CITY PLAYBOOKS FOR THE EQUITABLE ELECTRIFICATION OF MULTIFAMILY BUILDINGS

Playbook 3: Multifamily Guidance for Building Decision-Makers (Updated July 2022)

This Playbook provides resources and recommendations for engaging with multifamily decision-makers in order to advance building electrification equitably.

Building Electrification Institute
CITIES DRIVING CHANGE

Steven Winter Associates, Inc.
Improving the Built Environment Since 1972

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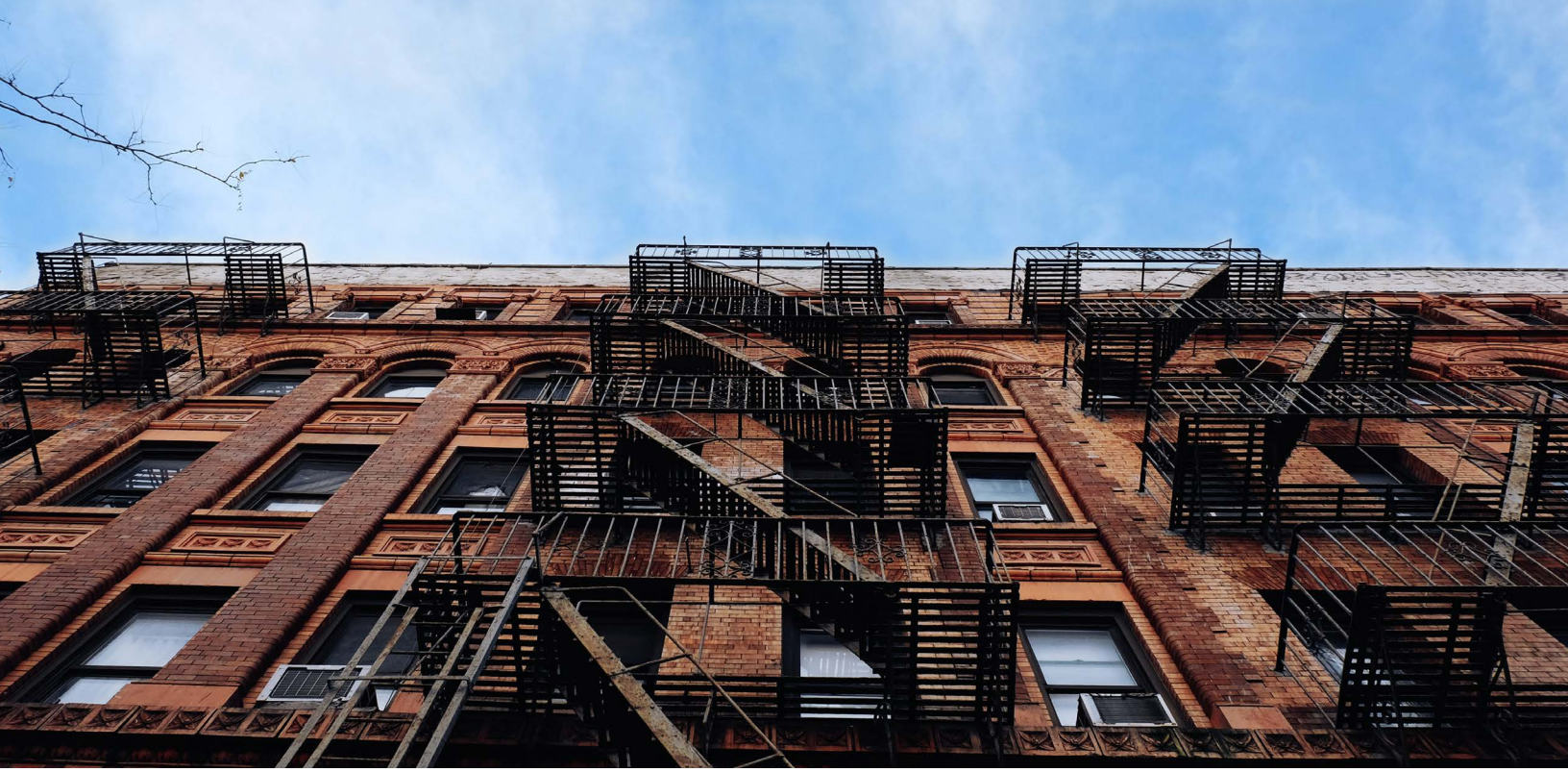
SUMMARY

Building electrification transitions fossil fuel-based building systems to highly-efficient electric equipment and offers considerable health and safety benefits, which include improved indoor air quality, reducing gas leaks from both gas pipes and inside the home, and providing cooling during increasingly hot summers as a result of climate change. Building electrification, along with most building upgrades, also comes with risks, and without proper planning and support could lead to increased rents, utility costs, and disruptions to tenants during the retrofit process.

This Playbook on *Multifamily Guidance for Building Decision-Makers* is the third in a three-part series on the equitable electrification of multifamily buildings. The **first Playbook** provides an overview of the project and provides recommendations for policymakers. The **second Playbook** identifies the most applicable electrification upgrades and technologies for four multifamily building typologies. This Playbook includes "Journey Pages" for each of these building typologies and recommendations for engaging building decision-makers to advance building electrification, with a focus on potential impacts to tenants. Examples of how this Playbook may be used could include:

- Using the Journey Pages in education, outreach, or technical assistance within programs that engage with multifamily building decision-makers;
- Sharing the Journey Pages with policymakers, program implementers, and other stakeholders who work with multifamily building decision-makers to help them understand the electrification retrofit process, and;
- Sharing the Journey Pages with contractors or building professionals and helping them understand how to use them in their work with multifamily building decision-makers.



