Deep Dive into WHPC's Portfolio & Next Steps

Data & Analysis as of July 2022

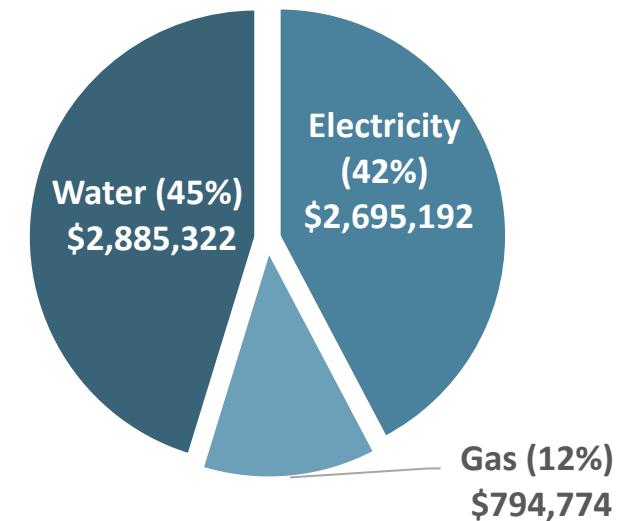
Overview of WHPC's Portfolio

- **Portfolio size (as of July 2022):**
 - 8,700 units
 - 528 buildings – 8 units per building (median)
 - 229 properties – 40% of properties have 2+ buildings
- **Year built:** 1980 (median)
- **Geographic reach:** 58 of Wisconsin's 72 counties
- **Utilities:** Served by 45 electric, 18 gas, and 165 water utilities
- **Total WHPC-paid utility cost (2020):** \$6,300,000
- **Median WHPC-paid utility cost/unit (2020):** \$727
- **Renewables installed:** 1 building with solar

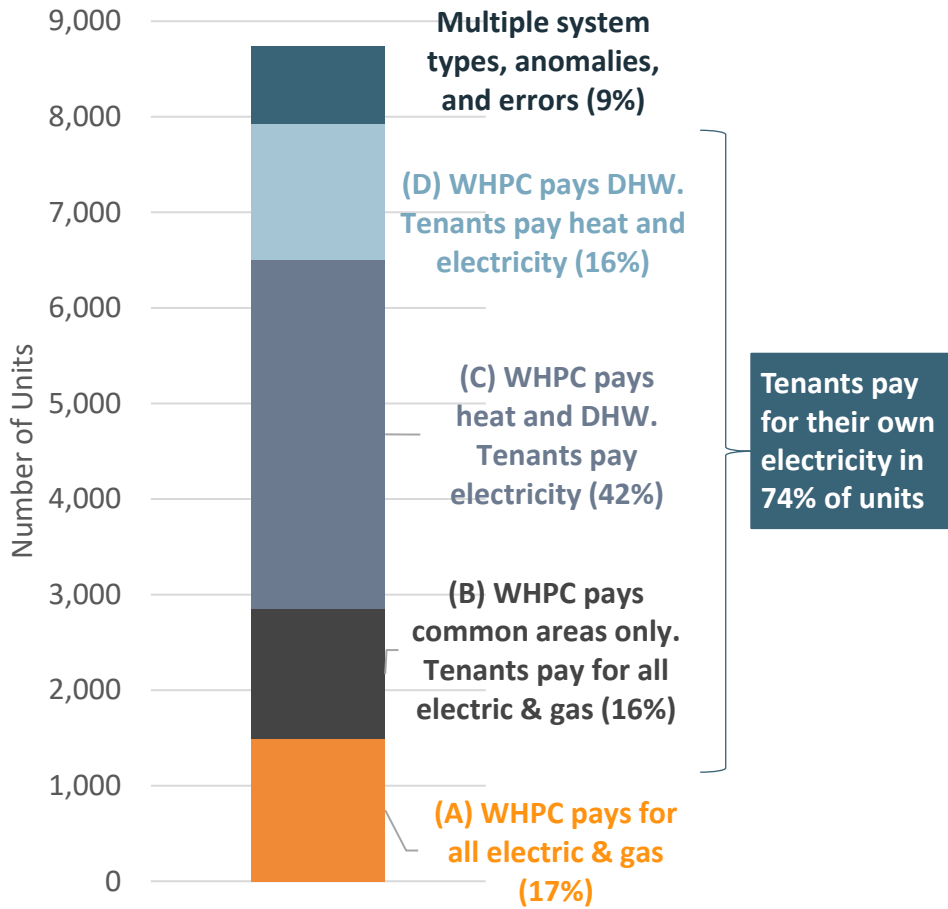


Chapel Terrace Building, Burlington, WI
Photo credit: Elevate

2020 Utility Costs



Utility Payment Summary: Electric + Gas



(A) In 17% of units, WHPC pays for all utilities. Space heating is typically provided by a gas boiler with gas central domestic hot water (DHW) OR space heating is electric baseboard with electric domestic hot water (central or individual).

