

The tear sheets accompanying this manual depict five common New York City affordable housing typologies based on age, size, and rental/ownership structure. For each typology, two scopes of work — a Low Carbon and No Carbon retrofit package — were created to represent viable retrofit pathways that achieve moderate and deep GHG emissions reductions, respectively.

Building industry stakeholders can use these tear sheets to assess example measures that comprise a retrofit package and to understand the relative impacts — such as greenhouse gas (GHG) savings, cost, and energy cost savings — of implementing system upgrades and electrification. This information can help project teams as they develop a decarbonization roadmap and retrofit packages to help ensure that their building will comply with LL97 requirements.

Building typology is based on age, size, and rental/ownership structure.

Baseline building conditions describe the system components comprising the existing building.

The Low Carbon retrofit package provides moderate emissions reductions through key system upgrades and strategic electrification.

The No Carbon retrofit package provides deep emissions reductions through more robust system upgrades and full building electrification, eliminating onsite fossil fuel use.

GHG savings show the percentage reduction associated with implementing the ECMs within each building system category.

Decarbonization Roadmap diagram lists key steps to developing a decarbonization retrofit plan.

Key Takeaways provide insight and rationale into the retrofit packages developed for that specific building typology.

Decarbonization Roadmap for Multifamily Affordable Housing

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post-1980 mid-rise senior rental housing

This tear sheet shows packages of energy conservation measures that reduce a building's greenhouse gas emissions in an effort to achieve anticipated LL97 emissions limits and to move towards carbon neutrality.

existing building overview

location: Bronx, NY

dwelling units: 99

building area: 70,460 sq. ft.

metering: gas; master electricity; direct

heating fuel: natural gas

heating system: hydronic baseboards

cooling system: thru-wall ACs

ventilation system: rooftop exhaust fans

utility payment structure: heating: owner-paid; cooling: tenant-paid

Local Law 97 2030 emissions limits not compliant

Based on the Maria Isabel affordable housing project

be ex building energy exchange

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NYC Department of Housing Preservation & Development

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Existing building overview provides a more detailed snapshot of the baseline building conditions.

Percentage of GHG emissions for the baseline building shows the portion of total emissions attributed to each building system.

ECMs are organized by specific building system categories.