During the development of the Playbooks, the team identified the following recommendations for policymakers. See *Playbook 1: Multifamily Electrification Background and Recommendations* for more details.

1. Local government staff should support proactive outreach and education to building decision-makers ahead of equipment failure to ensure holistic and early planning for the multifamily electrification retrofit process. This support must be tailored for the unique challenges of large and small building decision-makers.

2. Local governments can impact manufacturer product decision-making by making clear electrification policy goals, sharing data to support market sizing, and developing long-term coalitions with utilities, engineers, and manufacturers.

3. Local government staff working on buildings, electric vehicles and distributed generation should coordinate discussions with utilities and regulators on strategies to reduce barriers to electrical service upgrades.

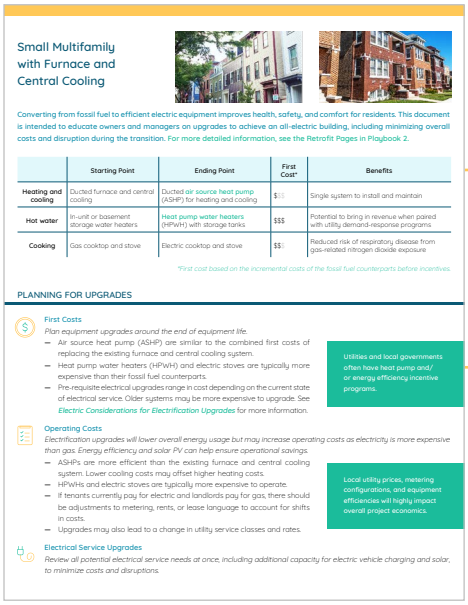
4. Environmental and sustainability staff must pursue partnerships with local housing staff and community groups in order to advocate for and develop ambitious and diverse solutions to the housing and climate crisis.

HOW TO USE THIS PLAYBOOK

This Playbook includes "Journey Pages," which are resources that can inform a holistic planning process for electrification upgrades in multifamily buildings that coincide with the end of equipment life. These Journey Pages are meant to help educate building decision-makers, contractors, policymakers, and other stakeholders on the examples of a multifamily building electrification retrofit. A Journey Page is available for each of the four multifamily building typologies that the project team identified as common across cities: **Low-rise (1 to 3 stories) with a Furnace**, **Low-rise (1 to 3 stories) with a Boiler**, **Mid-rise (4 to 7 stories)**, and **High-rise (8+ stories)**. There is also a Journey Page on **electrical needs** of a building that can be used in conjunction with any of the typology Journey Pages.

The Journey Pages are not intended to be engineering documents with scopes of work for each upgrade. During their development, the project team determined that it was important to educate building decision-makers, policymakers, and others on the experience of the retrofit and potential impacts to tenants in order to inform retrofit planning. While these documents can be used in conjunction with the technical information in the **Retrofit Pages from Playbook 2**, building decision-makers should rely on contractors, engineers, and building professionals to scope their specific retrofits and install the equipment.

Below includes a diagram of a Journey Page for a multifamily typology.



Small Multifamily with Furnace and Central Cooling

Converting from fossil fuel to efficient electric equipment improves health, safety, and comfort for residents. This document is intended to educate owners and managers on upgrades to achieve an all-electric building, including minimizing overall costs and disruption during the transition. For more detailed information, see the Retrofit Pages in Playbook 2.

	Starting Point	Ending Point	First Cost*	Benefits
Heating and cooling	Ducted furnace and central cooling	Ducted air source heat pump (ASHP) for heating and cooling	$$	Single system to install and maintain
Hot water	In-unit or basement storage water heaters	Heat pump water heaters (HPWH) with storage tanks	$$$	Potential to bring in revenue when paired with utility demand-response programs
Cooking	Gas cooktop and stove	Electric cooktop and stove	$$	Reduced risk of respiratory disease from gas-related nitrogen dioxide exposure

*First cost based on the incremental costs of the fossil fuel counterparts before incentives.

PLANNING FOR UPGRADES

First Costs

Plan equipment upgrades around the end of equipment life.

- Air source heat pump (ASHP) are similar to the combined first costs of replacing the existing furnace and central cooling system.
- Heat pump water heaters (HPWH) and electric stoves are typically more expensive than their fossil fuel counterparts.
- Pre-requisite electrical upgrades range in cost depending on the current state of electrical service. Older systems may be more expensive to upgrade. See *Electric Considerations for Electrification Upgrades* for more information.

Utilities and local governments often have heat pump and/or energy efficiency incentive programs.

Operating Costs

Electrification upgrades will lower overall energy usage but may increase operating costs as electricity is more expensive than gas. Energy efficiency and solar PV can help ensure operational savings.

- ASHPs are more efficient than the existing furnace and central cooling system. Lower cooling costs may offset higher heating costs.
- HPWHs and electric stoves are typically more expensive to operate.
- If tenants currently pay for electric and landlords pay for gas, there should be adjustments to metering, rents, or lease language to account for shifts in costs.
- Upgrades may also lead to a change in utility service classes and rates.

Local utility prices, metering configurations, and equipment efficiencies will highly impact overall project economics.

Electrical Service Upgrades

Review all potential electrical service needs at once, including additional capacity for electric vehicle charging and solar, to minimize costs and disruptions.

The top table introduces the existing building characteristics and future end point of the retrofits, including high-level benefits.

The planning section introduces what to consider while planning for upgrades including costs, impacts to utility bills and prerequisite needs.

COORDINATION WITH CONTRACTORS

Upgrades will involve multiple trades and utilities. Inform contractors of all planned electrification upgrades and prioritize contractors who have experience with heat pump equipment.

- ASHP and HPWH manufacturers have lists of contractors that often offer additional warranties.
- Pre-requisite electrical upgrades typically involve permitting and may require electricians to coordinate with the local utility for service upgrades.