(B) In 16% of units, tenants pay for all electricity and gas. Space heating is typically provided by electric baseboards or gas furnace, and domestic hot water units are individual gas or electric.

(C) In 42% of units, tenants pay for only their in-unit electricity (e.g., plug load and cooling). WHPC pays for space heating and domestic hot water, which are provided by either central electric or gas and individual electric or gas systems.

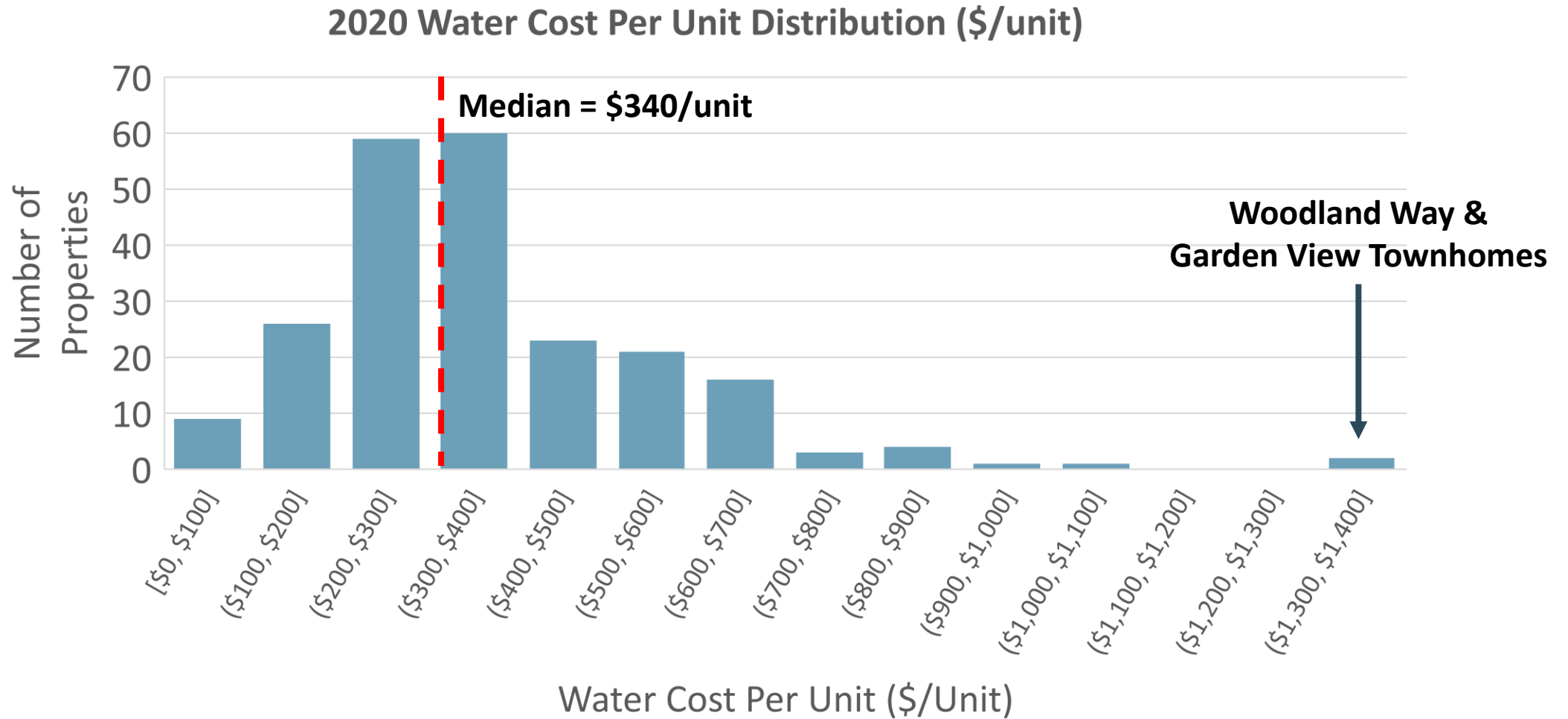
(D) In 16% of units, tenants pay for space heating and electricity. Heating is typically electric baseboard. WHPC pays for domestic hot water for these units, typically these systems are central domestic hot water systems.