typology: post-1980, mid-rise, senior rental housing

BUILDING SYSTEM	% OF GHG EMISSIONS	SYSTEM COMPONENTS	DESCRIPTION	ENERGY CONSERVATION MEASURES (ECM)	ESTIMATED TOTAL COST/DOU*	GHG SAVINGS RELATIVE TO BASELINE BUILDING AND BASED ON THE 2030 EMISSIONS FACTOR	ESTIMATED TOTAL COST/DOU*	GHG SAVINGS RELATIVE TO BASELINE BUILDING AND BASED ON THE 2050 EMISSIONS FACTOR
envelope	n/a	Roof Insulation, Windows/Glazing, Air Sealing & Weatherization, Above Grade Walls	Concrete deck, no insulation; Estimated to be U = 0.8; Unknown; Uninsulated brick wall assembly	R-38 above deck; New aluminum, double pane, low-e, argon filled, double hung; Door & window weatherstripping; Optional R-15 EIFS over-cladding	\$2,550, \$5,500, \$1,000, \$10,000	19%	\$2,550, \$4,500, \$1,000, \$10,000	0%***
heating	49%	Heating	Conventional hydronic boilers with Aquastat and baseboards	New conventional hydronic boilers with TRVs or zone valves; Heat Timer boiler controls with indoor temp feedback Real Time Energy Management (RTEM)	\$5,450, \$350, \$3,600	5%	\$9,350, \$9,350	52%***
cooling	26%	Cooling, Pumps, Pipe Insulation, Ventilation	Thru-wall ACs; (2) SHP single speed pumps; Some pipe insulation; Common Area: passive in-unit Bath: registers only in-unit Kitchen: passive via window	New thru-wall ENERGY STAR ACs; NEMA Premium pumps with VFDs; New pipe insulation; Direct drive, variable speed EC motor central exhaust fans with timers & CAR dampers	\$2,000, \$350, \$300, \$1,600	+12% WITH R-15 EIFS OVER-CLADDING	\$3,600, \$4,700, \$4,700	+0%*** WITH R-15 EIFS OVER-CLADDING
domestic hot water	26%	DHW	Heating hydronic boilers with Aquastat and small storage tank	Central air source heat pump (ASHP) with storage # T	\$8,050, \$600	23%	\$8,050, \$600	30%***
lighting	9%	Common Area, Exterior, In-unit	Predominately 4' T12; High wattage metal halide; T12 & incandescent	LEDs with occupancy/vacancy sensors; LEDs with photocells & timedlock; LEDs	\$600, \$1,000, \$1,000	1%	\$600, \$1,000, \$1,000	5%***
appliances	16%	Appliances	Non-ENERGY STAR refrigerators; Gas stoves; Central Laundry	ENERGY STAR refrigerators; ENERGY STAR refrigerators; (1) Non-ENERGY STAR washer (3) ENERGY STAR washers (3) Gas dryers	\$1,350, \$0, \$0	1%	\$950, \$0, \$0	13%***
renewables	None	None	None	62kW ballasted rooftop solar system	\$2,750	4%	\$2,750	0%
				electrical service and distribution upgrades; structural/finish upgrades including damage, patching, & sealing	\$3,200, \$10		\$6,400, \$4,950	
				2030 Emissions Factor	\$38,360	53%	\$56,050	100%
				2050 Emissions Factor	\$48,360	65%	\$66,050	100%

* Rough order of magnitude estimated costs based on current information at the time of publication that include material, labor, and mark-up. For more information, see the Decarbonization Roadmap for Multifamily Affordable Housing Best Practices Manual.

** Due to the conservativeness of the energy model, the GHG savings for envelope are attributed to the HVAC category for the 2050 scope.

*** Fully electrified systems in 2030 show a GHG savings increase in 2050 because of electrical grid transitioning to more clean energy sources.

**** GHG savings from envelope upgrades fall to zero once all related building systems and electrical and the electrical grid is fully decarbonized. However, improvements to the building envelope will reduce the need for heating and cooling, which saves energy and reduces operating costs.

Estimated cost per dwelling unit for individual ECMs and the total scope of work show the price associated with implementing each retrofit package.

Total GHG savings shows the percentage reduction of the baseline building emissions that results from implementing each retrofit package including the additional savings from the optional R-15 EIFS over-cladding.

Carbon Emissions Intensity graph depicts the emissions per square foot of the baseline building, the Low Carbon, and No Carbon retrofit packages.

Both retrofit packages are evaluated using the 2030 and 2050 emissions factors to show how emissions will reduce over time as the grid transitions towards clean energy sources.

LL97 emission caps are indicated in the graph to show how emissions from each scope of work compares to the increasingly stringent limits.

Decarbonization Roadmap for Multifamily Affordable Housing

- calculate carbon emissions
- compare to the LL97 emissions limits
- develop a retrofit master plan
- implement building decarbonization measures

carbon emissions intensity: post-1980 mid-rise

first year estimated savings (\$/DOU)

owners	\$320	\$400	\$95	\$200
tenants	\$10	\$50	\$0	\$10

key takeaways

- Simple low-cost retrofits can be a good fit for retrofit-type projects, but the high costs are an impediment to achieving deep decarbonization.
- Carbon retrofit packages would comply with LL97 2030 emissions limits. Adding PTHPs into existing AC systems, while retaining the existing gas/hydronic heating system, can provide cooling to vulnerable seniors while enabling a future cost-effective phase-out of fossil-fuels when the building is overlaid and/or the boiler is replaced to a heat pump.