CONSIDERATIONS AND CHALLENGES FOR INSTALLATION

Air source heat pumps (ASHP) will replace the furnace and central cooling system.

- Insulate, air seal, and replace windows if at end of useful life ahead of installation, and remediate mold and other health hazards. A blower door test can help identify leaks and correctly size the new ASHPs.
- Evaluate if ducts are in good condition to be used for ducted ASHPs. Otherwise, install ductless ASHPs, or "mini-splits", which will require access to tenant living spaces.

If in colder climates, it will be important to install "cold-climate" heat pumps.

Asbestos can significantly increase upgrades to walls and ceilings.

Heat pump water heaters (HPWH) will replace the current hot water system in the same location.

- Some HPWHs require additional air flow and should be in unheated indoor spaces.
- Split HPWHs (see below) can be used where indoor space is limited.

Electric stoves may be induction or electric resistance technology.

- Induction offers greater cooking precision and reduced fire risk, although are more expensive.

DUCTED ASHP, WITH INDOOR AND OUTDOOR COMPONENTS.

Scheduling

Upgrades will require clear communication with tenants of access needs and equipment downtime.

- Upgrades will likely require rewiring, either within tenant spaces or in electrical rooms. Extending wiring to new equipment is often the most disruptive step, requiring wall access.
- Consider the weather too — ASHPs should be installed in the in the spring or fall.
- Electric stoves and HPWH (if current water heaters are in tenant spaces) can be replaced during tenant turn over. Otherwise, coordinate installation with other planned kitchen renovation projects to minimize costs and disruption.

SPLIT HPWH, WITH HEAT PUMP OUTSIDE AND STORAGE TANK INSIDE.

ONGOING MAINTENANCE AND RESPONSIBILITIES

Education

Educate residents on efficient and comfortable operation of the new equipment.

- ASHPs should not be turned up and down dramatically throughout the day. The most efficient operations is to "set it and forget it."

Ongoing Maintenance

ASHP and HPWH regular maintenance includes changing or cleaning filters and keeping outdoor units clear and clean.

- Annual servicing of equipment is recommended, similar to furnace servicing.
- Consider and clearly communicate who is responsible, landlord or tenants, for these ongoing needs.

The following section provides recommendations on identifying and working with contractors on these upgrades.

The back provides a brief overview of the likely replacement equipment including key considerations that impact the retrofit experience.

Timing and scheduling of upgrades are highlighted, including the season to replace the existing system.

The bottom includes information on efficient operations and important maintenance requirements.

WORKING WITH DECISION-MAKERS

Even when motivated, or required, to electrify their buildings, building decision-makers often lack the full awareness of how to plan for the necessary upgrades within equipment lifecycles, or how the retrofit may impact resident experience. As a result, decision-makers may be surprised with elements of the electrification process. Without proactive planning, decision-makers may take an easier path and replace equipment with similar fossil fuel-based models. Tenants may also end up bearing the costs or disruptions that may result from the retrofit process.

Building decision-makers can include anyone who makes decisions on when and how a building is upgraded and/or operated. These may include building owners, managers, building operators or supers, and condo and/or co-op boards.

These Journey Pages are intended to help building decision-makers who have committed to electrifying a building. They can help inform the process of hiring contractors and scoping the final work. The Journey Pages will help building decisions-makers and others understand the holistic planning required for the most cost-effective and least disruptive path to electrify heating, hot water, and cooking. While this occurs to varying degrees today, it will be key to get more building owners and decision-makers to engage in this proactive planning process, and it will be critical for policymakers and program implementers to make the process as simple and streamlined as possible. Currently:

- Decision-makers of **small multifamily buildings** tend not to conduct capital planning nor work with energy consultants, engineers, or general contractors to coordinate across different trades and upgrades. They tend to have smaller capital reserves and budgets as well as less staff capacity. To serve their needs:
  - Policymakers and program implementers should conduct outreach and provide in-depth support to assist small multifamily building decision-makers in holistic planning. This could take the form of assessments, audits, or capital planning tools.
  - The Journey Pages can be used during early engagement with these building decision-makers to educate the importance of holistic planning.

- Decision-makers of **large multifamily buildings** are more likely to conduct capital planning and work with professionals to coordinate across different trades and upgrades. The upgrades in these buildings tend to be more complex compared to smaller buildings, but these decision-makers often have larger capital reserves, budgets, and staff capacity to plan for them. To serve their needs:
  - Policymakers can provide tools and education on how to incorporate building electrification into capital planning processes. They can also help build confidence and interest in building electrification with building professionals who often operate as coordinators across projects in larger multifamily buildings.
  - For these buildings, the Journey Page can be used to raise awareness and understanding of the important components that impact capital planning and coordination.

TENANT EXPERIENCES

Electrifying a building's heating, hot water, and cooking systems will impact tenants. There are benefits, which can include providing the ability to control their own heating and cooling, improved indoor air quality, increased access to cooling, and, in many cases, lower energy bills.

There are also potential negative impacts, which could include physical disruptions during the retrofit process, higher energy bills, and higher rents if landlords pass through the costs of the upgrades. In the worst-case scenario, this could result in tenant displacement, which is already a growing challenge across many cities that are experiencing housing affordability crises. Below is a summary of the potential negative impacts and some recommendations for mitigation.

Physical disruptions during the retrofit process: Installing refrigerant lines and electrical conduits from panels to electric equipment may require access to interior walls, which would require access to and potential major disruption in apartment units. Any distributed heating or hot water system will require some work within tenant spaces.