Annual Utility Payment Summary: Electric + Gas

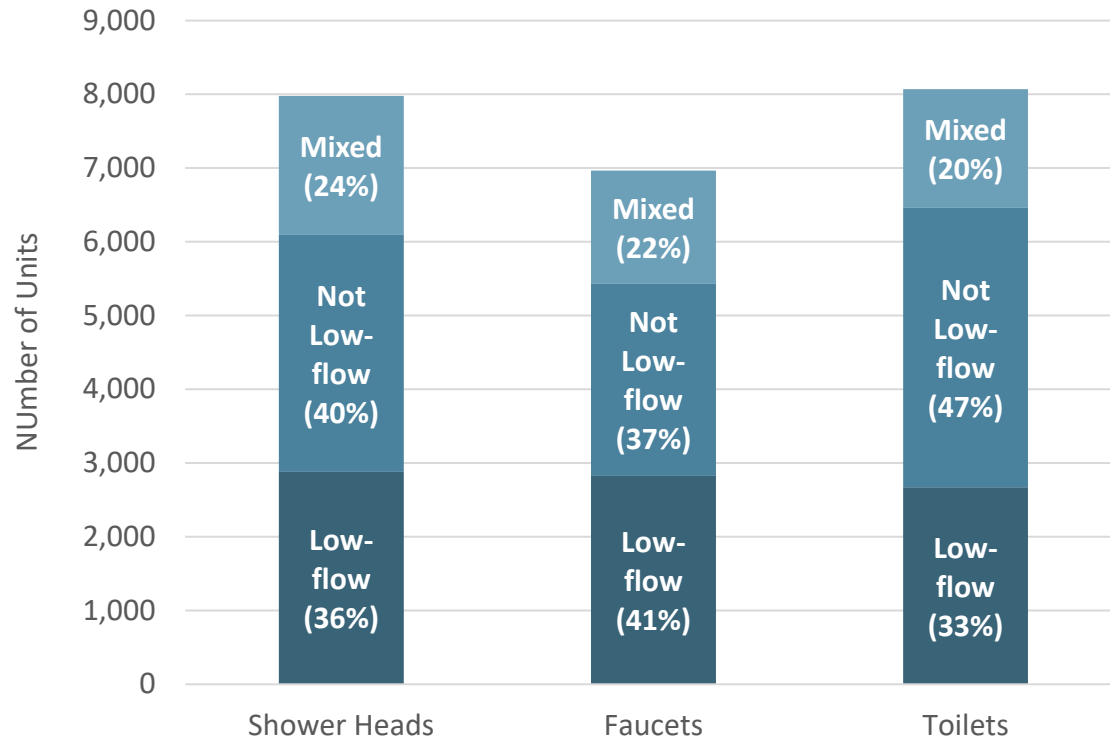
WHPC Pays For:	WHPC Median Utility Cost (\$/unit)*	Outliers
(A) All utilities (Electric + Gas)	\$693/unit	Westport Meadows – Port Washington (\$1,529/unit) Forest Acres (\$1,526/unit)
(B) Common Areas Only	\$113/unit	Great River (\$946) River Falls Terrace (\$421)
(C) Tenant Space Heating & Domestic Hot Water	\$356/unit	McKinley Gardens (\$906) Lake Forest II (\$840)
(D) Tenant Domestic Hot Water	\$291/unit	Rivercrest Village – Gays Mills (\$465) Ridgeview (\$434)

*Buildings included in calculation only if we have at least child-level utility data (i.e., skews results towards non-scattered sites)