- ***Recommendations:*** *Educate owners on the types of upgrades that should be completed at the time of tenant turn over, which provides access to an apartment when no one is there, or in conjunction with similar upgrades to minimize disruption. For example:*
  - *Mini-splits, packaged terminal heat pumps (PTHPs), electric stoves and integrated heat pump water heaters (if current water heaters are in the tenant space) can be upgraded at different points in time and therefore can be done at the time of tenant turn over.*
  - *Kitchen renovations, which provide a direct benefit to tenants, may be an opportune moment to also install conduit and electric stoves and reduce overall disruptions.*
  - *Installing wall insulation may be an opportunity to run refrigerant lines and conduits to mini-splits.*
  - *If any disruptions risk the health and safety of residents or extend over multiple days, residents should be offered a stay at a local hotel for no-cost.*

Changes to post-retrofit energy bills: When transitioning to all-electric systems, fossil fuel bills will inevitably decrease or be eliminated, and electricity bills will likely increase. The exact amounts, and whether residents experience an overall increase or decrease in the total energy bills, is dependent on the chosen retrofits as well as the local energy prices. To help ensure savings, electrification upgrades should prioritize the highest efficiency electric equipment and can also be paired with weatherization to reduce heating loads and solar PV systems to reduce electric rates. A building's metering configuration is also an important consideration to understand the potential impacts to tenant energy bills. If tenants pay for electricity, and heating system is retrofitted from a central to distributed system, tenants can see major increases in their electricity bills while the landlord will see decreases in their central heating gas bills.

- ***Recommendations:*** *Work proactively to ensure that energy bills do not increase for residents. For example:*
  - *Ensure that retrofits include combinations of measures that will guarantee energy bill savings for residents*
  - *Evaluate the expected bill increases and decreases under the building's metering configuration.*
  - *Consider leasing arrangements that will ensure tenants do not pay more than a specified amount for energy and/or are guaranteed shared savings with the owner.*
  - *Offer educational materials in appropriate languages to tenants on efficient operations of new electric equipment to ensure it operates as cost-effectively as possible. For example, heat pump systems should be allowed to run continuously, rather than being turned off and on, to achieve optimal efficiency.*

Increases in rents if landlords pass through the upgrade costs to tenants: Upgrades will cost owners capital, and there is the potential of increasing rents for tenants in a few ways. For one, multifamily building owners operating in competitive real estate markets may be able to raise their rents to recoup the costs of upgrades and rebuild reserves. Additionally, cosmetic building improvements, or those that offer additional services, such as cooling, can increase rents by attracting higher income renters to the building. Moreover, if upgrades are required, implementing complicated upgrades may pose too much of a cost burden for smaller property owners and may force local building owners to sell. Often these properties are sold to outside investors who have the resources or the economies of scale to complete upgrades, and may be more likely to increase rents on existing tenants or reposition the building to attract higher income renters.

- ***Recommendations:*** *Policymakers and program implementers should take steps to reduce the potential for the costs of building upgrades to be passed through to tenants. This can include:*
  - *Work to reduce the upfront costs of retrofits by providing incentives of grants to cover all or a portion of the costs or develop alternative financing arrangements, such as leasing arrangements with utility or third-party ownership of equipment.*
  - *Reduce costs and complexity of retrofit projects by providing technical assistance programs or support to streamline the retrofit process.*
  - *Support local ownership of multifamily buildings through proactive affordable housing preservation programs or new ownership models such as Community Land Trusts.*
  - *Partner with local housing staff and community organizations to support broader housing affordability solutions such as rent control, eviction protection, and new sources of funding for affordable housing construction and preservation. For a full list of findings and recommendations see* ***Appendix in Playbook 1****.*

Building Typology 1:

Low-Rise Multifamily (1-3 Stories) with Gas Furnace and Central Cooling

Converting from fossil fuel to efficient electric equipment improves health, safety, and comfort for residents. This document is intended to educate owners and managers on upgrades to achieve an all-electric building, including minimizing overall costs and disruption during the transition. For more detailed information, see the Retrofit Pages in Playbook 2.

Building System	Starting Point	Ending Point	First Cost*	Benefits
Heating and Cooling	Ducted furnace and central cooling	Ducted air source heat pump (ASHP) for heating and cooling (if existing ductwork can be used)	$$$	• Single system to install and maintain • Healthier indoor air • Tenants able to control temperature • Cooling more efficient and less drafty compared to window A/Cs
		Mini-split air source heat pump for heating and cooling (if existing ductwork cannot be used)		
Hot Water	In-unit or basement storage water heaters	Heat pump water heaters (HPWH) with storage tanks (could be either split or integrated system)	$$	Potential to bring in revenue when paired with utility demand-response programs
Cooking	Gas cooktop and oven	Electric cooktop and oven	$	Healthier indoor air and reduced risk of respiratory disease
Electrical Upgrades	Electrical upgrades are likely needed to support new electrical loads from electric hot water and cooking		$$ to $$$	Necessary in most buildings to complete other upgrades

**First cost is based on the total cost of the upgrades before incentives. Note that the incremental cost may be lower depending on the state of existing equipment. Incentives may further lower costs, but vary by region.*

First Cost Key	Cost per Apartment Unit
$	under $2,000
$$	$2,000 to $6,000
$$$	$6,000 to $18,000
$$$$	$18,000 to $30,000+

PLANNING FOR UPGRADES

First Costs

Plan equipment upgrades around the end of equipment life.

- Air source heat pump (ASHP) are similar to the combined first costs of replacing the existing furnace and central cooling system.
- Heat pump water heaters (HPWH) and electric stoves are typically more expensive than their fossil fuel counterparts.
- Pre-requisite electrical upgrades range in cost depending on the current state of electrical service. Older systems may be more expensive to upgrade. See *Electric Considerations for Electrification Upgrades* for more information.

Utilities and local governments often have heat pump and/or energy efficiency incentive programs.

Operating Costs

Electrification upgrades will lower overall energy usage but may increase operating costs as electricity is more expensive than gas. Energy efficiency and solar PV can help ensure operational savings.

- ASHPs are more efficient than the existing furnace and central cooling system. Lower cooling costs may offset higher heating costs.
- HPWHs and electric stoves are typically more expensive to operate.
- If tenants currently pay for electric and landlords pay for gas, there should be adjustments to metering, rents, or lease language to account for shifts in costs.
- Upgrades may also lead to a change in utility service classes and rates.

Local utility prices, metering configurations, and equipment efficiencies will highly impact overall project economics.

Electrical Service Upgrades

Review all potential electrical service needs at once, including additional capacity for electric vehicle charging and solar, to minimize costs and disruptions.

COORDINATION WITH CONTRACTORS

Upgrades will involve multiple trades and utilities. Inform contractors of all planned electrification upgrades and prioritize contractors who have experience with heat pump equipment.

- ASHP and HPWH manufacturers have lists of contractors that often offer additional warranties.
- Pre-requisite electrical upgrades typically involve permitting and may require electricians to coordinate with the local utility for service upgrades.

CONSIDERATIONS AND CHALLENGES FOR INSTALLATION

Air source heat pumps (ASHP) will replace the furnace and central cooling system.

- Insulate, air seal, and replace windows if at end of useful life ahead of installation, and remediate mold and other health hazards. A blower door test can help identify leaks and correctly size the new ASHPs.
- Evaluate if ducts are in good condition to be used for ducted ASHPs. Otherwise, install ductless ASHPs, or "mini-splits", which will require access to tenant living spaces.

Heat pump water heaters (HPWH) will replace the current hot water system in the same location.

- Some HPWHs require additional air flow and should be in unheated indoor spaces.
- Split HPWHs (see below) can be used where indoor space is limited.

Electric stoves may be induction or electric resistance technology.

- Induction offers greater cooking precision and reduced fire risk, although are more expensive.

If in colder climates, it will be important to install "cold-climate" heat pumps.

Asbestos can significantly increase upgrades to walls and ceilings.

DUCTED ASHP, WITH INDOOR AND OUTDOOR COMPONENTS.

SPLIT HPWH, WITH HEAT PUMP OUTSIDE AND STORAGE TANK INSIDE.

Scheduling

Upgrades will require clear communication with tenants of access needs and equipment downtime.

- Upgrades will likely require rewiring, either within tenant spaces or in electrical rooms. Extending wiring to new equipment is often the most disruptive step, requiring wall access.
- Consider the weather too — ASHPs should be installed in the in the spring or fall.
- Electric stoves and HPWH (if current water heaters are in tenant spaces) can be replaced during tenant turn over. Otherwise, coordinate installation with other planned kitchen renovation projects to minimize costs and disruption.

ONGOING MAINTENANCE AND RESPONSIBILITIES

Education

Educate residents on efficient and comfortable operation of the new equipment.

- ASHPs should not be turned up and down dramatically throughout the day. The most efficient operations is to "**set it and forget it**."

Ongoing Maintenance

ASHP and HPWH regular maintenance includes changing or cleaning filters and keeping outdoor units clear and clean.

- Annual servicing of equipment is recommended, similar to furnace servicing.
- Consider and clearly communicate who is responsible, landlord or tenants, for these ongoing needs.

Building Typology 2:

Low-Rise Multifamily (1-3 Stories) with Hot Water (Hydronic) Heating

Converting from fossil fuel to efficient electric equipment improves health, safety, and comfort for residents. This document is intended to educate owners and managers on upgrades to achieve an all-electric building, including minimizing overall costs and disruption during the transition. For more detailed information, see the Retrofit Pages in Playbook 2.

Building System	Starting Point	Ending Point	First Cost*	Benefits
Heating and Cooling	Boiler with hot water distribution and individual window A/Cs	Mini-split air source heat pump for heating and cooling	$$$	• Single system to install and maintain • Healthier indoor air • Tenants able to control temperature • Cooling more efficient and less drafty compared to window A/Cs
Hot Water	In-unit or basement storage water heaters	Heat pump water heaters (HPWH) with storage tanks (could be either split or integrated system)	$$	Potential to bring in revenue when paired with utility demand-response programs
Cooking	Gas cooktop and oven	Electric cooktop and oven	$	Healthier indoor air and reduced risk of respiratory disease
Electrical Upgrades	Electrical upgrades are likely needed to support new electrical loads from all upgrades		$$$	Necessary in most buildings to complete other upgrades

**First cost is based on the total cost of the upgrades before incentives. Note that the incremental cost may be lower depending on the state of existing equipment. Incentives may further lower costs, but vary by region.*

First Cost Key	Cost per Apartment Unit
$	under $2,000
$$	$2,000 to $6,000
$$$	$6,000 to $18,000
$$$$	$18,000 to $30,000+

PLANNING FOR UPGRADES

First Costs

Plan equipment upgrades around the end of equipment life.

- Mini-split air source heat pumps have a higher first cost than replacing a boiler and building-wide window A/C units.
- Heat pump water heaters (HPWH) and electric stoves typically have higher first costs than their fossil fuel counterparts.
- Pre-requisite electrical upgrades range in cost depending on the current state of electrical service. Older systems may be more expensive. See *Electric Considerations for Electrification Upgrades* for more information.

Utilities and local governments often have heat pump and/or energy efficiency incentive programs.

Operating Costs

Electrification upgrades will lower overall energy usage but may increase operating costs as electricity is more expensive than gas. Energy efficiency and solar PV can help ensure operational savings.

- Mini-splits are more efficient than the existing boiler and window A/Cs. Lower cooling costs may offset higher heating costs.
- HPWHs and electric stoves are typically more expensive to operate.
- If tenants currently pay for electric and landlords pay for gas, there needs to be adjustments to metering or lease language to account for shifts in costs.
- Upgrades may also lead to a change in utility service classes and rates.