Annual Utility Payment Summary: Water



Current Plumbing Fixture Summary

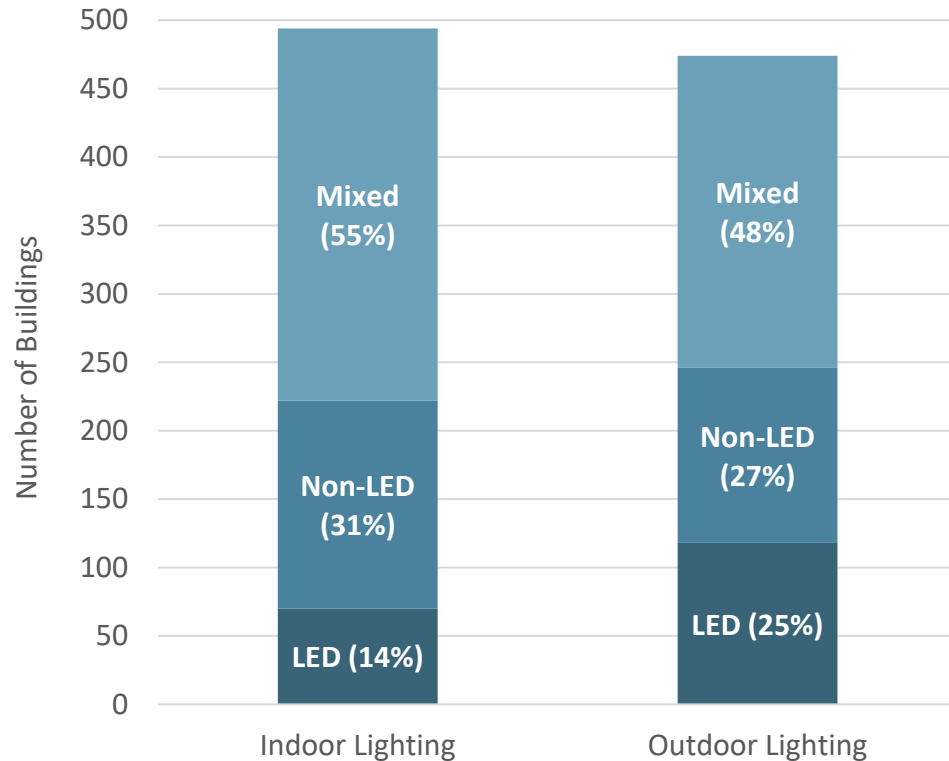


Finding: Over 60% of buildings have non-low-flow shower heads. Over 50% of buildings have non-low-flow faucets. Over 65% of buildings have non-low-flow toilets.

Recommended Action: Upgrade all plumbing fixtures to low-flow.

Action Plan Section: Plumbing Fixtures

Current Lighting Summary

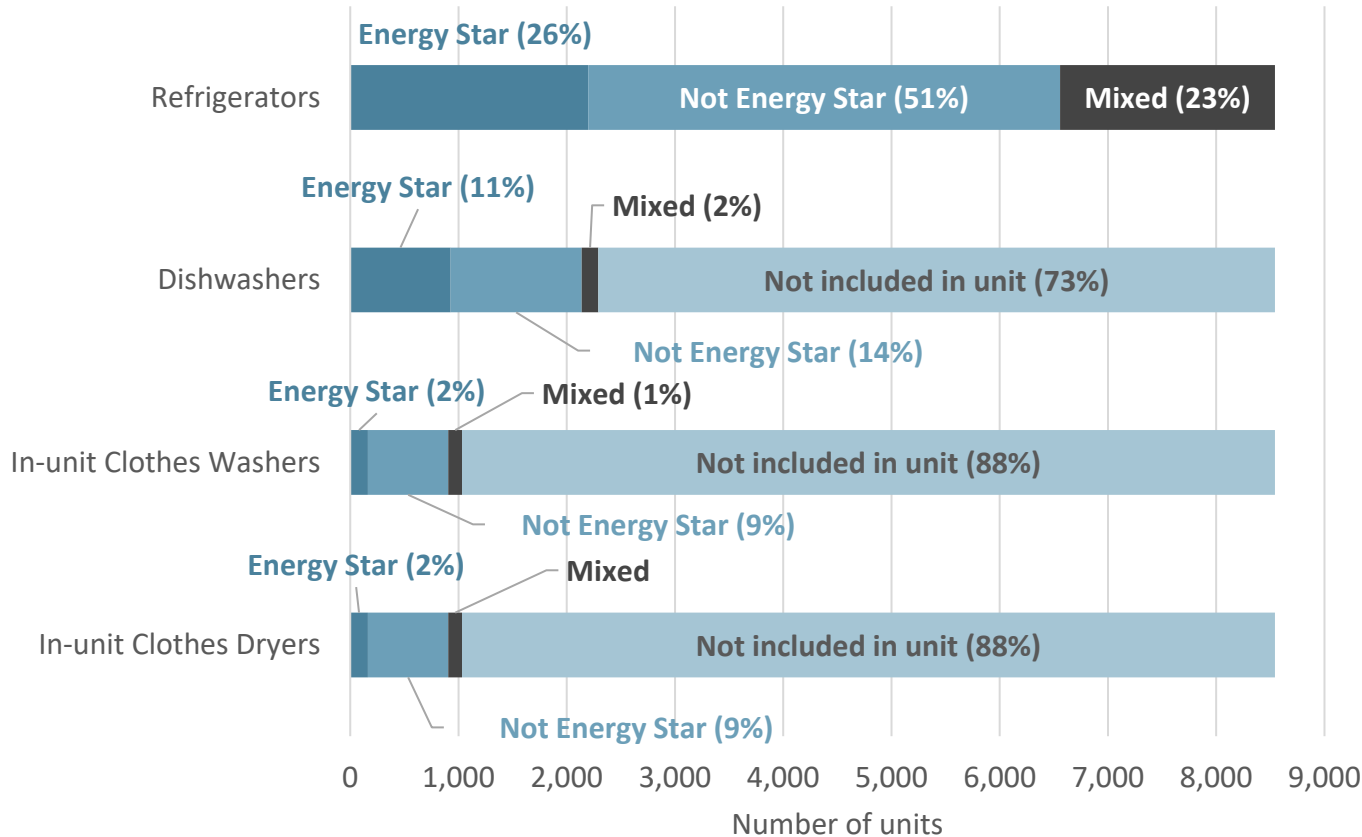


Finding: Over 80% of buildings have non-LED indoor lighting. 75% of buildings have non-LED outdoor lighting.