Local utility prices, metering configurations, and equipment efficiencies will highly impact overall project economics.

Electrical Service Upgrades

Review all potential electrical service needs at once, including additional capacity for electric vehicle charging and solar, to minimize costs and disruptions.

COORDINATION WITH CONTRACTORS

Upgrades will involve multiple trades and utilities. Inform contractors of all planned electrification upgrades and prioritize contractors who have experience with heat pump equipment.

- Mini-split and HPWH manufacturers have lists of contractors that often offer additional warranties.
- Pre-requisite electrical upgrades typically involve permitting and may require electricians to coordinate with the local utility for service upgrades.

CONSIDERATIONS AND CHALLENGES FOR INSTALLATION

Mini-splits will replace the heating system and window A/Cs.

- Outdoor units (see below) will likely be located on the roof, or perhaps at ground level if space permits. Outdoor units can also be mounted on exterior walls.
- Indoor units (see below) must be configured to deliver sufficient heating to each space. Installation will require access to tenant living spaces.
- Insulate, air seal, and replace windows if at end of useful life ahead of installation, and remediate mold and other health hazards. A blower door test can help identify leaks and correctly size the new ASHPs.

Heat pump water heaters (HPWH) will replace the existing hot water system in the same location.

- Some HPWHs require additional air flow and should be in unheated indoor spaces.
- Split HPWHs (see below) can be used where indoor space is limited.

Electric stoves may be induction or electric resistance technology.

- Induction offers grater cooking precision and reduced fire risk, although they are more expensive.

Scheduling

Upgrades will require clear communication of access needs and equipment downtime.

- Upgrades will likely require rewiring, either within tenant spaces or in electrical rooms. Extending wiring to new equipment is often the most disruptive step, requiring wall access.
- Consider the weather too— Mini-splits should be installed in the in the spring or fall.
- Electric stoves, mini-splits and HPWH (if current water heaters are in tenant spaces) can be replaced during tenant turn over. Otherwise, coordinate installation with other planned kitchen renovation projects to minimize costs and disruption.

If in colder climates, it will be important to install "cold-climate" heat pumps.

Asbestos can significantly increase upgrades to walls and ceilings.

MINI-SPLIT OUTDOOR AND INDOOR HEAT PUMP COMPONENTS.

SPLIT HPWH, WITH HEAT PUMP OUTSIDE AND STORAGE TANK INSIDE.

ONGOING MAINTENANCE AND RESPONSIBILITIES

Education and Training

Educate residents on efficient and comfortable operation of the new equipment.

- Mini-splits should not be turned up and down dramatically throughout the day. The most efficient operations is to "set it and forget it."

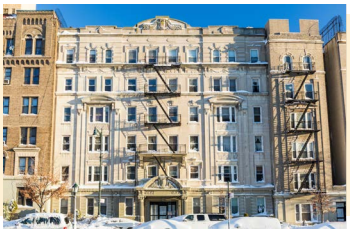
Ongoing Maintenance

Mini-splits and HPWH regular maintenance includes changing or cleaning filters and keeping outdoor units clear and clean.

- Annual servicing of equipment is recommended, similar to boiler servicing.
- Consider and clearly communicate who is responsible, landlord or tenants, for these ongoing needs.

Building Typology 3:

Mid-Rise Multifamily (4-7 Stories) with Steam Heating



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Building System	Starting Point	Ending Point	First Cost*	Benefits
Heating and Cooling	Boiler with steam distribution, and individual window A/C units	Mini-split air source heat pump for heating and cooling	$$$	• Single system to install and maintain • Healthier indoor air • Tenants able to control temperature • Cooling more efficient and less drafty compared to window A/Cs
Hot Water	Central hot water plant	Central split heat pump water heater	$$	Potential to bring in revenue when paired with utility demand-response programs
Cooking	Gas cooktop and oven	Electric cooktop and oven	$	Healthier indoor air and reduced risk of respiratory disease
Electrical Upgrades	Electrical upgrades are likely needed to support new electrical loads from all upgrades		$$$	Necessary in most buildings to complete other upgrades

**First cost is based on the total cost of the upgrades before incentives. Note that the incremental cost may be lower depending on the state of existing equipment. Incentives may further lower costs, but vary by region.*

First Cost Key	Cost per Apartment Unit
$	under $2,000
$$	$2,000 to $6,000
$$$	$6,000 to $18,000
$$$$	$18,000 to $30,000+

PLANNING FOR UPGRADES

First Costs

Plan equipment upgrades around the end of equipment life.

- Mini-split air source heat pumps have a higher first cost than replacing a boiler and building-wide window A/C units.
- Heat pump water heaters (HPWH) and electric stoves typically have higher first costs than their fossil fuel counterparts.
- Pre-requisite electrical upgrades may be a significant cost for larger, older buildings though depends on the current state of electrical service. See *Electric Considerations for Electrification Upgrades* for more information.

Utilities and local governments often have heat pump and/or energy efficiency incentive programs.

Operating Costs

Electrification upgrades will lower overall energy usage but may increase operating costs as electricity is more expensive than gas. Energy efficiency and solar PV can help ensure operational savings.

- Mini-splits are more efficient than the existing boiler and window A/Cs. Lower cooling costs may offset higher heating costs.
- HPWHs and electric stoves are typically more expensive to operate.
- If tenants currently pay for electric and landlords pay for gas, there should be adjustments to metering or lease language to account for shifts in costs.
- Upgrades may also lead to a change in utility service classes and rates.

Local utility prices, metering configurations, and equipment efficiencies will highly impact overall project economics.