Recommended Action: Upgrade all lighting to LED

Action Plan Section: Lighting

Current In-Unit Appliances Summary

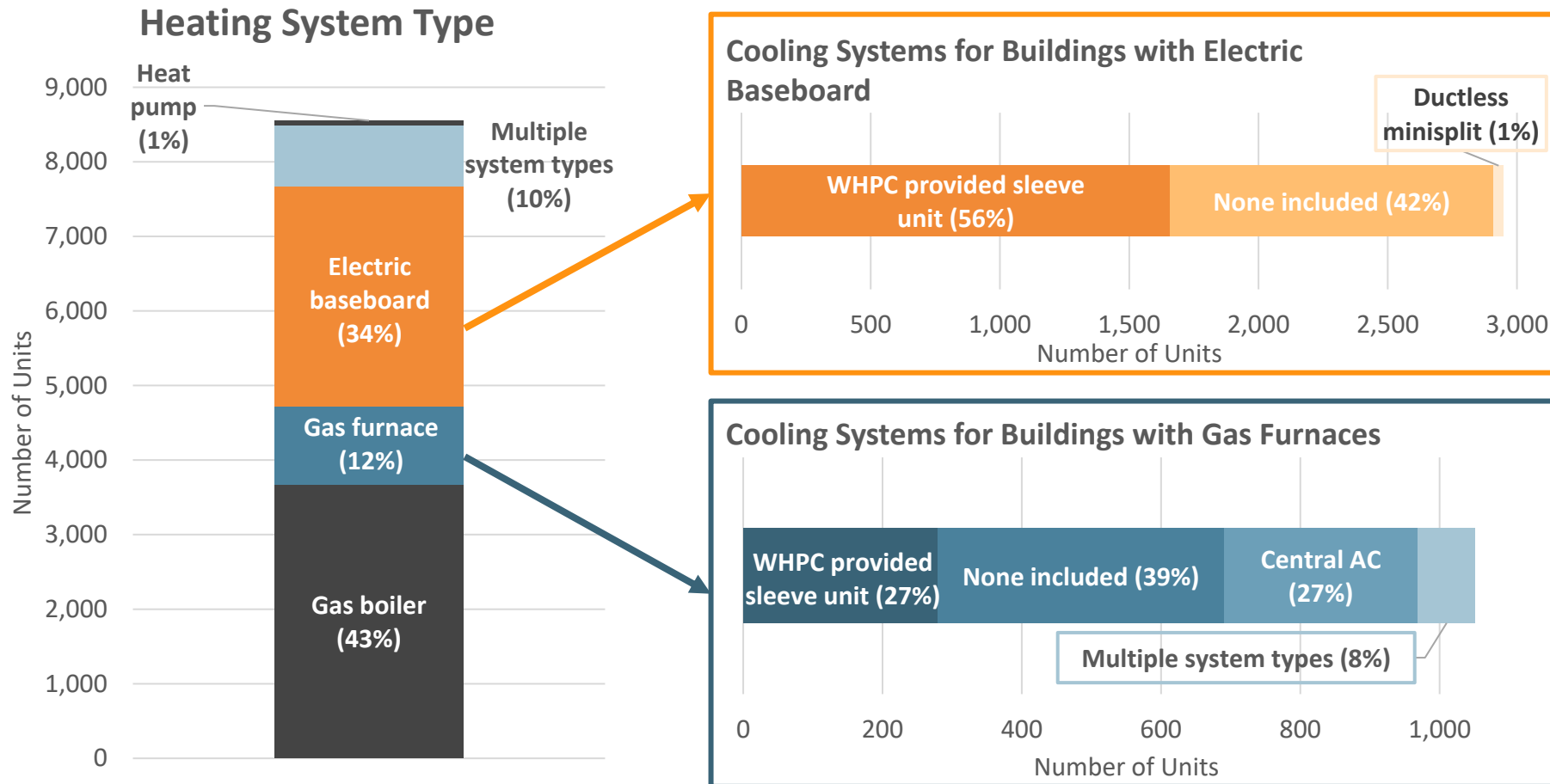


Finding: Over 70% of units have non-ENERGY STAR® appliances

Recommended Action: Upgrade all appliances to ENERGY STAR® models, and electrify when possible