Electrical Service Upgrades

Review all potential electrical service needs at once, including additional capacity for electric vehicle charging and solar, to minimize costs and disruptions.

COORDINATION WITH CONTRACTORS

These upgrades can be complex and involve multiple trades. Work with a trusted engineer or energy consultant to coordinate across the trades and other parties.

- Communicate the overall goal of an all-electric building and the importance of a holistic approach.
- Pre-requisite electrical upgrades typically involve permitting and may require electricians to coordinate with the local utility for service upgrades.
- Require fair wages, benefits and women- and minority-owned business status of contractors or subcontractors.

CONSIDERATIONS AND CHALLENGES FOR INSTALLATION

Begin with electrical upgrades and create a master plan for equipment replacement before the current equipment fails.

Mini-splits will replace the heating system and window A/Cs.

- Outdoor units (see below) will likely be located on the roof, or perhaps at ground level if space permits. Outdoor units can also be mounted on exterior walls.
- Indoor units (see below) must be configured to deliver sufficient heating to each space. Work with an engineer or energy consultant to identify the most likely design
- Insulate, air seal and remediate mold and other health hazards ahead of installation.

A central split heat pump water heater (HPWH) plant will replace the current hot water plant.

- These plants have a different design compared to gas hot water plants and will require extensive planning and potentially building and tenant disruptions.

Electric stoves may be induction or electric resistance technology.

- Induction offers grater cooking precision and reduced fire risk, although they are more expensive.

Scheduling

Upgrades will require clear communication with tenants of access needs and equipment downtime.

- Upgrades will likely require rewiring, either within tenant spaces or in electrical rooms. Extending wiring to new equipment is often the most disruptive step, requiring wall access.
- Consider the weather too— mini-splits should be installed in the in the spring or fall.
- Electric stoves and mini-splits can be replaced during tenant turn over. Otherwise, coordinate installation with other planned renovation projects to minimize costs and disruption.

If in colder climates, it will be important to install "cold-climate" heat pumps.

Asbestos can significantly increase upgrades to walls and ceilings.

MINI-SPLIT OUTDOOR AND INDOOR HEAT PUMP COMPONENTS. EACH UNIT ON THE ROOF SERVES A DIFFERENT APARTMENT.

CENTRAL SPLIT HPWH PLANT

ONGOING MAINTENANCE AND RESPONSIBILITIES

Education and Training

Educate residents on efficient and comfortable operation of the new equipment.

- Mini-splits should not be turned up and down dramatically throughout the day. The most efficient operations is to "**set it and forget it**."

Ongoing Maintenance

Mini-splits and HPWH regular maintenance includes changing or cleaning filters and keeping outdoor units clean and clear.

- Annual servicing of equipment is recommended, similar to typical heating systems.
- Consider and clearly communicate who is responsible, landlord or tenants, for these ongoing needs.

Building Typology 4:

High-Rise Multifamily (8+ Stories) with Steam or Hot Water (Hydronic) Heating

Converting from fossil fuel to efficient electric equipment improves health, safety, and comfort for residents. This document is intended to educate owners and managers on upgrades to achieve an all-electric building, including minimizing overall costs and disruption during the transition. For more detailed information, see the Retrofit Pages in Playbook 2.

Building System	Starting Point	Ending Point	First Cost*	Benefits
Heating and Cooling	Boiler with steam or hydronic distribution and individual window A/C units	Individual packaged terminal heat pump (PTHP) units for heating and cooling	$$$	• Healthier indoor air • Tenants able to control temperature • More efficient cooling
		Central heat pump plant	$$$$	
Hot Water	Central hot water plant	Central split heat pump water heater	$$	Potential to bring in revenue when paired with utility demand-response programs
Cooking	Gas cooktop and oven	Electric cooktop and oven	$	Healthier indoor air and reduced risk of respiratory disease
Electrical Upgrades	Electrical upgrades are likely needed to support new electrical loads from all upgrades.		$$$	Necessary in most buildings to complete other upgrades

**First cost is based on the total cost of the upgrades before incentives. Note that the incremental cost may be lower depending on the state of existing equipment. Incentives may further lower costs, but vary by region.*

First Cost Key	Cost per Apartment Unit
$	under $2,000
$$	$2,000 to $6,000
$$$	$6,000 to $18,000
$$$$	$18,000 to $30,000+

PLANNING FOR UPGRADES

First Costs

Plan equipment upgrades around the end of equipment life.

- For central systems, a central heat pump plant has a higher first cost than replacing a central boiler plant and building-wide window A/C units.
- For individual systems, replacing Packaged Terminal Air Conditioning units with cold-climate Packaged Terminal Heat Pump (PTHPs) is first cost comparable.
- Heat pump water heaters (HPWH) and electric stoves typically have higher first costs than their fossil fuel counterparts.
- Pre-requisite electrical upgrades may be a significant cost for larger, older buildings though depends on the current state of electrical service. See *Electric Considerations for Electrification Upgrades* for more information.

Utilities and local governments often have heat pump and/or energy efficiency incentive programs.

Review all potential electrical service needs at once, including electric vehicle charging and solar, to minimize costs and disruptions.

Operating Costs

Electrification upgrades will lower overall energy usage but may increase operating costs as electricity is more expensive than gas. Energy efficiency and solar PV can help ensure savings.

- Central or individual heat pumps are more efficient than the existing boiler and A/C units. Lower cooling costs may offset higher heating costs.
- HPWHs and electric stoves are typically more expensive to operate.
- If tenants currently pay for electric and landlords pay for gas, there should be adjustments to metering or lease language to account for shifts in costs.
- Upgrades may also lead to a change in utility service classes and rates.

Local utility prices, metering configurations, and equipment efficiencies will highly impact overall project economics.