Action Plan Section: Appliances

Current Space Heating and Cooling System Summary



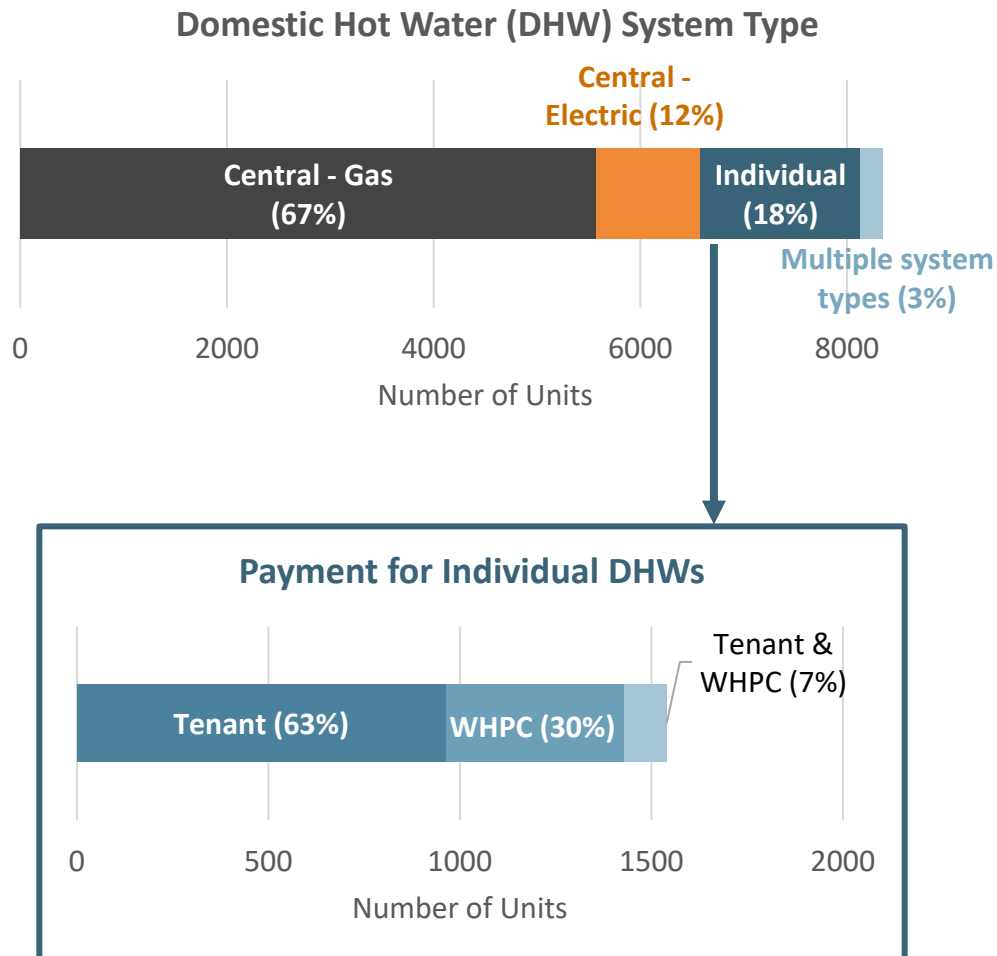
Findings: 34% of units (2,949 units) have electric baseboard heat. In these units, 42% have no cooling included.

Of the 12% of units served by gas furnaces, 66% of units do not have central cooling.

Recommended Action: Evaluate opportunities to upgrade units with furnaces and electric baseboard heat to air source heat pumps, which have the added benefit of cooling.

Action Plan Section: Heating – Forced Air Gas Furnace;
Heating – Electric Baseboards

Current Domestic Hot Water System Summary



Findings:

- Over 1,500 individual domestic hot water heaters across the portfolio; WHPC pays the utilities for 30% of these individual units
- WHPC pays for the central domestic hot water systems that serve 67% of units, typically located in larger buildings