COORDINATION WITH CONTRACTORS

These upgrades can be complex and involve multiple trades. Work with a trusted engineer or energy consultant to coordinate across the trades and other parties.

- Communicate the overall goal of an all-electric building and the importance of a holistic approach.
- Pre-requisite electrical upgrades typically involve permitting and may require electricians to coordinate with the local utility for service upgrades.
- Require fair wages, benefits and women- and minority-owned business status of contractors or subcontractors.

CONSIDERATIONS AND CHALLENGES FOR INSTALLATION

Begin with electrical upgrades and create a master plan for equipment replacement before the current equipment fails.

Central or individual heat pumps will replace the heating and cooling systems.

- The type depends on your existing configuration—likely a central heat pump plant, also known as a variable refrigerant flow (VRF) or cold-climate packaged terminal heat pumps (PTHP). Work with an engineer or energy consultant to identify the most appropriate technology.
- If a central heat pump plant is installed, the outdoor components will likely be located on the roof. Coordinate installations with roof maintenance and plan for potential future equipment like solar to ensure sufficient space.
- Insulate, air seal and remediate mold and other health hazards ahead of installation.

A central split heat pump water heater (HPWH) plant will replace the current hot water plant.

- These plants have a different design compared to gas hot water plants and will require extensive planning and potentially building and tenant disruptions.

Electric stoves may be induction or electric resistance technology.

- Induction offers greater cooking precision and reduced fire risk, although are more expensive.

Scheduling

Upgrades will require clear communication with tenants of access needs and equipment downtime.

- Upgrades will likely require rewiring, either within tenant spaces or in electrical rooms. Extending wiring to new equipment is often the most disruptive step, requiring wall access.
- Consider the weather— Heat pumps should be installed in the in the spring or fall.
- Electric stoves and PTHPs can be replaced during tenant turn over. Otherwise, coordinate installation with other planned renovation projects to minimize costs and disruption.

If in colder climates, it will be important to install "cold-climate" heat pumps.

Asbestos can significantly increase upgrades to walls and ceilings.

PACKAGED TERMINAL HEAT PUMP

CENTRAL HEAT PUMP PLANT

CENTRAL SPLIT HPWH PLANT

ONGOING MAINTENANCE AND RESPONSIBILITIES

Education

Educate residents on efficient and comfortable operation of the new equipment.

- Heat pumps should not be turned up and down dramatically throughout the day. The most efficient operations is to "set it and forget it."

Ongoing Maintenance

Heat pumps regular maintenance includes changing or cleaning filters and keeping outdoor units clean and clear.

- Annual servicing of equipment is recommended, similar to typical heating systems.
- Consider and clearly communicate who is responsible, landlord or tenants, for these ongoing needs.

Electric Considerations for Electrification Upgrades: Multifamily Buildings

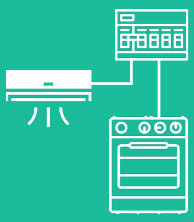
Upgrading buildings with electric heating, hot water, and cooking requires sufficient electric infrastructure. This guide provides an overview of these electrical needs and considerations for upgrades. Consider all of the electrical infrastructure needs for your retrofits, including potential future upgrades such as electric vehicle charging and solar. Plan ahead to reduce disruption and costs by minimizing rework on the same system.

ELECTRIFICATION UPGRADE IMPACTS

Apartment panels contain circuit breakers. Typically, each apartment will have its own panel.

Apartment panels must have sufficient space and capacity for new electric equipment.

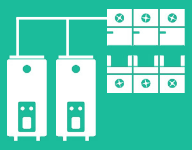
Panel upgrades may be needed if capacity is too low.



Conduit is electrical wiring which connects the apartment panel to electrical equipment such as mini-splits, electric stoves, appliances, and outlets.

Old gas equipment likely do not have conduit available for new electric equipment.

New conduit may be needed between the panels and equipment. This may require access to the interior of walls and can be disruptive to residents.



Master service panels, sometimes known as “switchgear” in large buildings, contain larger capacity circuit breakers and provide electrical service to different parts of the building.

Master service panels may need to be upgraded to support central equipment such as central heat pump water heaters and to provide more capacity to apartment panels.

Pre-1930s buildings may require significant upgrades to their panels and wiring to meet current electrical codes.

Electrical service is the amount of electrical capacity provided to the building from the utility.

Older, larger buildings and those without existing central cooling will likely require electrical service upgrades from the utility.

Coordinate with the electric utility as early as possible to understand complexity, timelines, and costs for service upgrades, which may vary widely.

APPENDIX

JOURNEY PAGES DEVELOPMENT

This report was graciously funded by the Urban Sustainability Directors Network (USDN) Innovation Fund 2019-2020 grant. The project team included three leading cities in building electrification, Boston, MA; Somerville, MA; New York City, NY who guided the project; the Building Electrification Institute (BEI) who served as the project manager; and Steven Winter Associates (SWA) as technical lead. The project was also supported by a team of advisors including the New York State Energy and Research Authority (NYSERDA), Massachusetts Clean Energy Center (Mass CEC), Emerald Cities Collaborative, and heat pump manufacturers including Mitsubishi Heating and Cooling, Fujitsu, and Rheem. Finally, this project had 13 observer cities from across the country.

This team identified the four common multifamily building typologies and developed "Retrofit Pages" that include the likely upgrades and equipment for each typology for **Playbook 2: Multifamily Electrification Retrofits and Considerations**.

While the Retrofit Pages are meant to help inform policymakers, the project team decided to complement these with "Journey Pages" to help building decision-makers understand the retrofit process and engage in holistic planning. To inform these pages, the team interviewed 9 building decision-makers or influencers of building decisions, including program administrators, community development corporations, building mangers, architects and owners. These interviews helped the team determine the information to include and leave out of the pages, how to frame information, and the design of the pages.

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