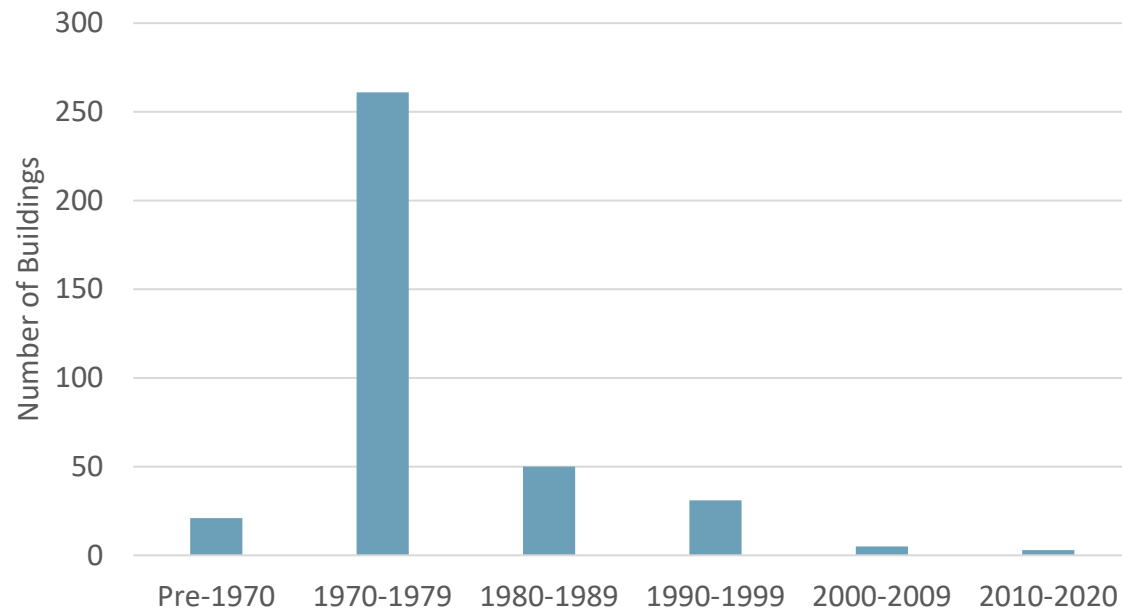
Recommended Action: Evaluate opportunities to:

- Upgrade individual systems to heat pump water heaters (HPWH) at the time of equipment replacement or rehab
- Invest in measures to increase central gas system efficiency, such as on-demand recirculation pumps, pipe insulation
- Upgrade central domestic hot water system to heat pump water heaters once technology is readily-available in the next 5-10 years

Action Plan Section: In-unit Domestic Water Heating System; Central Domestic Water Heating System

Building Envelope Summary

Age of Buildings



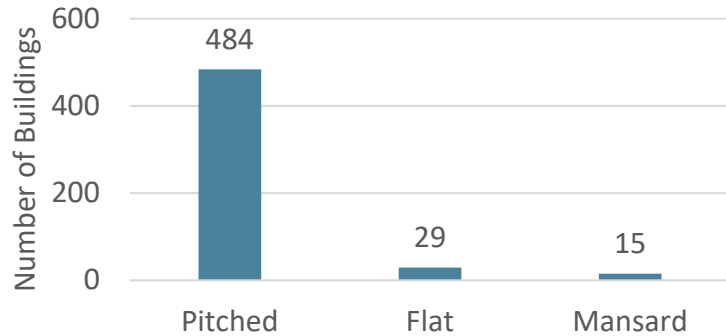
Findings: At least 282 buildings were built before 1980.

Recommended Action: Evaluate opportunities to add insulation in the attic/roof, walls & floors, and foundation.

Action Plan Section: [Building Envelope Overview](#)

Solar Rating Analysis Summary

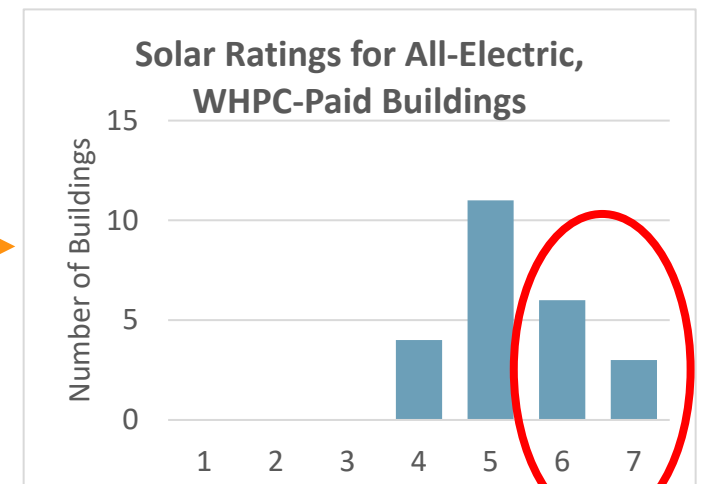
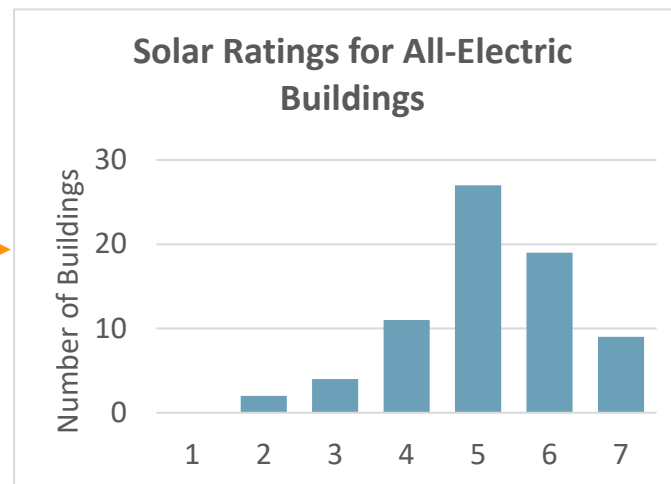
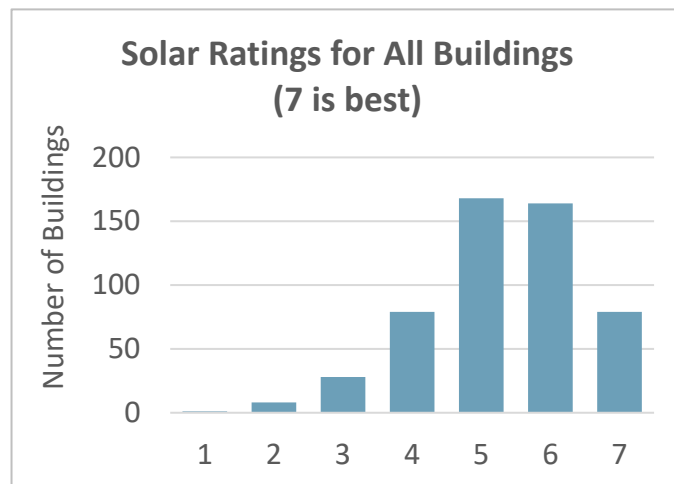
Roof Types



Findings: Across the portfolio, pitched roofs are the predominant roof type. In the subset of buildings that are all-electric, 70 buildings have a pitched roof, one has a flat roof, and one has a Mansard roof. Of the all-electric buildings with high solar ratings (6 or 7), WHPC pays for all the utilities in 9 buildings (8 have pitched roofs, one has a flat roof).

Recommended Action: Evaluate Solar PV feasibility in detail at the 9 WHPC-paid all-electric buildings with high solar ratings.*

Action Plan Section: Solar / Solar + Storage Overview



Next Steps: Ideas for Enhancing Planning Tools & Implementation

- Integrate LIHTC compliance periods, HUD contract end dates, and any other relevant housing finance data into the Database
- Develop a list of preferred efficient equipment, similar to the POAH Basis of Design
- Dive deeper to begin planning for specific properties
- Pilot new technologies as funding opportunities arise and engage property management and tenants for feedback
- Pursue modeling and consider solar to minimize increases in tenant utility bills as costs shift from WHPC-paid meters to tenant-paid meters as gas space heating and domestic hot water systems are upgraded to electric
- Follow evolution of technology, especially central space heating cold climate air source heat pumps (ccASHPs) and larger efficient electric central water heaters

For More information

Rob Dicke

Assistant Vice President, Asset
Management, WHPC

rdicke@whpccorp.org

608.807.1790



www.WHPCcorp.org

Abby Corso

Chief Strategy Officer, Elevate

Abigail.Corso@ElevateNP.org

608.807.1093



ELEVATE

www.ElevateNP.org



Appendix

Solar Rating Analysis: Definitions and Process

Definitions

- Shading
 - Are there trees, other buildings, or other objects that cause the roof to be in shade for part or all of the day?
- Rooftop Obstructions
 - Are there rooftop vents, different aspects, dormers, or other obstructions that will make placing panels on the roof difficult?
- Orientation
 - What direction are the roof aspects facing?
- Carport Potential
 - Does the property have space available in the parking lot that isn't heavily shaded, and could be used for a carport solar array?

Ratings Process

- Shading and Rooftop Obstructions are rated on a good, fair, poor scale. A "good" property would have minimal shading and a large amount of available roof space.
- For orientation, if a building had any roof aspects facing south, it was considered "good". All other configurations, such as east/west would be considered "fair". Orientation, while important, has less impact on solar potential than shading or obstructions.
- Carport Potential is either yes, there is available space for a carport array, or no.
- Overall buildings scores are based on a summation of these four criteria.